SESSIONAL PAPERS

VOLUME 17

THIRD SESSION OF THE ELEVENTH PARLIAMENT

OF THE

DOMINION OF CANADA

SESSION 1911

VOLUME XLV.

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OF THE

PARLIAMENT OF CANADA

THIRD SESSION, ELEVENTH PARLIAMENT, 1911.

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2. Public Accounts of Canada, for the fiscal year ended 31st March, 1910. Presented 21st November, 1910, by Hon. William Paterson.
Printed for both distribution and sessional papers.

3. Estimates for the fiscal year ending 31st March, 1912. Presented 2nd December, 1910, by Rt. Hon. Sir Wilfrid Laurier... ..*Printed for both distribution and sessional papers.*

4. Supplementary Estimates for the fiscal year ending 31st March, 1911. Presented 6th February, 1911, by Hon. W. S. Fielding.
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5. Further Supplementary Estimates of sums required for the service of the Dominion for the year ending on 31st March, 1911. Presented 16th March, 1911, by Hon. W. S. Fielding.. .. ..*Printed for both distribution and sessional papers.*

5*a*. Further Supplementary Estimates for the year esding 31st March, 1911. Presented 8th May, 1911, by Hon. W. S. Fielding.
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5*b*. Further Supplementary Estimates for the fiscal year ended 31st March, 1911. Presented 3rd May, 1911, by Hon. W. S. Fielding.
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5*c*. Further Supplementary Estimates for the fiscl year ending 31st March, 1912. Presented 9th May, 1911. by Hon. W. S. Fielding.
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5*d*. Further Supplementary Estimates of sums required for the service of the Dominion for the year ending on 31st March, 1912. Presented 17th May, 1911, by W. S. Fielding.
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6. List of shareholders in the Chartered Banks of the Dominion of Canada as on December 31, 1910. Presented 10th April, 1911, by Hon. W. S. Fielding.
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7. Report on dividends remaining unpaid, unclaimed balances and unpaid drafts and bills of exchange in Chartered Banks of the Dominion of Canada, for five years and upwards prior to December 31, 1910. Presented 19th July, 1911, by Hon. William Templeman.. .. ..*Printed for both distribution and sessional papers.*

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8. Report of the Superintendent of Insurance, for the year ended 31st December, 1910.
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9. Abstract of Statements of Insurance Companies in Canada for the year ended 31st December, 1910. Presented 27th April, 1911, by Hon. W. S. Fielding.
Printed for distribution.

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10. Report of the Department of Trade and Commerce, for the fiscal year ended 31st March, 1910. Part 1, Canadian Trade. Presented 22nd November, 1910, by Rt. Hon. Sir Wilfrid Laurier.. .. ..*Printed for both distribution and sessional papers.*

10*a*. Report of the Department of Trade and Commerce, Part II. Canadian Trade with France, Germany, United Kingdom and United States. Presented 32nd November, 1910, by Rt. Hon. Sir Wilfrid Laurier.
Printed for both distribution and sessional papers.

10b. Report of the Department of Trade and Commerce, Part III. Canadian Trade with foreign countries, except France, Germany, the United Kingdom and United States Presented 22nd November, 1910, by Rt. Hon. Sir Wilfrid Laurier.
Printed for both distribution and sessional papers.

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10c, Report of the Department of Trade and Commerce for the fiscal year ended 31st March, 1910. Part IV, Canadian Trade, Miscellaneous. Presented 31st March, 1911, by Hon. W. S. Fielding.. .. ..*Printed for both distribution and sessional papers.*

10d. Report of the Department of Trade and Commerce for the fiscal year ended March 31st 1910. Part V, Grain Statistics, including the crop year ended August 31st 1910, and the season of navigation ended December 6th, 1910. Presented 12th May, 1911, by Hon. William Paterson....*Printed for both distribution and sessional papers.*

10e. Report of the Department of Trade and Commerce for the fiscal year ended 31st March, 1910, Part VI., Subsidized steamship services. Presented 20th April, 1911, by Hon. William Paterson.. .. ..*Printed for both distribution and sessional papers.*

10*f* Report of Trade and Commerce for the fiscal year ended 31st March, 1910, part VII.—Trade of foreign countries and Treaties and Conventions. Presented 31st March, 1911, by Hon. W. S. Fielding.. ..*Printed for both distribution and sessional papers.*

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19b. Report upon Reconnaisance Survey of the Nelson River, September-October, 1909. Presented 16th February, 1911, by Hon. William Pugsley.
Printed for both distribution and sessional papers.

20. Report of the Department of Railways and Canals, for the fiscal year ended 31st March, 1910. Presented 21st November, 1910, by Hon. G. P. Graham.
Printed for both distribution and sessional papers.

20a. (1909.) Canal Statistics for the season of navigation, 1909. Presented 21st March, 1910, by Hon. G. P. Graham .. .. ..*Printed for both distrbiution and sessional papers.*

20a. Canal Statistics for the season of navigation, 1910. Presented 10th April, 1911, by Hon. G. P. Graham.. .. ..*Printed for both distribution and sessional papers.*

20b. Railway Statistics of the Dominion of Canada, for the year ended 30th June, 1910. Presented 16th December, 1910, by Hon. G. P. Graham.
Printed for both distribution and sessional papers.

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20c. Fifth Report of the Board of Railway Commissioners for Canada, for the year ending 31st March, 1910. Presented 21st November, 1910, by Hon. G. P. Graham.
Printed for both distribution and sessional papers.

21. Report of the Department of Marine and Fisheries (Marine, 1910. Presented 21st November, 1910, by Hon. L. P. Brodeur.
Printed for both distribution and sessional papers.

21a. Report of the Geographic Board of Canada containing all decisions to 30th June, 1910.
Printed for both distribution and sessional papers.

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21b. Report on Ice formation in the St. Lawrence River, and Report of the influence of Icebergs on the temperature of the Sea as shown by use of the Micro-Thermometer in a trip to Hudson Strait and Bay in July, 1910, by H. T. Barnes, D.Sc., F.R.S.C. Presented 16th May, 1911, by Hon. S. A. Fisher.
Printed for both distribution and sessional papers.

21c. List of Shipping issued by the Department of Marine and Fisheries, being a list of vessels on the registry books of Canada, on 31st December, 1910. Presented 19th July, 1911, by Hon. L. P. Brodeur.
Printed for both distribution and sessional papers.

22. Report of the Department of Marine and Fisheries (Fisheries), 1910. Presented 21st November, 1910, by Hon. L. P. Brodeur.
Printed for both distribution and sessional papers.

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23. Report of the Harbour Commissioners, &c., to 31st December, 1910.
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23a. Report of the Chairman of the Board of Steamboat Inspection, for the fiscal year 1910. Presented 21st November, 1910, by Hon. L. P. Brodeur.
Printed for both distribution and sessional papers.

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24. Report of the Postmaster General for the year ended 31st March, 1910. Presented 22nd November, 1910, by Rt. Hon. Sir Wilfrid Laurier.
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25. Report of the Department of the Interior, for the fiscal year ending 31st March, 1910. Presented 21st November, 1910, by Hon. Frank Oliver.
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25*a*. Report of the Chief Astronomer, Department of the Interior, for year ending 31st. March, 1910.. .. ..*Printed for both distribution and sessional papers.*

25*b*. Annual Report of the Topographical Surveys Branch, Department of the Interior, 1909-10. Presented 31st March, 1911, by Hon. Frank Oliver.
Printed for both distribution and sessional papers.

25*c*. Report of Dr. P. H. Bryce, Chief Medical Officer, Appendix to Report of Superintendent of Immigration. Presented 9th. December, 1910, by Hon. Frank Oliver.
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25*d*. Report of the Hydrographic Survey (Streams measurement). Department of the Interior.. .. ..*Printed for both distribution and sessional papers.*

26. Summary Report of the Geological Survey Branch, Department of Mines, for Calendar year 1910. Presented 19th. July, 1911, by Hon. William TeTmpleman.
Printed for both distribution and sessional papers.

26*a*. (1909) Summary Report of the Mines Branch of Department of Mines, for the calendar year, 1909. Presented 26th. January, 1911, by Hon. William Templeman.
Printed for both distribution and sessional papers.
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27. Report of the Department of Indian Affairs, for the year ended 31st March, 1910. Presented 21st November, 1910, by Hon. Frank Oliver.
Printed for both distribution and sessional papers.

28. Report of the Royal Northwest Mounted Police, 1910. Presented 2nd December, 1910, by Rt. Hon. Sir Wilfrid Laurier..*Printed for both distribution and sessional papers.*

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29. Report of the Secretary of State of Canada for the year ended 31st March, 1910. Presented 21st November, 1910, by Hon. Charles Murphy.
Printed for both distribution and sessional papers.

29a. (No issue).

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testing against or unfavourable to the same, and a copy of all correspondence had with the Government, or any member thereof, concerning reciprocity with the United States, since the 1st January, 1910. Presented 28th March, 1911.—*Hon. Mr. Foster.* *Not printed.*

59*j*. Further supplementary return to an Address of the House of Commons, dated 7th December, 1910, for a copy of all petitions, memorials and resolutions from individuals, Boards of Trade or other bodies and corporations, favouring or asking for a treaty of reciprocity with the United States; and also of all similar documents protesting against or unfavourable to the same, and a copy of all correspondence had with the government, or any member thereof, concerning reciprocity with the United States, since the 1st January, 1910. Presented 28th March, 1911.—*Hon. Mr. Foster.* *Not printed.*

59*k*. Further supplementary return to an Address of the House of Commons, dated 7th December, 1910, for a copy of all petitions, memorials and resolutions from individuals, Boards of Trade or other bodies and corporations, favouring or asking for a treaty of reciprocity with the United States; and also of all similar documents protesting against or unfavourable to the same, and a copy of all correspondence had with the Government, or any member thereof, concerning reciprocity with the United States, since the 1st January, 1910. Prsented 31st March, 1911.—*Hon. Mr. Foster.* *Not printed.*

59*l*. Further supplementary return to an Address of the House of Commons, dated 7th December, 1910, for a copy of all petitions, memorials and resolutions from individuals, Boards of Trade or other bodies and corporations, favouring or asking for a treaty of reciprocity with the United States; and also of all similar documents protesting against or unfavourable to the same, and a copy of all correspondence had with the government, or any member thereof, concerning reciprocity with the United States, since the 1st January, 1910. Presented 7th April, 1911.—*Hon. Mr. Foster.* *Not printed.*

59*m*. Further supplementary return to an Address of the House of Commons, dated 7th December, 1910, for a copy of all petitions, memorials and resolutions from individuals, Boards of Trade or other bodies and corporations, favouring or asking for a treaty of reciprocity with the United States; and also of all similar documents protesting against or unfavourable to the same, and a copy of all correspondence had with the Government, or any member thereof, concerning reciprocity with the United States, since the 1st January, 1910. Presented 19th April, 1911.—*Hon. Mr. Foster.* *Not printed.*

59*n*. Further supplementary return to an Address of the House of Commons, dated 7th December, 1910, for a copy of all petitions, memorials and resolutions from individuals, Boards of Trade or other bodies and corporations, favouring or asking for a treaty of reciprocity with the United States; and also of all similar documents protesting against or unfavourable to the same, and a copy of all correspondence had with the Government, or any member thereof, concerning reciprocity with the United States, since the 1st January, 1910. Presented 19th April, 1911.—*Hon. Mr. Foster.* *Not printed.*

59*o*. Further supplementary return to an Address of the House of Commons, dated 7th December, 1910, for a copy of all petitions, memorials and resolutions from individuals, boards of trade or other bodies and corporations, favouring or asking for a treaty of reciprocity with the United States. and also of all similar documents pro-

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testing against or unfavourable to the same, and a copy of all correspondence had with the Government, or any member thereof, concerning reciprocity with the United States, since the 1st January, 1910. Presented 2nd May, 1911.—*Hon. Mr. Foster.* *Not printed.*

59*p*. Further supplementary return to an Address of the House of Commons, dated 7th December, 1910, for a copy of all memorials and resolutions from individuals, Boords of Trade or other bodies and corporations, favouring or asking for a treaty of reciprocity with the United States; and also of all similar documents protesting against or unfavourable to the same, and a copy of all correspondence had with the Government, or any member thereof, concerning reciprocity with the United States, since the 1st January, 1910. Presented 5th May, 1911.—*Hon. Mr. Foster.* *Not printed.*

59*q*. Return to an Order of the House of Commons, dated 19th April, 1911, for a Return showing what duties are imposed by Australia, New Zealand, Norway, France, Spain, Sweden, Switzerland, Austria-Hungary, Japan, Argentine, Venezuela and Russia, respectively, upon each of the articles included in the reciprocity agreement between the United States and Canada.

And also, a statement showing the import prices in 1910 on which duty was collected on the butter, eggs cheese, salt, beef, bacon, hams, mutton, lamb, pork in brine and other meat products detailed, barley, beans, oats, peas, wheat, hay, flaxseed, green apples, and animals, imported from the above named countries. Presented 8th May, 1911.—*Hon. Mr. Foster*.. .. ..*Not printed.*

59*r*. Return to an order of the House of Commons, dated 8th May, 1911, for a Return showing, taking the latest Return of Commerce and Navigation of the United States as a basis, the advantage Canada will have in the United States market over her principal competitors, under the construction given at Washington by the United States Court of Customs Appeals on April 10th, 1911, regarding the favoured nation clause, by which the competitors of Canada in the United States market are denied the privileges granted to Canada by the reciprocal agreement in regard to the importation into the United States of the following goods and articles, namely: (*a*) Mackerel pickled or salted; (*b*) Herring, pickled; (*c*) Cod, Haddock, Hake and Pollock, dried, smoked, salted or pickled; (*d*) all other kinds of fish, salted or pickled; (*e*) Fish oils: (*f*) Butter; (*g*) Cheese; (*h*) Cattle; (*i*) Horses; (*j*) Oats; (*k*) Coke; (*l*) Mineral Waters; (*m*) Rolled Iron or Steel Sheets, coated with zinc, tin or other metal; (*n*) Mica; (*o*) Flax seed; (*p*) Beans and dried peas; (*q*) Onions; (*r*) Potatoes; (*s*) other vegetables in natural state.

Also showing the present rate of duty in the United States on the above goods and articles; the rate under the proposed reciprocal agreement of the said goods and articles; the value of goods; and the amount of duty collected on goods imported from said competitors on the trade of said year, which will be free under the agreement on goods from Canada. Presented 16th May, 1911.—*Mr. Sinclair*..*Not printed.*

59*s*. Further supplementary Return to an Address of the House of Commons, dated 7th December, 1910, for a copy of all memorials and resolutions from individuals, Boards of Trade or other bodies and corporations, favouring or asking for a treaty of reciprocity with the United States; and also of all similar documents protesting against or unfavourable to the same, and a copy of all correspondence had with the Government, or any member thereof, concerning reciprocity with the United States, since the 1st January, 1910. Presented 19th May, 1911.—*Hon. Mr. Foster*...*Not printed.*

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59*t*. Statements relative to (1) The yearly imports, quantity and value, for the past six years into Canada from, respectively, Australia, New Zealand, Denmark, Holland, Belgium, France, Argentine Republic and the United States, of wheat, oats, horses, cattle, sheep, lambs, mutton, beef, eggs, butter, cheese, fowl, vegetables and fruit.

(2) The average prices of butter and of eggs in London, England, for the past five years in comparison with the prices, respectively, in Eastern Provinces, in Montreal, in Toronto, in Minneapolis, in Chicago, in Detroit, in Buffalo, in Boston and in New York. Presented 28th July, 1911, by Hon. S. A. Fisher.. .. .. .. *Not printed.*

60. Return of orders in council passed between the 1st of November, 1909, and the 30th September, 1910, in accordance with the provisions of section 5 of the Dominion Lands Survey Act, Chapter 21, 7-8 Edward VII. Presented 11th January, 1911, 1911, by Hon. Frank Oliver.. .. .. *Not printed.*

60*a*. Return of Orders in Council which have been published in the *Canada Gazette* and in the British Columbia *Gazette*, between 1st November, 1909, and 30th September, 1910, in accordance with provisions of subsection (*d*) of section 38 of the regulations for the survey, administration, disposal and management of Dominion Lands within the 40-mile railway belt in the province of British Columbia. Presented 11th January, 1911, by Hon. Frank Oliver.. .. .. *Not printed.*

60*b*. Return called for by section 77 of the Dominion Lands Act, chapter 20 of the Statutes of Canada, 1908, which is as follows:—

"77. Every regulation made by the Governor in Council, in virtue of the provisions of this Act, and every order made by the Governor in Council, authorizing the sale of any land or the granting of any interest therein, shall have force and effect only after it has been published for four consecutive weeks in the *Canada Gazette*, and all such orders or regulations shall be laid before both Houses of Parliament within the first fifteen days of the session next after the date thereof, and such regulations shall remain in force until the day immediately succeeding the day of prorogation of that session of Parliament, and no longer, unless during that session they are approved by resolution of both Houses of Parliament." Presented 11th January, 1911, by Hon. Frank Oliver.. .. .. *Not printed.*

61. Return of Orders in Council passed between the 1st November, 1909, and the 30th September, 1910, in accordance with the provisions of the Forest Reserve Act, sections 7 and 13 of Chapter 56, Revised Statutes of Canada. Presented 11th January, 1911, by Hon. Frank Oliver.. .. .. *Not printed.*

62. Return to an order of the House of Commons, dated the 7th December, 1910, for a copy of Sir John Thompson's memorandum on the question of the rights of fishing in the bays of British North America, prepared for the use of the British Plenipotentiaries at Washington in 1888 , and a copy of the Treaty agreed to and approved by the President. Presented 11th January, 1911.—*Hon. Mr. Foster.*

Printed for sessional papers.

63. Return to an Address of the House of Commons, dated 7t7h December, 1910, for a copy of any memorials, correspondence, &c., between His Excellency the Governor General and the Colonial Office, or between any member of the government, and the foreign consuls general in Canada, relative to the status of the latter, at official functions, such as the vice-regal drawing room. Presented 11th January, 1911.—*Mr. Sproule.*

Printed for sessional papers.

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64. Return to an order of the House of Commons, dated 6th December, 1910, for a return showing:—1. What newspapers or companies publishing newspapers in the cities of Montreal and Quebec have directly or indirectly received sums from the Government of Canada for printing, lithographing, binding or other work, between the 31st March, 1910, and the 15th November, following.

2. What is the total amount paid to each of said newspapers or companies between the dates above stated. Presented 11th January, 1911.—*Mr. Monk.. .. ..Not printed.*

65. Return to an Address of the House of Commons, dated 7th December, 1910, for a copy of all Orders in Council, correspondence, papers, maps or other documents, which passed between the Government of Canada or any member thereof, and the Government of Quebec, or any member thereof, or any other parties on their behalf, or between the Government of Canada and the Government of Ontario, or any members thereof, regarding the extension of the boundaries of the province of Quebec, as set forth in an Order in Council dated 8th July, 1896, establishing a conventional boundary, therein specified. And also any correspondence, papers, documents, &c., that may have passed between the aforesaid governments or members thereof, relative to the passing of an Act to confirm and ratify the aforesaid conventional boundary, which was passed in 1898. Presented 11th January, 1911.—*Mr. Sproule.*

Printed for sessional papers.

66. Return to an Order of the House of Commons, dated 14th December, 1910, for a Return showing the names of manufacturers in Canada of turned kiln dried maple boot, last and shoe last blocks, in the rough, for making manufacturers' boot and shoe lasts. Presented 11th January, 1911.—*Mr. Hughes.. .. ..Not printed.*

67. Return to an Order of the House of Commons, dated 5th December, 1910, for a copy of all correspondence, reports, memorials, surveys and other papers in the possession of the Government, and not already brought down, regarding the oyster industry of Canada; also a copy of all correspondence, reports and other papers regarding the ownership and control of Oyster beds and of barren bottoms suitable for Oyster culture, and regarding the consolidating of the ownership with the control and regulation of such beds and barren bottoms, and vesting the same in the hands of the Dominion Government; olso a copy of all correspondence, reports, recommendations and other papers relating to the leasing or sale of such beds or barren bottoms or of portions of them, for the purpose of Oyster culture or cultivation. Also o copy of all correspondence and reports relating to the culture, cultivation asd conservation of oysters and other mollusks. Presented 11th January, 1911.—*Mr. Warburton.*

Printed for sessional papers.

68. Order of the House of Commons, dated 5th December, 1910, for a copy of all reports, evidence, correspondence, and other documents relating to an investigation into irregularities in the life saving station at Clayoquot, mentioned on page 353 of the Report of the Department of Marine and Fisheries for 1909 and 1910, sessional paper No. 22. Presented 11th January, 1911.—*Mr. Barnard.. .. ..Not printed.*

69. Return to an Order of the House of Commons, dated 14th December, 1910, for a Return showing how many employees of the custom house at Montreal have left the service since the 1st July, 1896, up to this date, with their names, duties, salaries and ages, respectively, and date of their leaving; the names, ages, salaries and duties of those who have replaced them, the date of their entry and their present salaries. Presented 11th January, 1911.—*Mr. Wilson (Laval).. .. ..Not printed.*

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76. Return to an Order of the House of Commons, dated 14th December, 1910, for a Return showing all applications made to the Government during the period of agreement with Japan concerning Japanese immigrants, to admit such immigrants for special purposes, together with a copy of all correspondence in connection with the same. Presented 12th January, 1911.—*Mr. Taylor (New Westminster)*.. .. .. ..*Not printed.*

76a. Return to an Order of the House of Commons, dated 7th December, 1910, for a Return giving a list of the special immigration agents appointed by the government since the 31st March, 1909, in what portions of Great Britain and Irelond, the European Continent, or other country they are severally located, their addresses when they were so appointed the date of their appointment in each case their respective salaries and expenses, and any commissions that may have been paid to each or any since their appointment. Presented 12th January, 1911.—*Mr. Wilson (Lennox and Addington)*.. .. ..*Not printed.*

76b. Return to an Order of the House of Commons, dated 11th January, 1911, for a Return showing the number of immigrants who have come to Canada since the 31st March last up to the present time, the countries from which they came, the number from each such country, the number of males and the number of females in each case, the number under fourteen years of age, between fourteen and twenty-one years, between twenty-one and forty, and between forty and sixty in each case, their occupations before coming to Canada, their religion, their destination in Canada, their occupation when they arrived at such destination; also the number who have been prevented from landing, and the number deported. Presented 6th February, 1911.—*Mr. Wilson (Lennox and Addington)*.. .. ..*Not printed.*

76c Return to an Order of the Senate dated 24th January, 1911, calling for the production in detail of the accounts and claims fyled at the Department of the Interior or the Immigration Office, Quebec, by Mr. Jacques Dery; restaurant keeper, during the navigation season of 1910. Presented 7th February, 1911.—*Hon. Mr. Landry.* *Not printed.*

76d. Return to an Order of the Senate dated 20th January, 1911, calling for the report received by the Immigration Department on the subject of the complaints brought against Mr. Jacques Dery, the keeper of the restaurant established in the immigration buildings at Quebec, and also of the correspondence exchanged and the inquiry held by the immigration agent with regard to the overcharges by the restaurant keeper, and of the refund which he had to make to immigrants of the price obtained for goods of bad quality. Presented 7th February, 1911.—*Hon. Mr. Landry.* *Not printed.*

76e. Return to an Order of the Senate dated 25th January, 1911, for the production of a complaint, signed by a large number of persons employed at the Immigration Office and Immigration buildings at Quebec and addressed to the agent of the Department at that place, against Mr. Jacques Dery, the restaurant keeper, and also of the reply of the latter. Presented 7th February, 1911.—*Hon. Mr. Landry*.. .. .. ..*Not printed.*

76f. Return to an Order of the Senate dated 25th January, 1911, that an Order of this House do issue for the production of a letter dated 1st June, 1910, written by Mr. L. Stein, of Quebec, addressed to Mr. W. D. Scott, Superintendent of Immigration. Presented 10th February, 1911.—*Hon. Mr. Landry*.. .. ..*Not printed.*

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76*g*. Return to an Order of the House of Commons, dated 3rd April, 1911, for a Return showing the itemized accounts, vouchers, statements, reports and other papers relating to the salary and expenses of and payments to W. O. Creighton, farmer delegate to Great Britain in 1910. Presented 28th April, 1911.—*Mr. Stanfield.. .. ..Not printed*

76*h*. Return to an Order of the House of Commons, dated 3rd April, 1911, for a Return showing all itemized accounts, vouchers, statements, reports and other papers relating to the salary of and payments to W. A. Hickman. immigration agent to Great Britain in 1902 and 1903. Presented 28th April, 1911.—*Mr. Stanfield.. .. ..Not printed.*

77. Return to an Order of the House of Commons, dated 5th December, 1910, for a Return showing:—1. The estimated quantity of each class of material required for the construction.

2. The rates or prices agreed upon and the estimated cost of each class of material, based on rates on accepted tender.

3. The total estimated cost based on these quantities and rates in each case of the several bridges let to contract during the fiscal year ended March 31, 1910, referred to on pages 3 and 4 of the Sixth Annual Report of the Commissioners of the Transcontinental Railway.

4. A copy of the specifications and contract in each case, the number of the contract and the name of the contractor.

5. The number of bridges yet to be let to contract, location and character, and the estimated quantity of the different kinds of material in each case.

6. Why these bridges have not been let to contract and when contracts will probably be entered into as to these.

7. The bridges let to contract before March 31, 1909, identified by locality, name of each contractor and number, the estimated cost of each of these bridges at the time the contract was let, based on contract prices, the changes made in the plans, specifications or contracts if any, and claims or allowances for alterations or extras, if any, the percentage of the work done, the payments made to date, the amounts retained as contract reserve, and the ascertained or estimated amount required to complete in each case.

8. The bridges that have been completed, identified as above, the estimated cost at the time of awarding the contract, the nature and extent of changes in plans, specifications, or contract, if any, the increase or decrease of cost thereby occasioned, and the actual total cost of each of those bridges. Presented 13th January, 1911.—*Mr. Lennox.. .. ..Not printed.*

77*a*. Return to an Order of the House of Commons, dated 5th December, 1910, for a copy of the Tender and contract of Haney, Quinlan & Robertson for construction of locomotive and other shops about six miles east of Winnipeg, and the total estimated cost based on contract prices. Also a copy of the several other tenders sent in and a statement of the total estimated cost based upon each of these tenders as moneyed out at the time of awarding the contract. Presented 13th January, 1911.—*Mr. Lennox.. .. ..Not printed*

77*b*. Return to an Order of the House of Commons, dated 11th January, 1911, for a Return showing as to each contract district of the National Transcontinental Railway between Moncton and Winnipeg, respectively, what was the original departmental estimate of quantities of solid rock, broken stone, earth, sand, &c., and the quantities of each kind of excavation, as above, already paid for. Presented 24th January, 1911.—*Mr. Ames.. .. ..Not printed.*

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83*b*. Return to an order of the House of Commons, dated 5th December, 1910, showing all data, statements, estimates, recommendations and reports with regard to an Intercolonial railway renewal equipment account, and as to the initiation of such account and the operation thereof to the present time.

2. A copy of all correspondence with the Auditor General and other persons in regard thereto.

3. A copy of all correspondence, inquiries and investigations by or on behalf of the Auditor General as to the need for such account, and as to the sufficiency or otherwise of moneys carried to such account, and also as to the application of such moneys.

4. The same returns as to the maintenance of rails account; and the same returns as to a maintenance of bridges account, also as to any other items of maintenance, and as to any recommendations regarding the adoption of such accounts. Presented 16th January, 1911.—*Mr. Barker*.. .. ..*Not printed.*

83*c*. Return to an order of the Senate dated 4th May, 1910, calling for the following information:—

1. Were tenders asked for, in 1908 and 1909, for the purchase of railway sleepers for the use of the Intercolonial railway, and were contracts awarded to the lowest tenderer?

2. Who had these contracts, and what is the name of each tendered, and also the amount of each tender?

3. Did the Department of Railways and Canals, in 1908 and 1909, award any contracts whatsoever for the purchase of the said sleepers and what price was paid to each contractor, and who had these contracts?

4. In 1908 and 1909, did the Department of Railways and Canals ask for tenders for the purchase of sleepers made of spruce, white, gray and yellow, as well as of birch, ash, poplar, &c.?

5. What quantity of these sleepers, for each kind of wood, was accepted and paid for in 1908 and 1909, and does the department propose to continue the system of purchasing these kinds of wood?

6. Who bought these sleepers of spruce, birch, ash, poplar, &c., and who gave the orders to receive these kinds of sleepers, and who received them and stamped them for the Intercolonial railway?

7. In 1909, did the department ask for tenders for sleepers of cedar, cyprus and hemlock? If so, who had these contracts and were these contracts granted to the lowest bidders, and what quantities were actually furnished by each contractor?

8. What quantity of sleepers has been furnished up to this date—

(*a*) by the contractors for New Brunswick; and

(*b*) by the contractors for Nova Scotia and for the province of Quebec, respectively?

9. Did the government by order in council authorize Messrs. Pottinger, Burpee or Taylor of Moncton, to purchase sleepers of spruce of all kinds and dimensions, and to cause these kinds of sleepers to be distributed in the district of Quebec, and notably in the district of River du Loup and Isle Verte?

10. What price did the department pay for the sleepers of spruce, hemlock, cedar, birch and poplar, &c.? Who is the contractor therefor? Who received and inspected the said sleepers?

11. Does the department know that these sleepers are absolutely unfit to be used in a railway, and that these sleepers are at the present time distributed along the Intercolonial railway to be used upon the main track?

CONTENTS OF VOLUME 23—*Continued.*

12. How much a carload does the freight of sleepers sent from New Brunswick cost in the district of Quebec? Presented 3rd February, 1911.—*Hon. Mr. Landry.* *Not printed.*

84. Return to an order of the House of Commons, dated 11th January, 1911, for a return showing the respective quantities of each of the staple varieties of fish landed by Canadian Atlantic fishermen yearly, since 1870, and the respective yearly values thereof. Presented 16th January, 1911.—*Mr. Jameson*.. .. ..*Not printed.*

85. Return to an order of the House of Commons, dated 7th December, 1910, for a copy of all letters, telegrams, correspondence, resolutions, memorials, reports, and all other papers in the possession of the government, not already brought down, regarding otter, beaver, or steam trawling, and the operations of the trawlers *Wren* and *Coquette* in the waters of the Northumberland strait, or elsewhere, in Nova Scotia. Presented 16th January, 1911.—*Mr. Chisholm (Antigonish)*.. .. ..*Not printed.*

86. Return to an order of the House of Commons, dated 7th December, 1910, for a return showing the revenue of the post offices of Acton Vale, Upton and St. Pie, in the county of Bagot, province of Quebec, since the year 1903 up to 1910 inclusively. Presented 17th January, 1911.—*Mr. Monk*.. .. ..*Not printed*

86a. Return to an order of the House of Commons, dated 16th January, 1911, for a copy of all instructions or communications from the Department of Public Works or any officer thereof, or the minister of public works. to the chief architect, or any other architect, with respect to the preparation of plans for the construction of a post office building at Parrsboro, Nova Scotia, and all other post office buildings or public buildings to be used wholly or in part by the Post Office Department, for which votes have been passed during the period from 1st January, 1908, to 31st December, 1910. Presented 20th April, 1911.—*Mr. Rhodes*.. .. ..*Not printed.*

87. Return to an address of the Senate dated 22nd April, 1910, for:—

1. Copies of all orders in council or of every order of the Department of Justice and of the Department of Public Works, and of all the correspondence exchanged between the government, the Departments of Justice and Public Works, the Bank of Montreal, the firm of Carrier & Lainé, of Lévis, and all other persons, on the subjects of—

(*a*) The acquisition by the government of the property of the firm of Carrier & Lainé, at the time of the sale thereof by the sheriff in 1908;

(*b*) the subsequent expropriation, for purposes of public utility, of the same property, which had fallen into the hands of the bank of Montreal;

(*c*) its definite purchase from the Bank of Montreal by the government;

(*d*) the appointment of an agent to represent the government at the sale by the sheriff;

(*e*) the appointment of experts for proceeding with the expropriation of the lands in question;

2. Copies of all reports submitted, directly or indirectly, to the government, or in its possession, by the experts hereinbefore mentioned, or by the arbitrators to whom the Bank of Montreal and the firm of Carrier & Lainé had submitted their differences, or by the various advocates or agents acting in the name and in the interests of the government.

3. Copies of the various contracts entered into between La Banque du Peuple and the People's Bank of Halifax in 1905, between the government and the bank of Montreal, in 1909, between the government and Mr Ernest Cann, who had become the

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lessee of the government, for a period of thirty years, of the lands and buildings formerly the property of Carrier & Lainé.

4. Copies of all documents whatsoever and of a correspondence relating to the various transactions aforesaid, and also a statement showing all the sums of money paid by the government with respect to such transactions, with the names of the persons to whom such sums were paid, and the amounts paid to each of them, and for what particular object. Presented 11th January, 1911.—*Hon. Mr. Landry-* *Not printed.*

87*a*. Supplementary return to an address of the Senate dated 22nd April, 1910, for:—

1. Copies of all orders in council or of every order of the department of justice and of the department of public works, and of all the correspondence exchanged between the government, the department of justice and public works, the bank of Montreal, the firm of Carrier & Lainé, of Lévis, and all other persons, on the subject of—

(*a*) The acquisition by the government of the property of the firm of Carrier & Lainé. at the time of the sale thereof by the sheriff in 1908;

(*b*) the subsequent expropriation, for purposes of public utility, of the same property, which had fallen into the hands of the Bank of Montreal;

(*c*) its definite purchase from the bank of Montreal by the government;

(*d*) the appointment of an agent to represent the government at the sale by the sheriff;

(*e*) the appointment of experts for proceeding with the expropriation of the lands in question;

2. Copies of all reports submitted, directly or indirectly, to the government, or in its possession, by the experts hereinbefore mentioned, or by the arbitrators to whom the bank of Montreal and the firm of Carrier & Lainé had submitted their differences, or by the various advocates or agents acting in the name and in the interests of the government.

3. Copies of the various contracts entered into between La Banque du Peuple, and the People's Bank of Halifax in 1905, between the government and the bank of Montreal, in 1909, between the government and Mr. Ernest Cann, who had become the lessees of the government, for a period of thirty years, of the lands and buildings formerly the property of Carrier & Lainé.

4. Copies of all documents whatsoever and of all correspondence relating to the various transactions aforesaid. and also a statement showing all the sums of money paid by the government with respect to such transactions, with the names of the persons to whom such sums were paid, and the amounts paid to each of them, and for what particular object. Presented 18th January, 1911.—*Hon. Mr. Landry.* *Not printed.*

87*b*. Further supplementary return to an address of the Senate dated 22nd April, 1910, for—

1. Copies of all orders in council or of every order of the Department of Justice and of the Department of Public Works, and of all the correspondence exchanged between the government, the Departments of Justice and Public Works, the Bank of Montreal, the firm of Carrier & Lainé, of Lévis, and all other persons, on the subjects of—

(*a*) The acquisition by the government of the property of the firm of Carrier & Lainé, at the time of the sale thereof by the sheriff in 1908;

(*b*) the subsequent expropriation, for purposes of public utility, of the same property, which had fallen into the hands of the bank of Montreal;

(*c*) its definite purchase from the Bank of Montreal by the government;

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(*d*) the appointment of an agent to represent the government at the sale by the sheriff;

(*e*) the appointment of experts for proceeding with the expropriation of the lands in question;

2. Copies of all reports submitted, directly or indirectly, to the government, or in its possession, by the experts hereinbefore mentioned, or by the arbitrators to whom the Bank of Montreal and the firm of Carrier & Lainé had submitted their differences, or by the various advocates or agents acting in the name and in the interests of the government.

3. Copies of the various contracts entered into between La Banque du Peuple and the People's Bank of Halifax in 1905, between the government and the Bank of Montreal in 1909, between the government and Mr. Ernest Cann, who had become the lessee of the government, for a period of thirty years, of the lands and buildings formerly the property of Carrier & Lainé.

4. Copies of all documents whatsoever and of all correspondence relating to the various transactions aforesaid, and also a statement showing all the sums of money paid by the government with respect to such transactions, with the names of the persons to whom such sums were paid, and the amounts paid to each of them, and for what particular object. Presented 27th January, 1911.—*Hon. Mr. Landry.*

Not printed.

87*c*. Supplementary return to an address of the Senate dated 22nd April, 1910, for copies:—

1. Copies of all orders in council or of every order of the Department of Justice and of the Department of Public Works; and of all the correspondence exchanged between the government, the Departments of Justice and Public Works, the Bank of Montreal, the firm of Carrier & Lainé, of Lévis, and all other persons, on the subjects of—

(*a*) The acquisition by the government of the property of the firm of Carrier & Lainé, at the time of the sale thereof by the sheriff in 1908;

(*b*) the subsequent expropriation, for purposes of public utility, of the same property, which had fallen into the hands of the bank of Montreal;

(*c*) its definite purchase from the Bank of Montreal by the government;

(*d*) the appointment of an agent to represent the government at the sale by the sheriff;

(*e*) the appointment of experts for proceeding with the expropriation of the lands in question;

2. Copies of all reports submitted, directly or indirectly, to the government, or in its possession, by the experts hereinbefore mentioned, or by the arbitrators to whom the Bank of Montreal and the firm of Carrier & Lainé had submitted their differences, or by the various advocates or agents acting in the name and in the interests of the government.

3. Copies of the various contracts entered into between La Banque du Peuple and the People's Bank of Halifax in 1905, between the government and the Bank of Montreal in 1909, between the government and Mr. Ernest Cann, who had become the lessee of the government, for a period of thirty years, of the lands and buildings formerly the property of Carrier & Lainé.

4. Copies of all documents whatsoever and of all correspondence relating to the various transactions aforesaid, and also a statement showing all the sums of money paid by the government with respect to such transactions, with the name of the persons to whom such sums were paid, and the amounts paid to each of them, and for what particular object. Presented 7th February, 1911.—*Hon. Mr. Landry.*

Not printed.

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87*d* Return to an order of the Senate dated 9th March, 1911, for a return of copy of the contract entered into between the Bank of Montreal and the People's Bank of Halifax, in 1905, in connection with the financial situation and with the obligations of the firm of Carrier-Laine, a copy of which contract was handed over to the government at the time of the financial transactions concluded between the Bank of Montreal and the government in 1909. Presented 4th April, 1911.—*Hon. Mr. Landry.* *Not printed.*

88. Return to an address of the Senate dated 24th November, 1910, for copies of all orders in council, memoranda or other correspondence respecting the resignation of the present Lieutenant Governor of the province of Quebec, the apopintment of his successor, the application for leave of absence, and the appointment of an administrator during the absence from the country of His Honour Sir Pantaleon Pelletier. Presented 11th January, 1911.—*Hon. Mr. Landry*.. .. ..*Not printed.*

88*a*. Return to an address of the Senate dated 8th February, 1911, for a copy of the order in council extending, for a period of two months, the leave of absence already obtained by Sir Pantaleon Pelletier, together with copy of all the correspondence on the subject between the government, His Honour the Lieutenant Governor of the province of Quebec, and the present administrator of the said province. Presented 14th February, 1911.—*Hon. Mr. Landry*.. .. ..*Not printed.*

89. Return to an order of the House of Commons, dated 16th January, 1911, for a copy of all correspondence, letters, telegrams, reports and papers of every description between the liquidators of the Charing Cross Bank or of A. W. Carpenter or anyone on their behalf, and any member of the government, or official thereof, regarding the affairs of the Atlantic, Quebec and Western railway, the Quebec Oriental railway, or the new Canadian Company, limited. Presented 18th January, 1911.—*Mr. Ames.* *Not printed.*

90. Return to an order of the House of Commons, dated 14th December, 1910, for a return showing how many wireless telegraph stations are owned by the government where are they located, the cost of each, and the revenue derived from each; what stations are leased, to whom they are leased, the amount of rental received each year and the period covered by said lease. Presented 18th January, 1911.—*Mr. Armstrong.* *Not printed.*

91. Return to an order of the House of Commons, dated 15th March, 1910, for a return showing the names of all persons who have been fined for breach of fisheries regulations in the coast waters of the counties of Pictou and Cumberland, Nova Scotia, and Westmorland, New Brunswick, during the years 1907, 1908 and 1909, together with a full statement of the penalties inflicted, moneys collected, and fines or portion thereof remitted, if any, in each case, and for a copy of all instructions issued, reports, correspondence and documents relating in any manner thereto. Presented 18th January, 1911.—*Mr. Rhodes*.. .. ..*Not printed.*

91*a*. Return to an order of the House of Commons, dated 11th January, 1911, for a return showing the names of all persons who have been fined for breach of fishery regulations in the coast waters of Prince Edward Island since the year 1900 up to this date, together with a statement of the penalties inflicted, moneys collected, and fines or portions thereof remitted, in each case; and for a copy of all instructions issued, reports, correspondence and documents relating in any manner thereto. Presented 6th March, 1911.—*Mr. Fraser*.. .. ..*Not printed.*

CONTENTS OF VOLUME 23—*Continued.*

92. Return to an order of the House of Commons, dated 16th January, 1911, for a copy of the mailing list, and names of all parties to whom the Department of Labour mailed or otherwise sent copies of the *Labour Gazette* during the year 1910, and of the names of all correspondents that report to the department on labour topics for the purposes of the *Labour Gazette.* Presented 18th January, 1911.—*Mr. Currie* (*Simcoe*). *Not printed.*

93. Return to an order of the House of Commons, dated 7th December, 1910, for a copy of all correspondence and other papers and documents that have passed between the government and any party or parties during the past year in connection with the dredging of the Napanee river; also any instruction given by the minister in connection therewith? Presented 18th January, 1911.—*Mr. Wilson* (*Lennox and Addington*)... *Not printed.*

93*a*. Return to an address of the House of Commons, dated 12th December, 1910, for a copy of all correspondence, specifications, tenders, orders in council, and other papers relating to a contract or contracts entered into by the Department of Public Works for dredging in Miramichi Bay, New Brunswick, since the close of the last fiscal year. Presented 13th February, 1911. *Mr. Crocket*... *Not printed.*

93*b*. Return to an order of the House of Commons, dated 23rd January, 1911, for a summary report on the state of the dredging works executed in the River Des Prairies up to the present time, making specially known the length, depth and width of the canal dredged up to date, and the amount expended on this work. Presented 22nd March 1911.—*Mr. Wilson* (*Laval*)... *Not printed.*

93*c*. Return to an order of the House of Commons, dated 23rd January, 1911, for a return showing:—1. A copy of the report of the engineer who made the survey and estimate of the Back River or Rivière des Prairies, between the eastern end of the Island of Montreal and the Lake of Two Mountains, in the province of Quebec, in view of the dredging and deepening of said river.

2. Details of work and expenditure to date in connection with the said work.

3. Estimate of cost of work remaining to be done and especially of the part between Bourde á Plouffe and the Lake of Two Mountains. Presented 22nd March, 1911.—*Mr. Monk*... *Not printed.*

93*d*. Return to an order of the House of Commons, dated 11th January, 1911, for a return showing during the seasons 1904, 1905, 1906, 1907, 1908, 1909 and 1910, what amounts were paid to Messrs. Dussault & Lemieux, dredging contractors, for work done by the *International*, the government dredge, leased to the said contractors, as far as the same can be ascertained. Presented 28th March, 1911.—*Mr. Sharpe* (*Ontario*). *Not printed.*

94. Return to an order of the House of Commons, dated 5th December, 1910, for a return showing the names and dates of first appointment of all lighthousekeepers, from Quebec to the sea, in the river and Gulf of St. Lawrence; also their present salaries, with an indication in each case of what they are obliged to provide for the lighthouse or signal service, and the amount of indemnity granted them for such provision. Also the rules or regulations which provide for the regular increase of their salaries. Presented 19th January, 1911. *Mr. Monk*... *Not printed*

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98*b*. Return to an order of the House of Commons, dated 23rd January, 1911, for a return showing in detail:—1. All sums paid by the concessionaires or grantees of the Beauharnois canal as rental or royalties upon the rights conveyed to them by the Crown on the Beauharnois canal, or paid by their assigns in the enjoyment of the said rights, since the concession.

2. Of all sums paid or expended by the government upon the said canal since the date of the said concession..

3. Of all sums actually due the Crown by the grantees or assigns for the use of the said canal or in connection therewith. Presented 7th February, 1911.—*Mr. Monk.* *Not printed.*

98*c*. Supplementary return to an order of the House of Commons, dated 11th January, 1911, for a copy of all memorials, petitions and requests received by the government since last session advocating the enlargement of the Welland canal, as well as all memorials, petitions, resolutions, &c., favouring the construction of the Montreal and Georgian Bay canal. Presented 10th February, 1911.—*Mr. Hodgins.. ..Not printed.*

98*d*. Return to an order of the House of Commons, dated 1st February, 1911, for a copy of all leases, agreements and contracts made with any person, persons, company or corporations, granting by way of lease or otherwise, any water powers on or along the Trent Valley canal; together with any correspondence in connection with same. Presented 9th March, 1911.—*Mr. Roche.. .. ..Not printed.*

98*e*. Return to an address of the House of Commons, dated 23rd January, 1911, for a copy of all correspondence concerning the lease or alienation of tho Beauharnois canal, of all reports called for by the government and made concerning the said alienation by experts, officers of the departments or others, of all orders in council respecting said alienation and of the deed or deeds between the Crown and the concessionaires embodying the said lease or alienation and respecting also any transfers of their rights and privileges by the original grantees. Presented 14th March, 1911.—*Mr. Monk.. .. ..Not printed.*

99. Return to an order of the House of Commons, dated 12th December, 1910, for a statement showing the amounts paid by the several government departments since 1st January, 1908, to the following law firms, or to any member thereof, and what has been in each case the nature of the service rendered; Messrs. Dandurand, Hibbard & Company, Montreal; Stewart, Cox & McKenna, Montreal; Smith, Markay & Company, Montreal; Hibbard, Boyer & Gosselin, Montreal. Presented 23rd January, 1911.—*Mr. Reid (Grenville).. .. ..Not printed.*

100. Return to an order of the House of Commons, dated 14th December, 1910, for a return showing the cost of the Senate of Canada for each year since the fiscal year 1896. under the headings of number of senators, indemnity, travelling expenses, printing, staff, and contingencies. Presented 23rd January, 1911.—*Hon. Mr. Foster.* *Not printed.*

101. Return to an order of the House of Commons, dated 16th January, 1911, for a return showing the names of the United States consuls or consular officers in the Dominion, the districts over which each has consular authority, the scale of fees which is exacted by them for certification of exports to the United States and the number of certified lots of goods exported under certificate during the year 1910. Presented 24th January, 1911.—*Mr. Rhodes.. .. ..Not printed.*

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110c. Return to an address of the House of Commons, dated 16th January, 1911, for a copy of all applications, petitions, letters, telegrams and other documents and correspondence, and all orders in council and certificates, relating to or connected with the establishment of the Farmer's Bank of Canada and its operations. Presented 1st February, 1911—*Mr. Taylor (Leeds).*
Printed for both distribution and sessional papers.

111. Return to an order of the House of Commons, dated 7th December, 1910, for a return showing the total cost to date of wharves at North Bay, Burks Falls and Maganatawan, Ontario; the name, date of appointment and salary of wharfinger in each case; the schedule of fees charged to public or others for use of wharf in each case; and a detailed statement of receipts for each wharf for the years 1907, 1908, 1909, giving name of party paying and for what. Presented 2nd February, 1911.—*Mr. Arthurs.*
Not printed.

112. Return to an order of the House of Commons, dated 23rd January, 1911, for a copy of all correspondence since the 1st January, 1909, with the Department of Justice or any officers of that department, making or supporting request for increase of pay to employees of the penitentiary at New Westminster; and of all reports or recommendations in that connection made by any officer of the department. Also a copy of all reports made during the period indicated, by the grand jury at New Westminster with reference to the conditions at said penitentiary. Presented 3rd February, 1911. *Mr. Taylor (New Westminster)*.. .. ..*Not printed.*

113. Report of proceedings between the Farmers' Delegation and the Prime Minister and members of the government held in the House of Commons chamber on the 16th December, 1910, with corresponding preliminary to the meeting. Presented 6th February, 1911, by Rt. Hon. Sir Wilfrid Laurier.
Printed for both distribution and sessional papers.

113a. Report of proceedings of the deputation of fruit and vegetable growers and the Prime Minister and members of the government held in the House of Commons on the tenth February instant. Presented 21st February, 1911, by Rt. Hon. Sir Wilfrid Laurier.
Printed for both distribution and sessional papers.

113b. Memorandum presented by the meat packers of Ontario and Quebec at a meeting held with members of the government on Monday, February 13, 1911. Presented 21st February, 1911, by Rt. Hon. Sir Wilfrid Laurier.
Printed for both distribution and sessional papers.

114. Return to an address of the Senate dated 12th January, 1911, for a copy of the order in council appointing His Honour Judge Jetté, administrator of the province of Quebec during the absence of Sir Pantaléon Pelletier, as well as a copy of any instruction whatsoever in connection with such appointment. Presented 19th January, 1911.—*Hon. Mr. Landry*.. .. ..*Not printed.*

115. Return to an address of the Senate dated 17th January, 1911, calling for dates of publication and distribution to members of parliament of the English and French editions of the debates of the Senate and of the House of Commons from the year 1900 to date. Presented 25th January, 1911.—*Hon. Mr. Landry*.. .. .. ..*Not printed.*

115a. Return to an order of the Senate dated 17th January, 1911, for a copy of a return showing, year by year, from 1900, up to the present day, the date of the publication and distribution to members of parliament:—

1. Of the English edition of the Journals of the Senate.

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2. Of the French edition of the same.
3. Of the English edition of the Journals of the House of Commons.
4. Of the French edition of the same. Presented 14th February, 1911.—*Hon. Mr. Landry*.. .. ..*Not printed.*

115*b*. Return to an order of the Senate dated 17th January, 1911, for a copy of a return showing, year by year, from 1900, up to the present day, the date of the publication and distribution to members of parliament:—
1. Of the English edition of the Jounrnals of the Senate.
2. Of the French edition of the same.
3. Of the English edition of the Journals of the House of Commons.
4. Of the French edition of the same. Presented 14th February, 1911.—*Hon. Mr Landry*.. .. ..*Not printed.*

116. Return to an address of the Senate dated 17th January, 1911, for a statement of the number of applications for and number of divorces granted by the parliament of Canada from 1894 to 1910 inclusive. Presented 24th January, 1911.—*Hon. Mr. McSweeny*.. .. ..*Not printed.*

117. Return to an address of the Senate dated 22nd April, 1910, showing the expenses incurred, and the date of each of the payments made by the government for the electric installation in each of the rooms of the immigration officer at Quebec during the years 1908 and 1909. Presented 31st January, 1911.—*Hon. Mr. Landry.*
1911.—*Mr. Lennox*.. .. ..*Not printed.*

118. Return to an order of the House of Commons, dated 16th January, 1911, for a return showing what amount the government paid Mr. F. H. Chrysler, K.C., for professional services between May, 1896, and 31st March, 1909, and what amount during the financial year ending 31st March, 1910; what amount since 31st March, 1910; what amount is now due by the government to Mr. Chrysler; and in what transactions or cases Mr. Chrysler is now engaged in for the government. Presented 6th February, 1911.—*Mr. Blain*.. .. ..*Not printed.*

119. Return to an order of the House of Commons, dated 25th January, 1911, for a statement showing:—

1. How much wheat was exported from Canada for the crop years ending 31st August, 1908, 1909 and 1910.

2. How much wheat was exported from Canada through United States ports during 1908, 1909 and 1910, naming said ports, and amount exported from each port.

3. How many terminal grain elevators are there at Port Arthur and Fort William, and what is the name of each.

4. How much grain was shipped through each elevator at Port Arthur and Fort William during each year 1908, 1909 and 1910, and what are the names of the elevators respectively.

5. How much wheat was exported from Canada during each crop year 1908, 1909 and 1910, not passing through the terminal elevators at Port Arthur and Fort William.

6. How many men are employed by the government in connection with the terminal elevators at Port Arthur and Fort William, and what is the total salary paid the men per year. Presented 7th February, 1911.—*Mr. Schaffner.*
Printed for sessional papers.

120. Return to an order of the House of Commons, dated 18th January, 1911, for a return showing how many appointments have been made by the government from the con-

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127. Return to an order of the Senate dated 17th January, 1911, for a return showing, in as many distinct columns:—

1. The names of all departments obliged by law to lay before parliament reports of their annual operations.

2. The date fixed by law for the laying of the said reports before parliament.

3. The date on which the said reports have been laid for the fiscal year ending 31st March, 1910, stating whether it was the English or the French edition which was so laid.

4. The date of the publication and distribution of the French edition of the said reports.

5. The title of the reports which, up to the 15th January, 1911, nine months and a half, after the fiscal year ending the 31st March, 1910, have not yet been published in French.

6. The titles of the reports which, up to the 15th January, 1911, twenty-one months and a half after the fiscal year ending the 31st March, 1909, have not yet been published in French. Presented 16th February, 1911.—*Hon. Mr. Landry.. ..Not printed.*

128. Return to an order of the House of Commons, dated 26th January, 1911, for a return showing the date of incorporation, a copy of the Act of incorporation, and any subsequent amendments thereto, all petitions, correspondence, applications and other papers or data asking for or relating to the grant of subsidy thereto, a copy of all contracts for construction, the subsidies granted and the several payments of the same, the dates of payment and the persons to whom cheques were issued therefor, a copy of engineer's reports and certificates on which payment was authorized in each case, the number of miles completed, the number now being operated, the number of miles still to be finished, the total cost to date and the estimated cost of completion, and the present condition of the road, in the case of the Atlantic, Quebec and Western Railway Company, the Quebec and Oriental R. R. Company and the new Canadian company. Also the shareholders, directors and officers of each of these companies, the capital subscribed and paid up by each subscriber, the amounts paid out each year to directors and officers as fees and salaries, the amount paid for promotion or other expenses, in detail, for each of the above companies. In the case of any mileage operated, the yearly revenues and working expenses. Presented 17th February, 1911.—*Hon. Mr. Foster.. .. ..Not printed.*

128*a*. Supplementary return to an order of the House of Commons, dated 23rd January, 1911, for a return showing the date of incorporation, a copy of the Act of incorporation, and any subsequent amendments thereto, all petitions, correspondence, applications and other papers for data asking for or relating to the grant of subsidy thereto, a copy of all contracts for construction, the subsidies granted and the several payments of the same, the dates of payment and the persons to whom cheques were issued therefor, a copy of engineer's reports and certificates on which payment was authorized in each case, the number of miles completed, the number now being operated, the number of miles still to be finished, the total cost to date and the estimated cost of completion, and the present condition of the road, in the case of the Atlantic, Quebec and Western Railway Company, the Quebec and Oriental R. R. Company and the new Canadian company. Also the shareholders, directors and officers of each of these companies, the capital subscribed and paid up by each subscriber, the amounts paid out each year to directors and officers as fees and salaries, the amount paid for promotion or other expenses, in detail, for each of the above expenses. In the case of any mileage operated, the yearly revenues and working expenses. Presented 17th March, 1911.—*Hon. Mr. Foster.. .. ..Not printed.*

CONTENTS OF VOLUME 24—*Continued.*

128b. Further supplementary return to an order of the House of Commons, dated 23rd January, 1911, for a return showing the date of incorporation, a copy of the Act of incorporation, and any subsequent amendments thereto, all petitions, correspondence, applications and other papers or data asking for or relating to the grant of subsidy thereto, a copy of all contracts for construction, the subsidies granted and the several payments of the same, the dates of payment and the persons to whom cheques were issued therefor, a copy of engineer's reports and certificates on which payment was authorized in each case, the number of miles completed, the number now being operated, the number of miles still to be finished, the total cost to date and the estimated cost of completion, and the present condition of the road, in the case of the Atlantic, Quebec and Western Railway Company, the Quebec and Oriental R. R. Company, and the new Canadian company. Also the shareholders, directors and officers of each of these companies, the capital subscribed and paid up by each subscriber, the amounts paid out each year to directors and officers as fees and salaries, the amount paid for promotion or other expenses, in detail, for each of the above companies. In the case of any mileage operated, the yearly revenues and working expenses. Presented 28th March, 1911.—*Hon. Mr. Foster.. .. ..Not printed.*

129. Return to an order of the House of Commons, dated 19th January, 1910, for a return showing in the construction of drill halls or armouries, or the leasing of sites for camps of instruction, in how many and what instances municipalities, regiments, or individuals, have contributed to the cost of the same in the way of concessions, sites, or moneys, and the amount in each case since 1904. Presented 20th February, 1911.—*Mr. Worthington.. .. ..Not printed.*

130. Return to an order of the House of Commons, dated 23rd January, 1911, for a copy of all correspondence with the Department of the Interior or any officer thereof in regard to half-breed scrips numbers A. 8931 and A. 9970 issued to Joseph William Malbœuf, together with a copy of all documents in any way relating to the said scrips. Presented 20th February, 1911.—*Mr. Martin (Regina).. .. ..Not printed.*

130a. Return to an order of the House of Commons, dated 18th January, 1911, for a copy of all corrspondence, reports, letters, telegrams and other documents, exchanged between the Right Reverend George Holmes, D.D., of Lesser Slave Lake, or anyone on his behalf, and the Minister of the Interior, or any official or temporary employee of the government, in reference to the issue or application of half-breed scrip. Presented 22nd February, 1911.—*Mr. Ames.. .. ..Not printed.*

131. Return to an order of the Senate dated 9th February, 1911, for a return showing the importations by the Dominion from the United States in the year 1910 of the following commodities:—

1. Beef and live cattle. 2. Sheep. 3. Poultry. 4. Ham. 5. Pork. 6. Bacon, 7. Flour. 8. Wheat. 9. Barley.

With the value of the different articles.

Showing also the exportations from the Dominion to the United States of the corresponding products with their relative value. Presented 22nd February, 1911.—*Hon. Mr. Macdonald (B.C.).. .. ..Printed for sessional papers.*

131a. Return to an order of the Senate dated 10th Februry, 1911, for a return showing in as many distinct columns, for the last five years, with an additional column containing the average thereof:—

I. The quality and value of each of the following products.—

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1. Live stock. 2. Pork and bacon. 3. Potatoes. 4. Eggs. 5. Butter. 6. Cheese. 7. Maple sugar. 8. Fruit. 9. Garden products. 10. Hay. 11. Wheat. 12. Flour. 13. Oats. 14. Other natural products. 15. Agricultural implements.

Of Canadian origin exported to:—(*a*) the United States; (*b*) the English market; (*c*) other countries.

II. The quantity and quality of the same articles, together with the amount of duty collected on each of them for consumption and imported from:—(*a*) the United States; (*b*) the British Isles; (*c*) other countries. Presented 14th March, 1911.—*Hon. Mr. Landry*.. .. ..*Not printed.*

132. Return to on order of the House of Commons, dated 23rd January, 1911, for a copy of all correspondence between the Department of the Interior, or any of its officers, and any other persons, respecting the timber on the Fanny Louise Irwin homestead in the District of Chilliwack, British Columbia, including any instructions to solicitors to issue a writ in Exchequer Court for cancellation of timber rights not reserved in Crown grant of the homestead. Presented 20th February, 1911.—*Mr. Taylor* (*New Westminster*).. .. ..*Not printed.*

133. Return to an order of the House of Commons, dated 18th January, 1911, for a return showing the total acreage of school lands sold in the provinces of Alberta and Saskatchewan in each of the years 1906, 1907 and 1908, with the average prices realized, also a statement of sales of such lands in each said province since 1st of January, 1909, to date, giving the places at which each sale was held and date of sale; the description of the land sold; the upset price at which it was offered and the price realized; and the area of land in each township, in which these school lands are located, that was under cultivation at the time it was decided to sell the school lands therein. Presented 20th February, 1911.—*Mr. McCarthy*.. .. ..*Not printed*

134. Return to an order of the House of Commons, dated 15th December, 1909, for a copy of all papers, letters, telegrams, documents, petitions, reports and correspondence with reference to, or in any way concerning the appointment of a government weigher at Montreal. Presented 20th February, 1911.—*Mr. Armstrong*.. .. ..*Not printed.*

135. Supplementary return to an order of the House of Commons, dated 28th February, 1910, for a return showing the number of persons in the employ of each department of the government during the year 1909 under the following heads: (*a*) civil service employees at Ottawa; (*b*) civil service employees outside of Ottawa; (*c*) in stated and regular employ, but not under the Civil Service Act, giving the distinctive service of each group; (*d*) those in temporary or casual employment, giving the distinctive work of each group, and also showing the total amount paid under each head. Presented 20th February, 1911.—*Hon. Mr. Foster*.. .. ..*Not printed.*

136. Return to an order of the House of Commons, dated 30th January, 1911, for a return showing the total quantity of coal delivered to ship at Pictou, in each year during which the SS. *Stanley* has been engaged in the winter service between Prince Edward Island and Nova Scotia, and the cost thereof.

Also, statements showing the total cost of putting coal aboard; the quantity of freight handled at Pictou, and the total cost of handling such freight. Presented 21st February, 1911.—*Mr. Stanfield*.. .. ..*Not printed.*

136*a*. Return to an order of the House of Commons, dated 30th January. 1911, for a return showing the total quantity of coal delivered to ship at Pictou, in each year during which the SS. *Earl Grey* has been engaged in the winter service between Prince Edward Island and Nova Scotia, and the cost thereof.

CONTENTS OF VOLUME 24—*Continued.*

Also, statements showing the total cost of putting coal aboard; the quantity of freight handled at Pictou, and the total cost of handling such freight. Presented 21st February, 1911.—*Mr. Stanfield*.. .. ..*Not printed.*

136*b*. Return to an order of the House of Commons, dated 30th January, 1911, for a return showing the total quantity of coal delivered to ship at Pictou, in each year during which the SS. *Stanley* has been engaged in the winter service between Prince Edward Island and Nova Scotia, and the cost thereof.

Also, statments showing the total cost of putting coal aboard; the quantity of freight handled at Pictou, and the total cost of handling such freight. Presented 21st February, 1911.—*Mr. Stanfield*.. .. ..*Not printed.*

137. Return to an order of the House of Commons, dated 6th February, 1911, for a copy of the last advertisement for tenders, and the specification and contract or proposed contract for the erection of the Quebec bridge. Presented 21st February, 1911.—*Mr. Lennox*.. .. .. *Not printed.*

137*a*. Return to an address of the House of Commons, dated 5th December, 1910:—

1. For a return showing the contract between the Quebec Bridge and Railway Company and M. P. Davis, dated July 27, 1903, providing for the construction of the lines of railway connecting the Quebec bridge with the city of Quebec and with certain other railways, the tender upon which the contract was based. and the estimated cost at the time of the contract based upon the scheduled quantities and prices.

2. The agreement transferring this undertaking to the government, and of all correspondence and documents in connection therewith and of the order in council of 16th February, 1909, transferring it to the commissioners of the Transcontinental railway.

3. And stating the mileage of the lines of railway embraced in this contract.

4. The sums paid on account by the Quebec Bridge and Railway Company, and the purposes for which it was paid.

5. The amount owing or claimed by the contractor for work done or material supplied up to the time the undertaking was taken over by the government, and the date of taking it over, the amount paid or undertaken to be paid by the government to the company or its members, the estimated amount at that time required to complete the work, the amount the government or commissioners have since paid and the estimated amount yet to be paid.

6. And setting forth the reasons for taking the undertaking out of the hands of the Bridge and Railway Company and for transferring it to the commissioners.

7. Any other sums paid, allowed or assumed for or on account of this company or its members, and the account on which paid, allowed or assumed. Presented 28th March, 1911.—*Mr. Lennox*.. .. ..*Not printed.*

137*b*. Return to an address of the House of Commons, dated 6th March, 1911, for a copy of the order in council appointing, or providing for the appointment of, the engineers to prepare and determine upon plans ond specifications, and superintend the construction of the Quebec bridge, and of all instructions, correspondence, writings and documents, in connection with these appointments, including the two additional engineers; and also a copy of any subsequent orders in council, or any instructions, correspondence, &c., relating to the refusal of any of the engineers to act, or continue in office, or the retirement, or substitutions of engineers. Presented 12th April, 1911. —*Mr. Lennox*.. .. ..*Not printed.*

137*c*. Return to an order of the House of Commons, dated 10th April, 1911, for a copy of all correspondence between the Department of Labour and various labour organizations,

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CONTENTS OF VOLUME 24—*Continued.*

or privileges were respectively given. 5. What constitutes forfeiture. 6. What grants, leases or licenses have been forfeited. 7. The general rules and regulations, if any, applying to the giving and holding of the water-powers on this river. 8. The amount of development effected by the grantees or lessees respectively. 9. What title or interest the Dominion claims in the running water, the bed of the river, and the banks thereof. Presented 24th February, 1911.—*Mr Haggart (Winnipeg).* *Not printed.*

145. Return to an order of the House of Commons, dated 5th December, 1910, for a return showing the total number of accidents on railways in Canada since 1st April. 1909, and up to date; the number of fatal accidents; the number on each railway, and the causes of the same. Also, the number of accidents on construction work, fatal or otherwise, on the Canadian Northern and the Grand Trunk Pacific railways, and the causes of the same. Presented 24th February, 1911.—*Mr. Smith (Nanaimo).* *Not printed.*

146. Return to an order of the Senate dated 24th January, 1911, showing, year by year, from 1st July, 1896, up to date, the amounts paid to Mr. J. B. Laliberté, of Quebec, merchant, by each of the departments of the government of this country. Presented 24th February, 1911.—*Hon. Mr. Landry.* . . . . *Not printed.*

147. Return to an order of the Senate dated 25th January, 1911, for the production of a statement showing, year by year, from the 1st July, 1896, up to this date, the sums of money paid to the newspaper, the *Daily Telegraph*, of Quebec, by each of the different departments of the government of this country. Presented 24th February, 1911.—*Hon. Mr. Landry.* . . . . *Not printed.*

148. Return to an order of the Senate dated 26th January, 1911, for a return showing, year by year, since 1st July, 1896, up to date, the amounts paid to Mr. Louis Letourneau, of Quebec, or to the Quebec Preserving Company, by each of the departments of the government of this country. Presented 24th February, 1911.—*Hon. Mr. Landry.* *Not printed.*

149. Return to an order of the Senate dated 27th January, 1911, for the production of a return showing, year by year, from the 1st of July. 1896, to this date, the sums of money paid to Messrs. Samson and Filion, of Quebec, merchants, by each of the different departments of the government of this country. Presented 24th February, 1911.—*Hon. Mr. Landry.* . . . . *Not printed*

150. Return to an order of the Senate dated 27th January, 1911, for the production of a return showing, year by year, from the 1st July, 1896, to this date, the sums of money paid to Mr. C. E. Taschereau, of Quebec, notary, by each of the different departments of the government of this country. Presented 24th February, 1911.—*Hon. Mr. Landry.* . . . . *Not printed.*

151. Return to an order of the Senate dated 27th January, 1911, for the production of a return showing, year by year, from the 1st July, 1896, to this date, the sums of money paid to Mr. George Tanguay, of Quebec, by each of the different departments of the government of this country. Presented 24th February, 1911.—*Hon. Mr. dry.* . . . . *Not printed.*

152. Return to an order of the House of Commons, dated 6th February, 1911, for a copy of the curator's reports in the cases of all banks for which curators have been appointed. Presented 27th February, 1911.—*Hon. Mr. Foster.* . . . . *Not printed*

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CONTENTS OF VOLUME 24—*Continued.*

158*a*. Return to an order of the House of Commons, dated 16th April, 1911, for a return showing the names of all persons in the province of New Brunswick who have received fishing bounties during the year ending 31st March, 1911, with the amount received by each. Presented 2nd May, 1911.—*Mr. Daniel*.. .. ..*Not printed.*

159. Return to an order of the House of Commons, dated 20th January, 1911, for a copy of all reports, correspondence, and documents, not already brought down, including report of survey made in 1909 of the harbour of Cape John and Tatamagouche Bay, in the counties of Pictou and Colchester. in the province of Nova Scotia, relating to the route of the winter steamers between Prince Edward Island and the mainland of Canada, and suggesting or recommending a change or changes on such route, and an increase in the number of trips daily of such winter steamers; also a copy of all similar papers, not already brought down, relating to the route of the summer mail steamers between Charlottetown and the mainland of Canada, and suggesting a change in that route and an increase in the number of trips daily; and also with regard to connecting such suggested route with a point on the Intercolonial railway. Also for a copy of all similar papers, if any, relating to or suggesting the route between Cape Traverse in Prince Edward Island and Cape Tormentine in the mainland, as a route for the winter and summer steamers. Also for a copy of all reports, papers and correspondence relating to additional or improved aids to navigation of the harbour of Charlottetown and entrance thereto and in Tatamagouche bay and harbour. Presented 6th March, 1911.—*Mr. Warburton*.. .. .. ..*Not printed.*

160. Return to an address of the House of Commons, dated 20th February, 1911, for a copy of all correspondence, recommendations, orders in council, or other documents relating to the case of R. E. Curran, a railway mail clerk, who was fatally injured in an accident at Owen Sound, on the 29th May, 1908, and with regard to which application was made for a compassionate grant or allowance to his heirs or family. Presented 7th March, 1911.—*Mr. Macdonell*.. .. ..*Not printed.*

161. Return to an address of the House of Commons, dated 27th February, 1911, for a copy of all orders in council, reports, correspondence, documents and papers touching the dismissal of the sub-collector of customs at Mahone bay, Nova Scotia. Presented 13th March, 1911.—*Mr. Taylor (Leeds)*.. .. ..*Not printed.*

162. Return to an order of the House of Commons, dated 20th February, 1911, for a return showing:—1. The nature of the subsidy which has been granted to the Vancouver Dry Dock Company.

2. The nature of payment of interest or of a guarantee of such subsidy. Presented 13th March, 1911.—*Mr. Barnard*.. .. ..*Not printed.*

163. Return to an order of the House of Commons, dated 6th March, 1911, for a copy of all papers, reports of appraiser, letters and correspondence relating to the appraising and passing the customs of the vessel *Wanda*, owned by one William R. Travers, Toronto, on the 20th October, 1909. Presented 14th March, 1911.—*Mr. Sharpe (Ontario)*.. .. ..*Not printed.*

164. Statement of the affairs of the British Canadian Loan and Investment Company (Limited) for the year ended 31st December, 1910.

Also, a list of the shareholders on 31st December, 1910, in accordance with chapter 57 of 39 Victoria. Presented (Senate) 14th March, 1911, by the Hon. the Speaker.
Not printed

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2. Who are the judges whose place of residence has been fixed or changed by order in council, and what is for each of these judges, the place of residence now fixed.

3. Who are the judges whose place of residence has never been fixed, neither in the commission nor by any subsequent order in council. and what is the judiciary district to which they were appointed. Presented 21st March, 1911.—*Hon. Mr. Landry*.. .. ..*Not printed.*

171. Return to an order of the House of Commons, dated 30th January, 1911, for a copy of all advertisements, letters, contracts, complaints, reports of inspectors and other correspondence regarding mail routes Trout creek to Loring and Powassan to Nipissing or Restoule. Presented 24th March, 1911.—*Mr. Arthurs*.. .. ..*Not printed*

173. Return to an order of the House of Commons, dated 27th February, 1911, for a return showing what ministers of the Crown were abroad in 1908, 1909 and 1910, on public business and on what business; what expenses were incurred by each while engaged on public business; what persons, if any, accompanied each minister on public business whose expenses were paid by the government, and the amount of such persons expenses. Presented 24th March, 1911.—*Mr. Sharpe (Ontario)*.. .. .. ..*Not printed*

173. Return to a order of the House of Commons, dated 27th February, 1911, for a return showing the value, respectively, of the following products of the country, by provinces, during the years 1909 and 1910, agricultural products of all kinds, including field products of every kind, fruit, vegetables, live stock, &c., dairy products, &c.; timber of all kinds; minerals of all kinds; fish of all kinds; and manufactured goods of all kinds. Presented 24th March, 1911.—*Mr. Macdonell*.. .. ..*Not printed.*

174. Report of the Manitoba Fisheries Commission, 1910-11. Presented 24th March, 1911, by Hon. L. P. Brodeur... .. ..*Not printed.*

175. Return to an order of the House of Commons, dated 14th December, 1910, for a return showing what amount has been paid by the government during the last fiscal year for cab hire and street railway fares in the city of Ottawa for the following persons, with the names and the amounts in each case: ministers of the Crown; speaker of the Senate and House of Commons; civil servants of all grades from deputy ministers down; all other persons employed in any government work or other service. Presented 27th March, 1911.—*Mr. Taylor (Leeds)*.. .. ..*Not printed.*

175*a*. Return to an order of the House of Commons, dated 14th December, 1910, for a return showing what amount has been paid by the government during the last fiscal year for travelling expenses with the names and the expenditure in each case, under the following heads, viz.: railway, steamship, and other lines of transportation; private cars; Pullman cars; tips to waiters; meals and hotel expenses; for the following persons: Ministers of the Crown; civil servants of all grades; immigration agents; and other persons employed by the government on any special or other work. Presented 20th April, 1911.—*Mr. Taylor (Leeds)*.. .. ..*Not printed.*

175*b*. Supplementary return to an order of the House of Commons, dated 14th December, 1910, for a return showing what amount has been paid by the government during the last fiscal year for travelling expenses with the names and the expenditure in each case, under the following heads, viz.: railway, steamship, and other lines of transportation; private cars; Pullman cars; tips to waiters; meals and hotel expenses, for the following persons: Ministers of the Crown; civil servants of all grades; immigration agents; and other persons employed by the government on any special or other york. Presented 20th July, 1911.—*Mr. Taylor (Leeds)*.. .. ..*Not printed.*

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176. Papers referring to the organization of a Secretariat, as follows:—1. Despatch to the governors of the self-governing colonies relative to the reorganization of the Colonial Office.

2. Note on a visit to Australia, New Zealand and Fiji in 1909, by Sir Charles Lucas, K.C.M.G., C.B., assistant under secretary of state for the Colonies.

3. Report of the Dominions Department of the Colonial Office for the year 1909-1910.

4. Imperial Copyright Conference, 1910, memorandum of the proceedings.

5. Further correspondence relating to the Imperial Conference.

6. Correspondence relating to th Imprial Confrence, 1911. Presented, 28th March, 1911, by Rt. Hon. Sir Wilfrid Laurier.. .. ..*Not printed.*

177. Return to an order of the House of Commons, dated 20th February, 1911, for a copy of the application by or on behalf of the Glace Bay Bait Association, Glace Bay, N.S., for moneys in connection with the cold storage building for the storage of bait, at Glace Bay, N.S.; also a copy of all correspondence between the said association or anyone on its behalf and the government, any department of the government, or anyone on behalf of the government or any of its departments. Presented 28th March, 1911.—*Mr. Maddin*.. .. ..*Not printed.*

177a. Return to on order of the House of Commons, dated 3rd April, 1911, for a copy of all the correspondence in connection with the building of bait freezers at Louisburg and Lingan in the riding of South Cape Breton. Presented 20th April, 1911.—*Mr. Mackenzie*.. .. ..*Not printed.*

178. Return to an address of the Senate dated 8th March, 1911, that an order of the Senate do issue for the production of a copy of the complaint made by the commandant of the 61st Regiment against the commandant of the 7th Military District, of the reply of the latter and of all correspondence on the subject between the authorities at Ottawa and those at Quebec and Montreal, together with a copy of the report of the Inspector General respecting the case. Presented 28th March, 1911.—*Hon. Mr. Landry*.. .. ..*Not printed.*

179. Return to an order of the House of Commons, dated 16th March, 1911, for a return showing the average prices of butter and of eggs in London, England, for the past five years in comparison with the prices, respectively, in eastern provinces, in Montreal, in Toronto, in Minneapolis, in Chicago, in Detroit, in Buffalo, in Boston and in New York. Presented 30th March, 1911.—*Mr. Sharpe (Ontario)*.. .. .. ..*Not printed.*

179a. Return to an order of the House of Commons, dated 23rd March, 1911, for a return showing the quantity and value of butter, eggs, poultry, chilled or frozen meat, bacon, lard, apples, vegetables, wheat, barley, cattle, horses and potatoes imported into Canada during the six months ending 1st March, 1911, the countries from which the same were imported and the duty collected thereon. Presented 6th April, 1911.—*Mr. Middlebro*.. .. ..*Not printed.*

179b. Supplementary return to an order of the House of Commons, dated 23rd March, 1911, for a return showing the quantity and value of butter, eggs, poultry, chilled or frozen meat, bacon, lard, apples, vegetables, wheat, barley, cattle, horses and potatoes imported into Canada during the six months ending 1st March, 1911, the countries from which the same were imported and the duty collected thereon. Presented 8th May, 1911.—*Mr. Middlebro*.. .. ..*Not printed.*

180. Return to an order of the House of Commons, dated 14th December, 1910, for a return showing the total payments made by the government to the Eclipse Manufacturing

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Company, Limited, for year 1909-10, and how these contracts were let; the total payments made by the government to the Office Specialty Manufacturing Company, Limited, for year 1909-10, and how these contracts were let; the total payments made by the government to Messrs. Ahearn & Soper for year 1909-10, and how these contracts were let. Presented 3rd April, 1911.—*Mr. Sharpe (Lisgar)*.. .. ..*Not printed.*

181. Return to an order of the Senate dated 22nd February, 1911, for a copy of all orders in council and of all orders issued by the Minister of the Interior giving, from time to time, to the commissioner for the Northwest Territories, since his appointment as such, the instructions which he is to follow in the exercise of his executive in so far as concerns the government of the Northwest Territories. Presented 4th April, 1911. *Hon. Mr. Landry*.. .. ..*Not printed.*

182. Return to an order of the Senate dated 16th March, 1911, calling for a copy of all correspondence relating to the stranding in August, 1910, of the ship *Manchester Engineer* near the Strait of Belle Isle, and of the investigation held with reference thereto at Quebec during the month of September or October last. Presented 4th April, 1911. —*Hon. Mr. Landry*.. .. ..*Not printed.*

183. Return to an order of the House of Commons, dated 15th February, 1911, for a return showing all communications, telegrams, letters, petitions or plans relating to the rifle range at Bear River, N.S., received since January, 1909.

2. From whom received and upon what dates respectively? Presented 5th April, 1911. —*Mr. Jameson*.. .. ..*Not printed.*

184. Return to an order of the House of Commons, dated 14th December, 1910, for a return showing what total amount has been annually expended in each province since 1880 by the Department of Public Works for harbours and rivers, together with the annual totals of said expenditure for the whole of Canada; also that the Department of Public Works prepare and lay upon the Table of this House with this Return a map for each province, showing the location of all wharves, piers, breakwaters, &c., constructed or purchased by the federal government, and presently owned by the Dominion of Canada. Presented 6th April, 1911.—*Mr. Ames*.. .. ..*Not printed.*

185. Return to an order of the Senate dated 22nd February, 1911, for:—

1. Copies of all papers relating to the appointment of Martin Dickie to the command of the 76th Regiment of the counties of Colchester and Hants.

2. Copies of all papers relating to the recommendation of Major J. L. Barnhill by Lieut. General Drury and others to the command of the said regiment.

3. Copies of all documents relating in any way to the reasons or causes why the said Major Barnhill as the senior officer of said regiment should not have been appointed to the command of the same.

4. Copies of all correspondence and other popers and documents relating to the recent reorganization of the 78th Colchester, Hants and Pictou Regiment of "Highlanders." Presented 4th April, 1911.—*Hon. Mr. Lougheed*.. .. ..*Not printed.*

186. Return to an order of the House of Commons, dated 27th March, 1911, for a return showing the mileage of railways owned, controlled or operated in the United States by the Grand Trunk, the Canadian Pacific and other Canadian railway companies.

2. Also the mileage of railways owned, controlled or operated by the United States railway corporations in Canada. Presented 10th April, 1911.—*Mr. Rutan.* *Not printed.*

187. Return to an order of the House of Commons, dated 3rd April, 1911, for a copy of all correspondence, declarations, telegrams, mailing lists, and other documents relating

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DEPARTMENT OF THE INTERIOR

REPORT

OF THE

CHIEF ASTRONOMER

FOR THE

YEAR ENDING MARCH 31

1910

VOLUME I.

PRINTED BY ORDER OF PARLIAMENT

OTTAWA
PRINTED BY C. H. PARMELEE, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY
1912

[No. 25a—1911.].

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REPORT OF THE CHIEF ASTRONOMER AND INTERNATIONAL BOUNDARY COMMISSIONER.

DEPARTMENT OF THE INTERIOR,
DOMINION ASTRONOMICAL OBSERVATORY,
OTTAWA, CANADA, May 2, 1910.

W. W. CORY, Esq., C.M.G.,
Deputy Minister of the Interior,
Ottawa.

SIR,—I have the honour to present the report of the Astronomical Branch of the Department of the Interior, for the year ending March 31, 1910.

The correspondence in twelve months was:—

Letters received	2,080
Letters sent	3,104
	5,184
Accounts examined	784

The work of the photographic division is shown in the following schedule:—

Work of the Photographic Division.

Sizes.	3¼ x 3¼ In.	4 x 5 In.	4¾ x 6½ In.	5 x 7 In.	4 x 14 In.	8 x 10 In.	7 x 21 In.	3¼ x 5½ In.	11 x 14 In.	16 x 20 In.	9 x 36 In.	20 x 30 In.	30 x 40 In.	40 x 60 In.	Total.
Plate negatives	.....	84	746	.....	.....	371	.....	.....	43	98	.....	.....	.....	.....	1,342
Blue prints	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	48	.....	.....	48
Transparencies	252	.....	252	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	504
Film negatives developed	.....	.....	.....	994	.....	.....	20	53	.....	.....	.....	.....	.....	.....	1,067
Bromide prints	.....	.....	.....	.....	.....	.....	.....	.....	1,159	346	440	214	14	18	2,191
Contact paper prints	.....	283	.....	3,210	73	402	169	104	.....	.....	.....	.....	.....	.....	4,241
Total	252	367	998	4,204	73	773	189	157	1,202	444	440	262	14	18	9,393

This statement does not include the development of the solar and stellar spectrum plates of the astrophysical division.

The library contains 3,550 bound volumes and 315 pamphlets. About 600 additional volumes are ready for binding. The need of additional shelf room is becoming urgent.

In the workshop, a great many repairs have been made to field instruments, theodolites, levels, cameras, &c. Counterpoising attachments have been made for the meridian circle, and certain parts of that instrument have been refitted. A wide-field camera, provided with adjustments, has been attached to the tube of the equatorial telescope. The driving apparatus of the equatorial has been overhauled, and new gears made, which reduce the periodic error of running. Many minor improvements have been made to other instruments. The number of visitors to the Observatory, registered in the book kept for the purpose, amounted to 3,754 during the year. This number includes daytime visitors, as well as those taking advantage of the 'open night' each Saturday.

As formerly, meetings of the Royal Astronomical Society of Canada have been held monthly during the winter months in the lecture room of the Observatory. At these many valuable scientific papers have been presented. The Society has also given monthly, alternately with these, lectures in the city, which have been of a more popular character.

TIME SERVICE.

The time service has been continued as before without important addition or alteration. A few dials have been added, and the location of others changed. The following list shows the distribution of dials and clocks:—

—	March 31st, 1910.	March 31st, 1909.	March 31st, 1908.
Minute dials—			
*Parliament Building	53	49	46
*Eastern Block	40	36	35
*Western Block	65	63	61
*Langevin Block	49	48	48
*Post Office	20	20	20
Thistle Block	2	2	2
Ottawa Electric Company	2	1	1
Mint	16	16	....
*Archives	7	7	....
*Observatory	28	28	28
Seconds dials (Observatory)	5	3	2
Tower clocks (Post Office and Observatory)	2	2	2
Programme clock (Observatory)	1	1	1
Total electrically driven clocks	290	276	246
Secondary master clocks	8	8	7
Primary clocks	4	4	4
Total	302	288	257

Buildings marked * have secondary master clocks, synchronized to standard time by the principal master clock in the Observatory. In the Observatory itself there is a system of distribution of both mean and sidereal time by electrically driven dials beating seconds.

MERIDIAN WORK.

On the completion of the new pivots of the meridian circle, as described in my last annual report, the telescope was put together and mounted in April, and the adjustment proceeded with. As soon as possible a preliminary measurement of pivot errors was made, with the gratifying result that they were found to be very small—too small, in fact, for their existence to be definitely established without more refined measurements than those made at the time. The greater part of the work with this instrument during the past year, has consisted in the carrying out of the various alterations outlined in the last report, and in test observations on standard stars. Owing to pressure of work in the workshop these alterations have proceeded very slowly; the more important ones have now, however, been practically completed.

Adjustment of the positions of the graduated circles on the axis, and of their planes perpendicular to the axis, was completed by the methods described in previous reports. For the adjustment of relative position (so that the microscopes might remain in focus after reversal), the instrument had again to be dismounted and a small cut taken off one end of the axis; the adjustment was then finished by scraping. From the measurements taken during the process of adjustment of the planes of the circles perpendicular to the axis, residuals developed which showed the probability of the existence of irregular flexure of the axis. Direct observations which were made by suitable methods confirmed this hypothesis; they showed that the differential flexure was a maximum when the telescope was vertical, and that apparently it was not symmetrical along the axis; this points to the probability of a small variation of collimation error for different zenith distances; the question will if possible be further investigated.

New counterpoises of improved design have been made and installed.

The eye-end has been thoroughly overhauled; it was found necessary to true up all the surfaces engaged in the two slides controlling the eye-piece, which were neither flat nor parallel; the screw controlling the motion of the eye-piece in the right ascension was slightly bent, and had to be renewed; a necessary improvement was made to the recording device of the zenith distance micrometer by adding spools and rollers to carry an inked ribbon; new spider lines at more suitable distances were put on both the right ascension and zenith distance micrometer slides.

The circle microscopes also required overhauling; four out of the eight are now completed and mounted, making it possible to proceed with declination work. In the majority of them the micrometer slides did not work freely and were not parallel; the springs were too short and stiff, and a slight alteration in the design was found necessary in order to introduce longer springs; the numbering of the graduations on one-half of the micrometer heads was reversed in order to allow of reversal of one of the microscopes of each pair to eliminate effects of wear of the screws; the spider lines, which had been at unsuitable and varying distances, have been renewed.

It was found that the mounting of the microscopes was deficient in rigidity; this can in great part be eliminated by connecting each set of microscope carriers together by a metallic ring; these rings are now being made.

The collimators have been mounted temporarily on the piers provided; the permanent mounting cannot well be proceeded with until the completion of the azimuth marks. Some changes have been made in the spider lines and in the arrangement for the illumination of the fields; higher power eye-pieces are desirable for the collimators, one of the meridian circle eye-pieces is being used in the meantime; higher power eye-pieces are also required for the circle microscopes and for the pivot tester, and reversing eye-pieces for the telescope and the collimators. The nadir eye-piece has been altered to give a higher magnification, and a method of reading the nadir adopted which involves the obliteration of bright by dark lines in a dark field.

The electric wiring for lights and for chronograph connections and seconds dials has been completed in both the meridian circle room and the transit room; a system of steps has been arranged around the instrument piers for reading of microscopes, &c., and several other similar details have been attended to. In May, 1909, it was found that there was an accumulation of water in the pits of the collimator piers; this was found to be due to the fact that the earth around the piers was water-soaked, owing to the drains surrounding the piers not being brought near enough to the surface. This defect was remedied and the pits covered with a coating of pitch; there has been no further trouble.

The wiring in the chronograph room has been completed, and a small, compact plug switchboard installed. It is now possible by insertion of two plugs to connect any one of four chronographs for work at any one of the three piers in the transit annex, using any clock desired; two or more of the chronographs can be used simultaneously by different observers if desired.

A new barometer was ordered and received; the tube was damaged in shipment, and in an attempt to repair it, it was broken; a new tube has been ordered and is expected shortly. Three thermographs, a Regnault hygrometer, and two dial hygrometers have also been obtained, with a view to a study of atmospheric temperature and moisture within and without the meridian circle room, and their effects on refraction.

The Hough printing chronograph arrived, and tests and alterations have been made. Some of the electric mechanisms and connections were altered, and an arrangement installed for feeding an inked ribbon through, along with the band of paper, to improve the printing; alterations were also made in the governors; by these changes its performance was very much improved, but a new and improved governor is required; this has not yet been made.

During the summer of 1909 a considerable series of transit observations was made with the meridian circle for test purposes, but the results were not satisfactory. In the spring of 1910, after the repairs to the eye-end, the observations have been much improved. A few test observations have also been made in zenith distance. Personal equation observations for clock error are now in progress in preparation for the determination of the longitude of Winnipeg. A description of the star list and method of observation used will be given in the appended report of Mr. R. M. Stewart, Astronomer in charge of time and meridian work.

LONGITUDE WORK.

During the summer of 1909 the longitudes of eleven stations in eastern Canada were determined from Ottawa, two observers being engaged in the field operations (including the determination of latitudes), and three at Ottawa. There were 77 exchanges of time signals on 53 nights. The instruments used were the Cooke transits, 3 inches aperture, 35 inches focal length. The stations determined were: Charlottetown, P.E.I.; Shippigan and Bathurst, N.B.; Sydney, Mulgrave, Yarmouth and Digby, N.S.; and Cochrane, Pickerel, Haliburton and Bancroft, Ont.

Later in the season the latitudes and longitudes of four stations in the west were determined: Erwood and Macdowall, Sask., and Lloydminster and

Stonyplain, Alta. Direct telegraphic communication between such distant points and Ottawa being impracticable, an intermediate station was necessary, to which the longitudes of the out-stations could be referred. Winnipeg was selected, as being the most convenient basal station for the Northwest generally.

The difference of longitude between Ottawa and an astronomical station in Winnipeg had been determined in 1896. It was found, however, that the station then occupied (between Princess and King streets, near Notre Dame) had been since closed in by high buildings and was unsuitable for astronomical observations. A site farther from the centre of the city was necessary, and through the courtesy of the Department of Militia and Defence and the Officer Commanding at Winnipeg, one was obtained on the barracks ground of Fort Osborne. A small transit house was erected there. Thirty-seven exchanges of time were made on 34 nights between the observer at this station and the observer at the four out-stations.

The longitude of the Fort Osborne station relative to Ottawa remains to be determined. This will be undertaken during the present year.

Observations were made here in the autumn to determine the relative personal equations of the observers engaged in the longitude work. The personal equations were found to be of the same order of magnitude as those for the summer of 1908.

The star list used in these observations contained all the suitable stars in Newcomb's Fundamental Catalogue. To the places of stars not contained in the Berliner Jahrbuch, systematic corrections depending on the declination were applied to reduce them to the same system. These corrections were deduced from a comparison of the B. J. stars with their places as given in Newcomb's catalogue.

ASTROPHYSICAL WORK.

This comprises:—

1. Stellar spectroscopy, including measurement of stellar radial velocities, determination of the velocity curves and the elements of the orbits of spectroscopic binary stars, and allied investigations.

2. Solar research, including solar observations with the coelostat and grating spectroscope, solar photographs with the equatorial telescope and other work on similar lines.

3. Micrometric and miscellaneous work, including the measurement of position angles and distances of double stars, determination of the positions of comets, comet and star photography, the observation of occultations of stars by the moon, &c.

During the twelve months ended on March 31 last, 910 star spectra for radial velocity determination were obtained on 144 nights, the total number now on record being 3,368. The velocity curves and orbits of seven spectroscopic binaries have been deduced, and those of seven others are in hand. A loss of light at the violet end of the stellar spectra was traced to a varying collimation error of the correcting lens, due to flexure. This has been corrected by making the lens adjustable.

Investigations of the effect of increase of slit width on the accuracy of velocity determinations and of the relative accuracy obtainable with different dispersions are described in Mr. Plaskett's report, hereto appended. He has found that the slit width may be increased, within certain limits, beyond the width usually employed, without loss of accuracy, and that the probable error of velocities determined increases in a less ratio than that of decrease of dispersion. Both of these results have a useful application, in lessening the time of exposure on a given star, or in enabling fainter stars to be observed.

Some peculiarities in the plane grating used with the coelostat in the solar work were noticed in last year's report. It was found that while the definition could be improved by covering certain parts of the grating, reducing the aperture about one-half, it even then was poor. Some work on solar rotation and on sun spots has been done with it, but the results are unsatisfactory. Steps have been taken to secure a better grating. One is now on trial.

Solar photographs have been taken every clear day with the enlarging camera of the fifteen-inch telescope in order to secure a record of sun-spots.

The micrometric observations of double stars are made with the fifteen-inch telescope, and the stellar and cometary photography with the Brashear star camera which is attached to the tube of the same telescope. As this telescope is also used for the stellar spectrographic work it is not available for the former work every night. In the allotment of the use of the telescope among the different observers only three half nights a week can be allowed for the micrometric and photographic work. To remedy this as far as regards the photographing, it is proposed to procure a separate mounting for the Brashear camera, which will be installed in a small building to be erected to the southeast of the main building.

Tests made of the eight-inch lens of this camera, which were described in last year's report, indicated the presence of considerable spherical aberration. The lens has been refigured by the makers, and now gives much improved definition, star images being sharply defined, without halo.

Good photographs have been taken with it of Comet 1910*a*, which was a conspicuous object in the sunset in the latter part of January, and of Halley's comet. This lens, however, does not cover a wide enough field of view to include the whole extent of the tail of the latter. To give a wider field, a Zeiss-Tessar objective of twelve inches focal length has been mounted on a special adjustable camera attached to the tube of the fifteen-inch telescope near the objective.

GEOPHYSICAL DIVISION.

The seismograph has been in constant operation and has furnished records of all severe earthquakes wherever occurring. This is the only highly sensitive instrument on this continent which has photographic registration, whereby the first preliminary tremors of distant quakes (the most important phase of the phenomenon in regard to earthquake theory) are recorded with certainty. With instruments having mechanical registration, friction or yielding of the parts frequently causes failure to register these small movements. The total number of earthquakes recorded was 86, the most distant being that in Sumatra, June 3, 1909, distant about 9,500 miles. The only Canadian shock was a very light one felt locally on December 10, 1909, which rattled windows, and was accompanied by a noise like that of a rapidly moving heavy wagon.

Exchanges of earthquake bulletins are made with some forty other earthquake stations. These bulletins giving the time of arrival of the pulsations at different points afford material for the study of the constitution of the interior of the earth, for the velocity of transmission of the vibrations of the earth's crust is dependent upon the elasticity and density of the matter through which they pass.

A graphical method has been devised by Dr. Klotz for the determination of the positions of earthquake centres, from the records of three or more stations.

Dr. Klotz attended the International Seismological Conference at Zermatt, Switzerland, in September last, where he presented a paper on 'Microseisms,' a subject which received particular attention at the Conference.

The magnetic survey of Canada was continued in 1909, and observations were taken at 33 stations on the north shore of the river and gulf of St. Lawrence from Quebec to Blanc Sablon, a distance of 750 miles. At each station the three elements, declination, inclination and horizontal intensity, were determined, also the diurnal variation, the observations extending from the greatest eastern elongation in the morning to the greatest western in the afternoon. Observations were taken on September 25, during the great magnetic storm which prevailed on that day; variations in declination amounting to 10° were observed.

The magnetic work was standardized in the usual manner by observations taken at the Magnetic Observatory, at Agincourt, Ont., both before and after the field work.

INTERNATIONAL BOUNDARY SURVEYS.

In my last report the substance of the Boundaries Delimitation Treaty, which was ratified by His Majesty on June 3, 1908, was given, with a brief historical sketch of the various boundary questions which had arisen from time to time in respect to different parts of the southern boundary of Canada, and which, so far as outstanding, were finally settled, with one sole exception, by the Treaty.

The exception was the question of the location of the line in the southern part of Passamaquoddy bay, involving the jurisdiction over a small island, and over certain fishing grounds, the total length of boundary line in dispute being under three miles.

By the Treaty, six months from the date of ratification, *i.e.*, to December 3, 1908, were allowed for the two governments to prepare their 'cases.' The cases were duly submitted by the governments, each to the other, at the date specified.

A further period of six months, or until June 3, 1909, was allowed for the governments to come to an agreement by negotiation, failing which, the Treaty provided that the question should go to arbitration.

The governments failed to reach an agreement before the prescribed date, and steps were taken for the selection of an arbitrator and the submission of the question to him. However, negotiations between the governments for the direct solution of the matter have been resumed, and agreement has practically been reached, which of course will have to be validated by a new Treaty.

The work of surveying and demarcation of the boundary line was carried on during the open season of 1909, on the sections covered by articles 2, 3, 5, 6 and 8 of the Treaty of 1908.

On the second section, following St. Croix river, a Canadian and an American party were employed. The survey consists in the placing of reference monuments on the shores, which are connected by triangulation, and to which the boundary line, following along the deepest channel as determined by hydrographic survey, is referred. The work done extended from the mouth of the river, at Joe's point, to near the towns of St. Stephen and Calais.

The work on the third section was of similar character, the part of the line surveyed being the channel of St. John river from the intersection of the meridian of the source of the St. Croix river to near Edmundston, N.B. One party, a joint one, was engaged on this work.

On the fifth section, which extends from Lake Superior to Lake of the Woods, little work has yet been done. Some reconnaissance for triangulation has been made, and an American party has made a stadia survey of the lower part of Pigeon river. The country is a difficult one to work in, being closely wooded, and with few commanding heights which would facilitate triangulation.

The sixth section runs from the northwest angle of the Lake of the Woods south to the 49th parallel, and thence along the parallel to the summit of the Rocky mountains, a total length of 891 miles. A Canadian party under Mr. J. J. McArthur surveyed the line and placed permanent monuments on it from the point at which he terminated in 1908, which is about 100 miles east of Coutts, Alta., for 100 miles farther east, to a point near Frenchman creek. A United States party surveyed the line from the summit of the Rocky mountains eastward to a point between St. Mary and Milk rivers. This party was accompanied by a Canadian surveyor, and Mr. McArthur's by an American. On the eighth section, following the water boundary in the straits of Georgia, Haro and Fuca, a Canadian party was engaged placing reference monuments on the shores and connecting them to triangulation points, by means of which the governing points of the boundary in the water will be referred to the monuments.

The survey of the boundary of the Alaska 'Coast Strip' under the Treaty of 1903, and the supplementary agreement of 1905, was carried on by two Canadian parties and one United States party.

The part of this line covered by the agreement referred to was finally completed. As stated in my last annual report, the commissioners had selected intervisible mountain peaks, covering the gap of 50 miles, which fulfilled the requirements of the agreement.

The final survey of this section was entrusted to Mr. N. J. Ogilvie, D.L.S., in charge of a large Canadian party, who carried it out successfully. A most unfortunate accident occurred on this survey. Mr. Joseph Shepherd, of Nanaimo, through the breaking of a snow cornice fell two thousand feet down a precipice. Every possible effort was made to recover the body, but without success.

Another Canadian party worked on the Iskut river, a branch of the Stikine, and an American party, which was accompanied by a representative of the British Commissioner, on the tributaries of Unuk river.

The survey of the 141st meridian under the Treaty of 1906 was energetically pushed forward. One Canadian and one American party were employed in placing the permanent monuments, cutting out the vista, and making the triangulation and topographic survey along the line between the Yukon and the Natashat range (part of the St. Elias Alps). A season's work for one party, cutting the vista and placing monuments, is necessary to complete this part of the line. An exploration southward into the Natashat range showed that the 90 miles of line from this point to the Coast Strip boundary at Mt. St. Elias runs through an extremely difficult region of high mountains and glaciers. Further survey in this region, it is thought best to postpone for the present.

Work on the line northward from Yukon river was proceeded with by an American party. Mr. J. D. Craig, who has general charge of the Canadian parties engaged on the 141st meridian, made an exploration of the country between Black and Porcupine rivers with a view to ascertaining the best manner in which the line survey could be carried through it, supplies forwarded, &c.

The precise levelling to connect White Pass with a point on the 141st meridian reached a point on the Whitehorse-Dawson road about 50 miles south of Dawson. There remains a season's work for the party to reach the 141st meridian.

THE GEODETIC SURVEY OF CANADA.

Two observing parties, measuring the horizontal angles of the triangulation, were employed in the Province of Quebec. A large area was covered, and the quality of the work, as exhibited by the closing errors of the triangles, was very good. One observing party was employed for a short time on the triangulation of the Bay of Fundy, but under difficult weather conditions.

Two precise levelling parties were employed, one in Ontario, one in New Brunswick and Quebec, the latter party connecting the United States bench mark at St. Stephen, N.B., with the precise levels of the Public Works Department at Rivière du Loup.

Reconnaissance for selection of triangulation stations was carried on in Nova Scotia, New Brunswick, Quebec, Ontario and (lately) on the British Columbia coast. One tower building party was employed in Ontario.

An invitation having been extended by Sir Geo. H. Darwin, British representative on the International Geodetic Association, and vice-president of the Association, to the Government of Canada to send a representative of the Geodetic Survey of Canada to attend the forthcoming session of the Association in London and Cambridge, I was delegated, and attended the meetings, which were held in London from September 21 to September 25, and in Cambridge from September 28 to September 30. I presented a report of the operations of the Geodetic Survey of Canada from its inception four years before. Much interest was manifested by the attending delegates in this survey, whose existence had been unknown to most of them and whose extent was matter for surprise. The Canadian Government was commended for their decision to have the survey made of primary accuracy, rather than of such less degree of accuracy as might appear to be sufficient merely as a basis for a topographical survey of a particular scale.

The object of the Association is to correlate the results of geodetic surveys and investigations all over the world, with a view to the advancement of knowledge as to the dimensions, figure and constitution of the earth. Meetings are held every three years, at which reports are presented, papers read, and results discussed. To some investigations the Association makes financial contributions. These and the other expenses of the Association are provided for out of the contributions of the countries represented in the Association, comprising almost every nation in the world.

At this last meeting were present delegates from Great Britain, Germany, France, Austria, Belgium, Chili, Denmark, the United States, Hungary, Italy, Japan, Norway, Holland, Portugal, Russia, Siam, Sweden and Switzerland. These countries, being contributing members of the Association, have each, one representative on the central board, the directing body. Many of them, however, had several delegates present. Besides these there were representatives from the British overseas dominions not being contributors, but represented on invitation of Sir Geo. H. Darwin, the British representative, namely: Australia, Canada, Egypt, India and South Africa.

Herewith are submitted as appendices, reports by Dr. Otto Klotz, Messrs. J. S. Plaskett, R. M. Stewart, J. Macara and F. B. Reid, on the work under their respective charge; also the report of Dr. R. A. Daly upon the geology of the region adjacent to the international boundary line between the summit of the Rocky mountains and the strait of Georgia. When the work of resurvey of that part of the boundary line was first begun in 1901, Dr. Daly was appointed geologist to the International Boundary Commissioner (Canadian section), to investigate the geological structure of that interesting region. He continued his investigations in the field and in the study until October 1, 1907, when his field work having been completed, and his report well advanced, he resigned his position to accept a research professorship at Harvard. The completion of his report was delayed by the non-completion of the topographical maps which he needed for illustrative purposes. These having been furnished, he was enabled to complete the report, which he has lately handed in. It is a very complete report, presenting the results of a comprehensive and thorough investigation.

I have the honour to be, sir,

Your obedient servant,

W. F. KING,

Chief Astronomer.

APPENDIX 1.

REPORT OF THE CHIEF ASTRONOMER, 1910.

SEISMOLOGY, TERRESTRIAL MAGNETISM AND GRAVITY.

BY

OTTO KLOTZ, LL.D.

CONTENTS.

ILLUSTRATIONS.

APPENDIX 1.

SEISMOLOGY, TERRESTRIAL MAGNETISM AND GRAVITY, BY OTTO KLOTZ, LL.D.

OTTAWA, ONT., April 1, 1910.

Dr. W. F. KING, C.M.G.,
Chief Astronomer,
Department of the Interior,
Ottawa.

SIR,—I have the honour to submit the following report on the work carried out under my charge: Seismology, Terrestrial Magnetism and Gravity, for the fiscal year April 1, 1909, to March 31, 1910.

SEISMOLOGY.

The instruments which are in service are: two Bosch photographic seismographs, the pendulums being of about 200 grammes each; a Callendar thermograph, electric recorder; a Shaw-Dines microbarograph; they have all rendered continuous and efficient service. No change occurred during the year except with the damping and with the electric lamp for the seismograph. The damping of the pendulums as originally furnished was simply by a vane moving in an air chamber with adjustable sides. This does not produce as much damping as desirable, being less than 2 for the damping ratio, so that the simple vane was changed to an aluminum parallelopipedon of four sides, the rectangle just having room to move in the air-chamber. By this means the damping ratio was about doubled.

The trouble that at times occurred by oscillations being set up in the single filament electric light due in part to its length of about 22cm., is now wholly overcome by having had Siemens and Halske construct lamps of only 14 cm. filament. This necessitated the introduction of a resistance coil, on the 104 volt alternating circuit. The nominal candle-power of the light is 25, but this is maintained for a few hours only, when the brightness settles down to a constancy which is maintained for months before the filament breaks or the glass is dimmed. The four years' experience with photographic registration has been amply justified. The most important phase of an earthquake is the first preliminary tremors or longitudinal waves. For distant quakes the horizontal component of them becomes very weak, so much so that it may fail to be recorded by mechanical registration due to the friction, while the beam of light from the disturbed mirror will leave its trace on the photographic paper.

The Seismograph.

A few years ago Professor Wiechert investigated the theory of seismographs, and his results are now applied by most seismologists. The object of the seismograph is to record the movements of the earth, or more strictly, the movements of the earth particles. It is obvious that in order to attain that end, we must know the behaviour of the instrument when subject to disturbances, pulsations, in short, the theoretical considerations that come into play for the proper interpretation of the seismogram or record.

Wiechert lays down the fundamental theorem that all seismographs may be treated as mathematical pendulums, of lengths dependent upon the period of the respective seismograph. From this it follows that if T_0 = period of the freely oscillating seismograph, $T_0 = 2\pi\sqrt{\frac{L}{g}}$ in which L is the length of the simple pendulum. If we imagine the line of the pendulum to be prolonged to a total length J, then the extremity will give a magnification V, where $V = \frac{J}{L}$ of the motion of the pendulum.

A pendulum or seismograph once set oscillating would continue to do so indefinitely were there no friction, and with equal amplitudes. The friction in seismographs is generally a small quantity, so that the amplitudes do not decrease very rapidly.

The ideal condition of a seismograph would be when the 'bob' or mass were actually a 'steady mass,' and only the frame supporting the pendulum suffered the displacement produced by the motion of the earth particles. As this ideal condition cannot be attained we approach it by 'damping' the pendulum, that is, the induced oscillations of the horizontal pendulum itself by the pulsations of the earth particles are rapidly reduced in amplitude, so as to mitigate the confusion in the record of the motion of the pendulum itself and the motion of the earth particles. The damping is effected in various ways, by air-chambers, by oil, and by a magnetic field, but mostly the first is applied.

In the accompanying figure the damping effect on the amplitude is shown.

The damping ratio would then be

$$\frac{AP}{BP'} = \frac{BP'}{CP''} = \ldots\ldots = \frac{1}{f}$$

If T = period of the damped pendulum, we have in time $\frac{T}{2}$ the amplitude decreased by $\frac{1}{f}$ and in time $n\left(\frac{T}{2}\right)$ the amplitude is reduced $\frac{1}{f^n}$ If we designate by τ the time in which the amplitude is reduced $\left(\frac{1}{e}\right)^{\text{th}}$, where e = base of Napierian logarithms, we have $n = \frac{2\tau}{T}$ and $\frac{1}{f} = \frac{1}{e^{\frac{T}{2\tau}}} = e^{-\frac{T}{2\tau}}$ Hence the damping ratio will be $1 : e^{-\frac{T}{2\tau}}$ or $e^{\frac{T}{2\tau}} : 1$.

This ratio is generally written $\epsilon : 1$.

The equation of the damping curve (friction not being considered) is,

$y = ce^{-kx}(\pi \text{ Cos } \pi x + k \sin \pi x)$ where $c\pi = d$, when $x = 0$. $\epsilon = e^k$ (e = base Nap. log.)

Hence we may write $y = d\epsilon^{-x}\left(\text{Cos } \pi x + \frac{\log e^{\epsilon}}{\pi}\sin \pi x\right)$. Where $y = 0$, *i. e.*, where the curve cuts the axis of x we have $0 = d\epsilon^{-x}\left(\text{Cos } \pi x + \frac{\log e^{\epsilon}}{\pi}\sin \pi x\right)$ or $\text{Cot. } \pi x = -\frac{\log e^{\epsilon}}{\pi}$
from which the value of x or point of intersection is readily found.

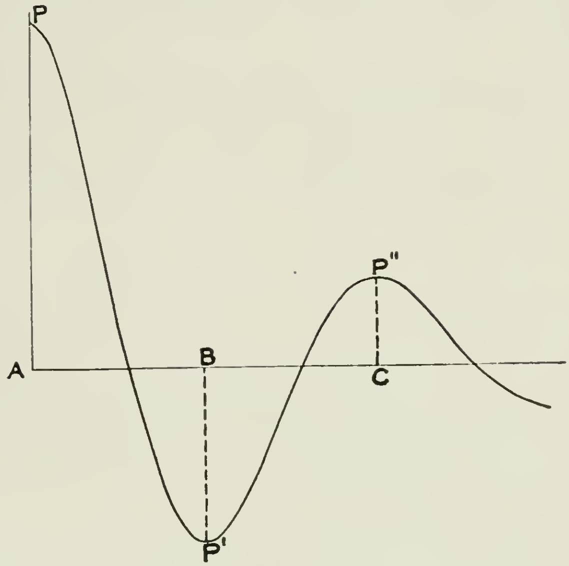

FIG. 1—Damping Curve.

2 : 1

By taking the successive values of x as .1 .2 .3 ..... 1.0, where the last represents the foot of the ordinate after one oscillation, or time $\frac{T}{2}$, and substituting them in the general equation, we obtain the corresponding values of y, from which the curve can be plotted for any particular value of ϵ. Further parts of the curve can be plotted with the preceding values of y by simply reducing them respectively by the constant ratio ϵ for the succeeding oscillation; by ϵ^2 for the next, and so on.

When there is no damping $\tau = \infty$.

The relation between the damped period T and undamped period T_0 is given by

$$T = \frac{T_0}{\sqrt{1 - \left(\frac{T_0}{2\pi\tau}\right)^2}} \text{ or } T_0 = \frac{T}{\sqrt{1 + \left(\frac{T}{2\pi\tau}\right)^2}}$$

The theoretical value of the magnification V of a seismograph may be obtained in various ways: by direct measurement of the displacement of the centre of oscillation of the pendulum with its corresponding displacement of the recording stylus; or, as was done with our Bosch photographic seismograph of 200 grammes, by computing the position of the centre of oscillation from the moments of inertia of the different parts and measuring and comparing this with the distance of the reflecting mirror from the recording surface or photographic sheet. In other cases the compounded system of levers gives the theoretical magnification.

It has been found that the actual magnification with which we have to deal in earthquake records or seismograms is dependent upon the ratio of the period of the pendulum to the period of the oscillating earth particles, and upon the damping ratio.

Preserving the notation so far adopted, and calling $\mathcal{V}$ the actual magnification, T_e the period of the earth particles, we have:

$$\mathcal{V} = \frac{V}{\sqrt{\left\{1 + \left(\frac{T_e}{T_0}\right)^2\right\}^2 + 4\left(\frac{T_0}{2\pi\tau}\right)^2\left(\frac{T_e}{T_0}\right)^2}}$$

Remembering that $e^{\frac{T}{2\tau}} = \epsilon$ and $\left(\frac{T_0}{2\pi\tau}\right)^2 = \frac{T^2}{T^2 + (2\pi\tau)^2}$

the above may be written

$$\mathcal{V} = \frac{V}{\sqrt{\left\{1 - \left(\frac{T_e}{T_0}\right)\right\}^2 + 4\,\frac{(\text{nat. log}\ \epsilon)^2}{\pi^2 + (\text{nat. log}\ \epsilon)^2}\left(\frac{T_e}{T_0}\right)^2}}$$

or adapting it to common logarithms

$$\mathcal{V} = \frac{V}{\sqrt{\left\{1 - \left(\frac{T_e}{T_0}\right)^2\right\}^2 + 4\,\frac{\cdot 537\ (\log \epsilon)^2}{1 + \cdot 537\ (\log \epsilon)^2}\left(\frac{T_e}{T_0}\right)^2}}$$

It will be seen that $\mathcal{V}$ is equal to V when $T_e = 0$, and approaches it when T_e is very small, for all values of ϵ.

Hence at the inset, if sufficiently sharply defined, of the first preliminary tremors we can apply the theoretical magnification.

The best way to get a proper notion of what the expression for $\mathcal{V}$ means is by a graphic representation.

Values of $\mathcal{V}$ in terms of V have been computed for varying values of the ratio $\frac{T_e}{T_0}$, from 0 to 3 by intervals of ·1, which are laid off on the axis of X. On the axis of Y the ratio $\frac{\mathcal{V}}{V}$ is laid off on an arbitrary scale, also at intervals of ·1.

When the ratio $\frac{T_e}{T_0} = 1$, then for $\mathcal{V} = V$ requires a damping $\epsilon = 6{\cdot}13$.

It will be observed that when $\frac{T_e}{T_0}$ exceeds unity the magnification rapidly decreases.

The value of T_e is, of course, not under our control, but the value of T_0, that of the freely (undamped) pendulum is. The periods of T_e are very variable, in the first place depending upon the phase of the quake to which they belong. In the first preliminary tremors they are always short, from a second upward,

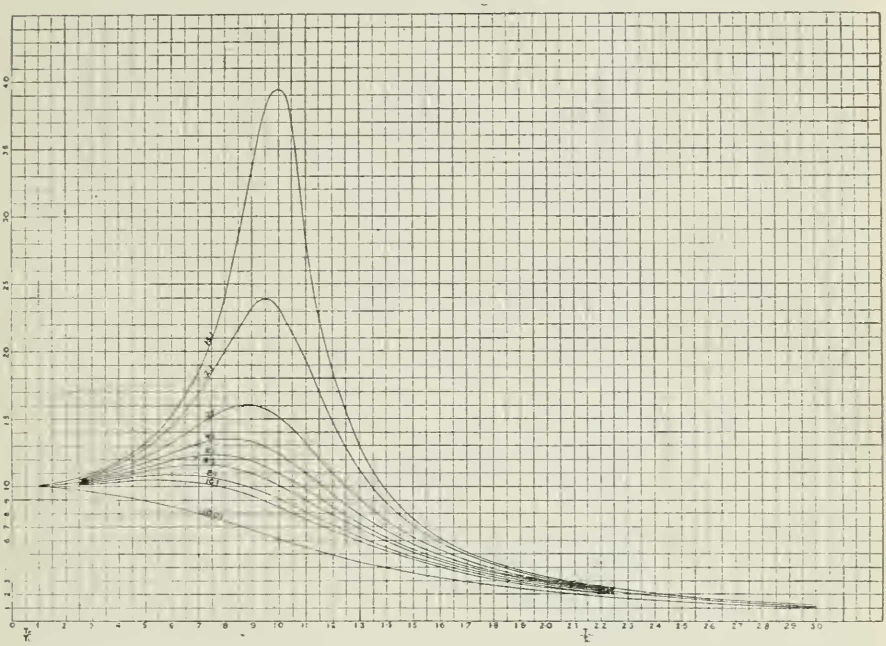

FIG. 2.—Magnification Curves.

while in the principal portion they are always long or relatively long, varying from 6 or 8 seconds to 20 seconds and more. When it is remembered what a medley of pulsations and waves are sent out by the débacle of an earthquake it will be apparent that the finding of uniform periods for any length of time, even for a short time, on the seismogram is scarcely to be expected, and in fact is not found except for the long (Rayleigh) waves, which make their appearance after the longitudinal and transverse waves together with their reflections have died out almost completely.

As stated in the beginning, the object or function of the seismograph is to give us a true story of the movements of the earth particles produced by an earthquake. What interests one, of course, in the first instance is the time element, that is, the time of occurrence of the various phases by means of which we determine the distance to the epicentre. This is done wholly empirically. Curves have been constructed on a rectangular system of co-ordinates from the records of various stations of well known (geographically) earthquakes, showing the progress of the first preliminary, second preliminary and long waves, respectively. So that for any other earthquake if we are able from the seismogram to read the occurrence of the different phases, obtaining thereby the difference of time between the phases, we can readily apply this to the interval between the standard curves above referred to and obtain the distance to the epicentre with a considerable degree of accuracy, say, within one or two per cent.

As the path of the longitudinal and transverse waves is through the earth, the velocity is a function of the depth; so that when the velocity of such waves is spoken of, it is simply the quotient of the arcual distance from the epicentre to the station divided by the time interval, and hence is an average velocity for that particular distance.

With a severe earthquake there is never any difficulty in determining the distance to the disturbed area. When the earthquake is very distant, then the horizontal component of the first preliminary becomes very small, with the result that it probably is not recorded at all; on the other hand, however, we generally find the long waves to predominate and to be well shown. Beside the first and second preliminary tremors it has been found that frequently with well recorded earthquakes, that the seismogram shows reflected waves of the longitudinal and transverse pulsations. It is obvious—taking a once reflected wave of the 1st P.T.—that its angle of emergence is decreased and the horizontal component increased. Although some of the energy is lost, due to the longer path of this reflected wave, yet the increase in the horizontal component may be sufficient to record it, while the original wave fails to do so. The best records we have here of these reflected waves are of Mexican earthquakes.

For a thorough study of a seismogram it would be desirable to examine it again at a future time, when one has received sufficient reports or data from other stations by means of which the earthquake can be definitely located, and thereby pretty approximate times deduced for the various phases for one's own station, and then comparison made with the waves recorded, which at the time may not have been well recognized as to their relative position.

The problem of determining the direction of the epicentre from the station appears at first sight quite simple. We have two seismographs mounted on a pier, one in the N.-S., the other in the E.-W. direction, or one seismograph giving the two components. Let us suppose that the first impulse is sufficiently strong to give a good record at the station. It apparently would follow that $\tan \alpha = \frac{A_E}{A_N}$ where α is the azimuth and A_E, A_N the amplitudes of the east-west and north-south components. The magnification for the two components is assumed to be the same, which is generally the case, or nearly so. Another assumption is made, however, about the truth of which we are not assured, and that is, that the direction with which the pulsation arrives, lies in the plane of the great circle passing through the hypocentre and station, or whether it has not suffered deflections, especially in the latter part of its course through the various geological formations, where the density varies less uniformly than deeper down in the earth. The deviation from the above plane would probably be confined to the depth of the stratum within which gravitational compensation takes place, being at about 120 kilometres. So far as known to the writer, no one has succeeded in definitely deducing the correct azimuth of an epicentre from the reading of a single seismogram, except Prince Galitzin, who has recently presented a paper on the subject, given in 'Bulletin de l'Académie Impériale des Sciences de St. Petersbourg,' entitled 'Zur Frage der Bestimmung des Azimuts des Epizentrums eines Bebens.' He puts the question 'What is the relation between the measured maximum first offset (amplitude) on the galvanometre-seismogram and the corresponding absolute motion of the earth (surface)?' He subjects the problem to mathematical analysis, and deduces a formula especially applicable to the conditions of his apparatus, in which the periods of the pendulum are $22^s{\cdot}1$ and $23^s{\cdot}4$, respectively; and of the galvanometres, $23^s{\cdot}7$ and $23^s{\cdot}2$, correspondingly, while the damping ratio of the former is 1030 : 1, and of the latter ∞ : 1. Galitzin then takes measurements on twelve of his seismograms and computes the azimuth of each epicentre, the geographical co-ordinates of which are known from other sources, and hence the azimuth of each from Pulkowa. It is found that the two azimuths for each agree pretty well; in a number of cases there is coincidence to the individual degree, and the greatest difference is 6°. He sums up the results of his investigation:—

1. 'It is possible from the records of two aperiodic and highly sensitive pendulums (application of the galvanometric registration) to deduce with a fair degree of accuracy the azimuth of the epicentre of an earthquake, from the deflections of the pendulums at the beginning of the first preliminary tremors. As the epicentral distance can be deduced pretty well from the times P and S (first and second preliminary tremors), it follows that the approximate geographical position of the epicentre can be determined from the record of a *single* station.
2. 'The angle between the plane of oscillation of a particle on the surface of the earth at the beginning of the second preliminary tremors, and the principal plane passing through the epicentre, station and centre of the earth is in most cases very small.
3. 'The fact that the azimuth of an epicentre can be determined fairly well from the first preliminary tremors, may be looked upon as a direct proof that the elastic oscillations of the first preliminary tremors really belong to longitudinal waves.'

Galitzin draws attention to the occurrence at times of a small 'nick' immediately preceding and in the opposite direction to the deflection of the first preliminary tremors. This has been observed, too, by the writer and others. The explanation he suggests is the one generally accepted, that it is due to the pier acting momentarily as a pendulum, so that the impulse from the earth to the base of the pier produces apparently a motion in the opposite direction at the top.

In the ultimate analysis of a seismogram we should be able to trace and follow the motions of the earth particles that produce the seismogram, but this is so involved by the different kinds and periods of waves together with superposed motion of the pendulum itself, that there is no prospect for a general and complete solution of the interpretation of the seismogram. The few investigators that have attempted the problem have generally confined themselves to the first preliminary tremors of the longitudinal waves.

The recent 'Thesis' of Hugo Arnold, 'Die Erdbewegung während des ersten Vorläufers eines Erdbebens,' deals with this question. He uses the seismograms of a Wiechert seismograph of 1200 kg., period 12^s to 14^s, magnification 170, and 'relaxation time' 5^s, that is the time in which the amplitude of the damped pendulum is reduced $\left(\frac{1}{e}\right)^{th}$. For examination of the seismogram, the first minute = 1 cm. of the quake is enlarged photographically about ten times and from this the measurements are then made. The registration by the above seismograph is mechanical and involves, therefore, the friction of the stylus, a serious matter, much more so than the friction of the system of levers and connections is. The determination of the position of the zero line of the pendulum also introduces a difficulty.

Only seismograms giving the two horizontal components were considered. The motion of the particle in space is referred to a system of three rectangular co-ordinates, and a general equation of motion is deduced, covering all the terms that enter into the production of the seismogram. This equation becomes simplified for the horizontal components, which are the ones dealt with.

After all the minute measurements, integration of curves, application and insertion of all terms affecting the record, all of which are carried out with great detail, one is forced to conclude that the results are not satisfactory, and that there are at present no immediate prospects of bettering them.

In other directions the modern sensitive seismograph, which is as yet not installed at all seismological stations, is giving us valuable information, and that is, with reference to the constitution of the earth. It is obvious that when a wave is propagated from one part of the earth to another part, the time interval is a function of the density and elasticity of the material along its path. This applies especially to the longitudinal and transverse pulsations whose path lies within the earth. With all the groping of science heretofore about the constitution and condition of the interior of the earth, these pulsations are the first messengers to traverse that interior, and through the seismograph write the story of their journey with indelible pencil. With the better class of seismographs and accurate time, the readings can be made to the individual second, (if no microseisms prevail), especially for the inset of the first preliminary tremors of a severe earthquake,—and only such can enter into a discussion of the propagation of the waves through the earth. The problem is an intensely complicated one, involving not only the constitution and composition of the material along the path, but also the direction of the impulse to the planes of symmetry of the rocks. This latter consideration will probably be confined more particularly to the first hundred kilometres of the earth.

In 1900, Professor Nagaoka published the results of his investigations on the 'Elastic Constants of Rocks and the Velocity of Seismic Waves,' in which he gives the values of E, the modulus of elasticity (Young's), and the modulus of rigidity for rocks ranging from the archæan to the cainozoic period.

Nagaoka says: 'Unquestionably plane waves whose velocity of propagation in an isotropic medium is given by the formula $\sqrt{\frac{\lambda + 2\mu}{\rho}}$ (following Lamé's notation) would seldom come into existence. A complete discussion of waves in quasi-crystalline rocks requires complicated analysis, which necessitates the knowledge of the elastic behaviour of rocks cut in various directions. To obtain a general view of the propagation, I have thought it advisable to calculate $V_l = \sqrt{\frac{E}{\rho}}$ for the longitudinal waves. Suppose that Young's modulus is determined by flexure experiments on a prism cut parallel to a plane of symmetry, then V_l will give the velocity of longitudinal waves travelling through the prism. The velocity in the sense above explained is given under V and the velocity of the transverse wave $\sqrt{\frac{\mu}{\rho}}$ under V_t. I do not mean to say that the actual velocity of longitudinal waves in various rocks is given by V_l, but when such values are not obtainable, V_l will probably give a rough estimate.'

As is to be expected, the rocks of the older formations show in general a higher velocity than do those of more recent origin.

In the experiments, the maximum velocity was found to be about 7 km. per second, which is a little over half the velocity of the first preliminary tremors, which come *through* the earth. From this it is obvious that for the distance beneath the surface of the earth in which we do find a continuous increase in velocity for those waves, the rate of increase of elasticity must be considerably greater than that of density. What the exact limit of increase of velocity is, is not known. It is supposed to be at about 1500 km. The future study of seismograms will, however, reveal it.

Nagaoka significantly says: 'The investigation of the seismic waves affords the best means of feeling the pulse of the interior of the earth: the elastic nature and the density distribution of the constituent rocks, or even the condition of the inaccessible depth will in some future day be brought to light by the patient study of the disturbance, which traverses the strata of heterogeneous structure and appears as tremors or earthquakes on the earth's surface.' In connection with the above quotation, it occurs to one that some central bureau should be charged with the collection of reliable seismograms to be put into the hands of a competent geophysicist for investigation. There is now sufficient material available from which important results as to the constitution of the interior of the earth could be obtained, more than what we now have.

I think it was Dr. C. Chree who a good many years ago* suggested the idea that the ratio of the wave velocities was a way of finding Poisson's ratio, which idea has been recently carried out by Dr. L. Geiger.

In his inaugural dissertation, 'Ueber die Elastizität der Erde' (1908), Alfred Brill utilizes the values of Wiechert and Zöppritz for the velocity of the transverse waves, 4·0 km. at the surface to 6·75 km. at a depth of 1500 km., for the evaluation of the mean coefficient of elasticity for the 'mantle' (of a thickness of 1500 km.), and finds it to be $7{\cdot}13 \times 10^{11}$ C.G.S.; this is very nearly that of plate glass ($7{\cdot}24 \times 10^{11}$) given in Adams and Coker's table (Carnegie Institution Publication, No. 46). In the above value, $7{\cdot}13 \times 10^{11}$, the mean value of V for the mantle is 5·23 km., the mean density 3·2, and the ratio of transverse contraction to longitudinal extension (Poisson's ratio), 0·25.

For the central or remaining inner part of the earth, Brill deduces the elasticity coefficient, $14{\cdot}48 \times 10^{11}$ C.G.S. These values from the nature of the data and the manner in which they are utilized can only be approximate values. However, we can confidently look forward to the time when the records made by highly sensitive and efficient seismographs will give us the data whereby the physical constitution of the earth, step by step, from the surface to the centre will be revealed.

Geiger in a recent paper, 'Ueber Erdbebenwellen' (aus den Nachrichten der K. Gessellschaft der Wissenschaften zu Göttingen. Mathematisch—Physikalische Klasse 1909), says: 'Every substance is characterized in its elastic properties by its coefficients of elasticity; if we knew besides the velocities a and b the density, then we could compute these coefficients of elasticity. However, as the density is unknown, we can at least compute Poisson's ratio, μ, as a function of the depth, which in itself allows important conclusions to be drawn regarding the nature of the substance.'

* Philosophical Mag., March, 1897, pp. 199-200.

Thus applying the expression

$$\mu = \frac{a^2 - 2b^2}{2\ (a^2 - b^2)}$$

for values of the velocities a and b for longitudinal and transverse waves, for depths from 0 to 1400 km., the corresponding values of μ are obtained.

It is found that μ for all depths does not much exceed $\frac{1}{4}$; the extreme values being ·2578 and ·2795.

At the present moment the reading or interpretation of seismograms from different kinds of seismographs often differs relatively many *minutes*, a condition that must be considered intolerable in any investigation.

About what constitutes the best seismograph for geophysical research, the last word has not yet been spoken.

Earthquakes.

The total number of earthquakes recorded during the fiscal year is 86. The most distant one recorded was the earthquake in Sumatra, on June 3, 1909, distant 15,200 km., or about 9,500 miles. It is scarcely necessary to say that every severe earthquake in whatever part of the world is recorded here in Ottawa. The only Canadian quake recorded was the local shock felt in Ottawa on December 10, 1909. It occurred in the early morning hours and many people were awakened, windows rattled, and the noise created resembled that of a rapidly moving heavy dray. The acceleration produced was, however, small, being 312 microns per second per second, or 31 milligals. This part of Canada being so free from earthquakes—in fact nearly the whole of Canada may be regarded as a non-seismic area—the slightest disturbance alarms the people unduly.

The following is the list of the earthquakes recorded, with the times, periods and amplitudes of the various phases.

RECORD of the Earthquake Station, Dominion Astronomical Observatory, Ottawa, Canada. Latitude, 45° 23′ 38″, Longitude, 75° 42′ 57″, or $5^h\,02^m\,51^s.8$ W. Greenwich. Time: Mean Greenwich, midnight to midnight. Instruments: Two Bosch photographic horizontal pendulums. Nomenclature: Göttinger.

No.	Date.	Char.	Phase.	Time.	Period.	Amplitude.		Remarks.
						A_E	A_N	
	1909.			h. m. s.	s.	μ	μ	
1	Apl. 10...	*I*	*P*	5-44-38?	.....	......	.....	
			S_N	5-53-34?	.....	......	...	
			S_E	5-55-16?	.....	......	.....	
			L_N	6-16-20	.....	......	.....	
			L_E	6-17-32	.....	......	......	
			M_N	6-24	20	2	......	
			M_E	6-26	20	......	6	
			F	7-30	....	......	...	
2	Apl. 10...	*II*	P_N	18-56-35	2	......	....	
			S	19-04-24	7	......	....	Distance epicentre 6,300, *P* not recognizable for E-W component.
			L_E	19-14-00	....	......	......	
			M_E	19-20	14	10	......	
			M_N	19-22	14	......	12	
			$M^1{}_E$	20-24	14	6	.....	
			$M^1{}_N$	20-27	14	......	8	
			F	21	......	......	......	
3	Apl. 16...	*I*	P_N?	3-30-38	....	....	......	
			S?	3-33-20	......	......	......	
			F	3-45	....	....	.....	
4	Apl. 23...	*I*	*eL*	18-01-40	24	....	......	
			F	18-30	....	......	......	
5	Apl. 24...	*I*	*P*	13-39-06	......	......	.....	
			S	13-44?	....	......	......	
			L	13-50-50	16	......	......	
			M	13-54	....	5	....	
			F	14-25	....	......	......	
6	Apl. 25...	*I*	P_N	1-21-10	......	......	......	
			P_E	1-21-18	.....	..	..	
			M_N	1-27 44	5	....	12	

RECORD of the Earthquake Station, Dominion Astronomical Observatory, Ottawa, Canada, &c.—*Continued.*

No.	Date	Char.	Phase.	Time.	Period.	Amplitude. A_E	Amplitude. A_N	Remarks.
	1909.			h. m. s.	s.	μ	μ	
	Apl. 25..	*I*	M_E	1-28-20	5	10	...	
			F	2-00	....	.	.	
7	Apl. 27...	*I*	*P*?	13-03-40	....	...	....	
			S?	13-15-36	....	..	....	Strong microseisms present, *L* alone well recognizable.
			i	13-24-40	....	......	..	
			L	13-41-40	24	2	.....	
			F	14-20	.....	....	.....	
8	Apl. 28...	*I*	*P*	7-18 42	......	......	......	
			F	7-30	....	.....	.....	
9	Apl. 29...	*I*	*e*	23-02-40	...	.....	....	
			eL	23-48	20	......	.....	
			M	24-02	20	3	......	
			F	24-30	....	....	....	
10	May 2...	*I*	*eL*	19-14	20	......	......	
			M	19-17	20	2	...	
			F	19-40	....	....	......	
11	May 5...	*I*	*P*	2-48-20?	....	.....	......	
			S	2-50-40	......	......	....	
			L?	2-53-20	....	...	.....	
			M	2-54	7	17	....	
			F	3-24	......	......	.....	
12	May 12...	*I*	P_N	0-14-30?	.....	.....	......	
			P_E	0-15?	......	......	....	
			S	0-21-16	......	......	.....	
			L	0-25-14	....	......	......	
			M_E	0-29	7	8	.	
			F	1-30	......	....	......	
13	May 16..	*I*	*P*	4-18-28	......	......	....	Epicentre 2,500 km.
			S	4-22-28	....	......	.....	
			L	4-24-20	....	......	......	

RECORD of the Earthquake Station, Dominion Astronomical Observatory, Ottawa, Canada, &c.—*Continued.*

No.	Date.	Char.	Phase.	Time.	Period.	Amplitude. A_E	Amplitude. A_N	Remarks.
	1909.			h. m. s.	s.	μ	μ	
	May 16...	*I*	*M*	4-25-12	7	17	......	
			F	5-00	......	......	......	
14	May 17...	*II*	*P*	8-13-17	......	.....	.....	
			S	8-21-47	....	.....	......	
			L	8-35	19	...	......	Epicentre 7,000 km.
			M_N	8-22	....	......	35	
			M_E	8-23-40	....	100	.....	
			F	10-12	......	......	......	
15	May 18...	*II*	*P*	16-58-22	......	.....	.....	
			S	17-04-55	....	.....	.....	
			M_N	17-05-30	....	.....	17	Epicentre 4,900 km.
			M_E	17-08-40	....	30	....	
			F	18-00	......	.....	.....	
16	May 18...	*II*	*P*	18-24-52	....	......	......	
			S	18-31-26	....	.....	.....	
			M	18-32-32	....	12	8	Epicentre 4,900 km.
			F	19-18	....	...	......	
17	May 23...	*I*	*P?*	5-39-16	......	...	......	
			S?	5-46-16	......	......	......	
			L?	5-30-36	13	......	......	
				6-15	...	......	......	
18	May 25...	*I*	*eL*	5-43	20	.....	......	
			F	6-24	......	......	......	
19	May 26...	*I*	*e*	2-30	......	......	.....	
			eL	3-05	20	.....	......	
			F	3-40	....	...	..	
			e	13-03·5	.....	.....	......	
20	May 26...	*I*	*e*	14-27·5	......	..	...	
			e	14-45·5	....	....	......	
21	May 30...	*I*	*eL*	6-57	....	......	......	
22	May 30...	*I*	*P*	21-24	....	......	.....	

RECORD of the Earthquake Station, Dominion Astronomical Observatory, Ottawa, Canada, &c.—*Continued.*

No.	Date.	Char.	Phase.	Time.	Period.	Amplitude. A_E	Amplitude. A_N	Remarks.
	1909.			h. m. s.	s.	μ	μ	
	May 30...	*I*	*S*	21-30	......	....	.....	
			L	21-34	8	......	.....	
			F	22-10	.....	....	.....	
23	June 3....	*II*	P_N	19-02-40	......	......	.....	
			P_E	19-03-24	......	......	.....	
			S_N?	19-15-13	......	.....	.....	
			S_E?	19-21	......	......	...	Long waves well shown.
			eL_N	19-30	22	......	.....	
			eL_E	19-37	20	......	......	Korinchi earthquake, Sumatra?
			L_N	19-41	22	......	......	Epicentre 15,200 km.
			L_E	19-42	52	......	.....	
			L_E	19-46	66	......	......	
			L_N	19-49	38	......	......	
			M	20-03-30	18-20	17	17	
			F	21-15	......	......	.....	
24	June 6....	*I*	*e*	5-49	......	...	......	
			eL	5-55	.....	......	....	
			L	5-59	20	......	......	
			F	6-10	.....	.....	......	
25	June 8....	*I*	*P*	5-57-52	......	......	.....	
			S	6-07-09	.....	22	10	
			eL_E	6-19-34	34	......	......	
			M_E	6-21	34	10	....	
			M_N	6-35	.....	....	10	
			L_E	6-30	18	......	......	
			F	8-00	......	.....	.....	
	June 9....	*I*	*P*	0-34	...	......	......	
			S	0-48-07	......	......	......	
			L	1-08	......	......	.....	
			M_N	1-12	18	......	2	Epicentre 13,000 + km.

Record of the Earthquake Station, Dominion Astronomical Observatory, Ottawa, Canada, &c.—*Continued.*

No.	Date.	Char.	Phase.	Time.	Period.	Amplitude. A_E	Amplitude. A_N	Remarks.
	1909.			h. m. s.	s.	μ	μ	
	June 9...	*I*	M_E	1-12	16	1	......	
			F	1-35	....	...	.....	
27	June 11...	*I*	*eL*	20-40	.....	..	..	No other phases recognizable. Earthquake south of France.
28	June 12...	*I*	*P*	20-40	....	....	......	
			eL_E	21-36	24	......	...	
			eL_N	21-42	18	.....	......	
			L_E	21-40	20	.....	.....	
			F	22-24	....	......	......	
29	June 22...	*I*	*P*	13-15-42	.....	...	......	
			S	13-25-00	5-7	6	2	Epicentre 8,000 km.
			L	13-38	20	....	....	
			M	13-49	....	1	.....	
			F	14-25	.....	.....	....	
30	June 27...	*II*	*P*	7-33-36	......	......	......	Epicentre 11,100 km.
			S	7-45-26	......	......	....	
			L	8-14-36	20	...	.....	
			M	8-20	18	5	....	
			F	9-15	....	......	......	
31	July 7...	*II*	*P*	21-50-42	....	......	......	
			S	22-00-54	.....	......	25	Epicentre 10,000 km.
			L	22-20	16	.....	......	
			M	22-22	16	17	10	
			F	23-50	......	......	....	
32	July 13...	*I*	*P?*	13-24-47	......	...	.....	
			iS	13-34-00	8	10	......	No *L* recognizable.
			F	14-10	....	.....	....	
33	July 17...	*I*	*i*	10-55-21	7	6	......	
			F	11-10	....	.....	......	
34	July 20...	*I*	*i*	18-41-23	....	.....	.....	
			F	18-46	....	.....	......	

RECORD of the Earthquake Station, Dominion Astronomical Observatory, Ottawa, Canada, &c.—*Continued.*

No.	Date.	Char.	Phase.	Time.	Period.	Amplitude. A_E	Amplitude. A_N	Remarks.
	1909.			h. m. s.	s.	μ	μ	
35	July 21...	*I*	*P* ?	4-07-17	....	.....	......	
			M	4-20	7	3	......	
			F	4-50	....	......	......	
36	July 25...	*I*	*e*	1-55-30	......	.....	....	
			F	3-02	......	....	......	
37	July 25...	*I*	*e*	7-56-20	......	.....	.....	
			i	8-02-30	......	......	......	
			M	8-17	8	2	.....	
			F	8-57	....	.....	......	
38	July 30...	*II*	*iP*	10-58-44	3	...	.....	Quake in Mexico.
			S	11-04-16	....	......	.....	Epicentre 3,750 km.
			L	11-07-40	....	.....	......	
			M_E	11-15	24	167	.....	
			F	13	....	.....	.....	
39	July 31...	*I*	*c*	10-00	....	....	.....	
			F	10-25	......	......	....	
40	July 31...	*II*	*iP*	19-25-48	......	......	....	
			S	19-31-20	.....	......	......	
			L	19-38	......	......	.....	Epicentre 3,750.
			M	19-42	24	50	......	Mexico.
			F	21-25	......	......	.....	
41	Aug. 1...	*I*	*e*	21-48	7	....	......	
			F	22-22	......	......	...	
42	Aug. 7...	I_u	*c*	17-07-22	....	......	......	
			S ?	17-17-40	......	.....	...	
			M	17-48	20	2	......	
			F	18-45	....	.....	.....	
43	Aug. 14...	I_u	*P*	6-54-46	....	......	.....	
			L ?	7-16	36	....	......	Earthquake in Japan. Epicentre 10,600 km.
			L	7-21-40	19	......	......	
			L	7-22-20	......	....	.....	

RECORD of the Earthquake Station, Dominion Astronomical Observatory, Ottawa, Canada, &c.—*Continued.*

No.	Date.	Char.	Phase.	Time.	Period.	Amplitude. A_E	Amplitude. A_N	Remarks.
	1909.			h. m. s.	s.	μ	μ	
	Aug. 14...	I_u	*M*	7-31	16	9	6	
			F	8-13	....	....	.....	
44	Aug. 16..	*II*	*P*	7-06-13	4	......	......	
			S	7-12-11	.....	......	.....	
			L	7-18-12	......	......	......	Epicentre 4,700 km.
			M_E	7-18-30	20	85	.....	
			M_N	7-20-30	17	....	33	
			F	8-32	....	......	......	
45	Aug. 18...	*I*	*P*	1-00-09	......	......	.....	
			S	1-10-14	....	....	....	
			L	1-36	......	....	......	
			M	1-42	21	10	.....	
			F	2-27	......	.....	.....	
46	Aug. 31...	*I*	P_E	12-04-29	......	......	......	Microseisms present.
			P_N	12-04-43	....	.....	......	
			S	12-10-24	.....	......	......	
			M	12-11-08	......	......	8	
			M_E	12-11-20	......	25	.....	Epicentre 3,900 km.
			L	12-14	15	.....	......	
			F	13	.....	......	.....	
47	Sep. 8....	I_u	*iP*	16-59-25	....	..	.....	
			iS	17-07-19	....	....	...	Epicentre 6,400 km.
			L_N	17-14	.....	....	.....	
			L_E	17-16	.....	.....	.....	
			M_N	17-18	22	...	10	
			M_E	17-22	20	27	.....	
			F	20	....	......	......	
48	Sep. 16...	I_u	*eS?*	20-01-50	....	....	......	Microseisms mask record.
			eL	20-25	20	....	.....	
			F	20-45	......	..	.....	

RECORD of the Earthquake Station, Dominion Astronomical Observatory, Ottawa, Canada, &c.—*Continued.*

No.	Date.	Char.	Phase.	Time.	Period.	Amplitude. A_E	Amplitude. A_N	Remarks.
	1909.			h. m. s.	s.	μ	μ	
49	Sep. 19....	I_u	*e*	20-28	......	......	....	
			M	20-45	......	37	14	
			F	21-20	......	......	.....	
50	Oct. 2....	*I*	*e*	8-11-17	......	......	.....	
			F	8-22	......	.....	......	
51	Oct. 3....	*I*	*e*	15-08	....	.....	......	
			M	15-11	......	4	...	
			F	15-20	......	......	....	
52	Oct. 3....	*I*	*e*	17-06-22	......	.....	......	
			M	17-13-40	.....	4	...	
			F	17-23	......	......	......	
53	Oct. 3....	*I*	*e*	21-03-21	....	......	......	
			M	21-07-30	.....	12	.....	
			F	21-21	......	......	...	
54	Oct. 18...	*I*	*e*	8-36	......	.....	......	
			M	8-49	......	18	....	
			F	9-25	......	......	.....	
55	Oct. 21....	*I*	*e*	0-06	......	.....	....	
			eL	0-27	......	.....	......	
			M	0-33	25	3	1	
			F	1-30	......	.....	......	
56	Oct. 29....	*I*	*e*	7-00	......	......	......	Earthquake Eureka, California.
			M	7-06-52	10	12	10	
			F	7-30	......	......	......	
57	Oct. 31....	*II*	*P*	10-30	4	......	......	Relay to cut off light for time-scale failed after 7 h. G. M. T. - Hence time for *P* is assumed, and other phases based thereon.
			PR_1	10-31-27	......	......	......	
			S	10-35-40	......	......	....	
			eL	10-39-20	......	......	......	
			L	10-40-44	40	.....	....	

Record of the Earthquake Station, Dominion Astronomical Observatory, Ottawa, Canada, &c.—*Continued.*

No.	Date.	Char.	Phase.	Time.	Period.	Amplitude.		Remarks.
						A_E	A_N	
	1909.			h. m. s.	s.	μ	μ	
	Oct. 31...	II	M_N	10-45-04	....	......	25	
			M_E	10-46-00	....	42	......	Epicentre 4,000 km.
			F	11-30	....	....	.....	
58	Nov. 10...	I	eP	6-41	....	......	.....	
			i_N	6-47-13	....	......	......	Microseisms prevailed. No distinct *M*.
			eL	6-47-26	14	.....	.....	
			L	6-49	15	......	......	
			L	7-00 to 7-12	21	......	.....	
			F	8-25	....	.....	.....	
59	Nov. 14...	I	eP	11-58-48	......	......	......	
			F	12-20	....	......	......	
60	Nov. 21...	I	eL	8-33	22	......	......	Strong microseisms present and mask other phases.
			F	9-06	....	......	......	
61	Nov. 22...	I	iS ?	19-52-22	....	....	...	
			eL	20-02	8	......	......	Microseisms mask phases.
			L	20-15	13	......	......	
			F	21	......	......	......	
62	Dec. 4...	I	P	1-21-29	......	......	......	
			S	1-27-07	6	......	......	
			L	1-31	10	......	.....	
			M	1-38	10	6	3	
			F	2-10	....	....	......	
63	Dec. 9....	II	P	15-54-18	......	......	......	
			S	15-59-44	....	....	......	
			L	16-04-13	11	...	...	Epicentre 3,800 km.
			M	17-00	16	8	4	
			F	18-10	.....	.....	....	
64	Dec. 9....	I	i	22-09-08	......	......	......	
			L	22-23	12	.....	......	
			F	23-20	......	....	.....	

RECORD of the Earthquake Station, Dominion Astronomical Observatory, Ottawa, Canada, &c.—*Continued.*

No.	Date.	Char.	Phase.	Time.	Period.	Amplitude. A_E	Amplitude. A_N	Remarks.
	1909.			h. m. s.	s.	μ	μ	
65	Dec. 9....	I	P?	23-46	......	......	.....	
			iS?	23-57-30	....	.....	......	
			L	24-20	31	......	....	
			F	25-21	......	....	......	
66	Dec. 10..	I_v	i	6-24-10	1	8	8	Local shock. Windows rattled. People awakened. Noise resembled that of rapidly moving heavy dray. Duration 5s. Acceleration 31 milligals
67	Dec. 22...	I	eL	10-40	10	....	......	
			F	10-49	......	......	.....	
68	Dec. 22...	I	eL	13-52	16	.....	......	
			M	14-00	16	5	....	
			F	14-20	......	.....	.....	
69	1910. Jan. 10...	I	e	5-42	....	......	......	Earthquake of Jan. 1 not recorded.
			L	5-53·5	14	......	......	Clockwork of cylinder out of repair.
			M	6-00	7	8	3	
			F	6-30	......	.....	.....	
70	Jan. 12...	I	e?	2-28	......	......	......	
			e	2-42·7	....	......	.....	
			M	2-45	14	1	....	
			F	2-53	....	....	......	
71	Jan. 22...	II	P	8-55-35	3	......	......	
			PR_1	8-57-16	3·1	......	......	Distance to epicentre 4,100 km.
			S	9-01-29	8	....	.....	
			L	9-04	.....	......	......	
			M	9-11·5	13	80	50	
			F	10-52	......	.....	......	
72	Jan. 23...	I	P	18-56-34	4·4	......	....	
			PR_1	18-58-12	......	......	.....	Distance epicentre 4,100 km.
			S	19-02-19	5·6	17	10	

RECORD of the Earthquake Station, Dominion Astronomical Observatory, Ottawa, Canada, &c.—*Continued.*

No.	Date.	Char.	Phase.	Time.	Period.	Amplitude. A_E	Amplitude. A_N	Remarks.
	1910.			h. m. s.	s.	μ	μ	
	Jan. 23...	I	L	19-05	40	......	......	No decided maximum.
			F	20-10	....	......	......	
73	Jan. 30...	I	e	4-10	....	......	......	Microseisms mask phases. No maximum.
			eL_E	4-54 to 5-15	28 to 14	......	......	
			F	5-58	....	......	......	
74	Jan. 30...	I	eP?	16-21-30	....	......	......	
			L	16-23-34	10	......	......	
			M	16-22-30	....	9	......	
			F	16-36	....	......	......	
75	Feb. 3...	I	e	17-26	....	......	......	
			eL_E	17-52 5	24	......	......	
			L_E	18-06	16	......	......	
			F	18-25	....	......	......	
76	Feb. 4...	I	eL	14-33	20	......	......	All of E-W component.
			L	15-01 to 15-06	21	......	......	
			L	15-08 to 15-13	17·5	......	......	N-S component less strong.
			L	15-17 to 15-25	16	......	..	
			M	15-10	....	10	.....	
77	Feb. 4...	I	L_E	19-42	17·5	......	......	
			F	20-00	....	......	......	
78	Feb. 12...	I	e ?	18-27	....	....	.....	
			i	18-33-00	6	6	10	
			i	18-33-43	8	14	7	
			L	18-36	13	......	....	
			F	19-20	....	......	......	
79	Feb. 18...	I	e	5-29-42	....	......	......	
			F	5-52	....	......	...	Quake in Crete.
80	Feb. 18...	I	e	7-29	....	......	......	
			M	7-43·6	....	3	......	
			L	7-45	18	....	......	
			F	8-00	....	....	......	

RECORD of the Earthquake Station, Dominion Astronomical Observatory, Ottawa, Canada, &c.—*Continued.*

No.	Date.	Char.	Phase.	Time.	Period.	Amplitude. A_E	Amplitude. A_N	Remarks.
	1910.			h. m. s.	s.	μ	μ	
81	Feb. 21...	*I*	*e*	3-50-25	....	......	.....	
			M	3-50-40	4	6	5	
			F	3-55	....	.....	.....	
82	Feb. 28...	*I*	*P*	21-08-43	....	......	.....	Long waves show up well from 9-26 to 9-52.
			PR_1	21-10-32	....	......	......	
			S	21-15-28	....	.....	......	
			eL ?	21-19	15	......	......	
			L	21-26	23	.....	......	
			M	21-27	23	9	10	
			L	21-39	11	......	......	
			F	22 25	....	......	......	
83	Mar. 11...	*I*	*eL*	7-10·5	....	......	.....	Earthquake in California.
			L	7-12	9	....	....	
			M_N	7-13	....	.....	2	
			F	7-32	.....	......	......	
	Mar. 18...	....	....	....	....	......	..	Recording clockwork under repairs.
84	Mar. 25...	*I*	*e*	15-21	....	......	......	No record on preceding sheet for some hours. The *e* seem to be trailers of a preceding quake.
			P ?	15-35-15	4	......	3	
			S	15-44-32	.....	6	..	
			L	15-52·5	16	.....	......	
			F_E	16-10	....	......	......	
			F_N	21	....	......	......	
85	Mar. 30...	*I*	*P* ?	17-01-38	....	....	......	*P* and *S* through small microseisms very uncertain.
			S ?	17-16-25	4	......	......	
			eL	17-26	20	.....	......	
			M	18-00	24	10	5	
			L_E	17-57 to 18-05	24	....	.....	
			L_E	18-09 to 18-17	16	.....	......	
			F	19·5	....	......	.....	

RECORD of the Earthquake Station, Dominion Astronomical Observatory, Ottawa, Canada, &c.—*Continued.*

No.	Date.	Char.	Phase.	Time.	Period.	Amplitude. A_E	Amplitude. A_N	Remarks.
	1910.			h. m. s.	s.	μ	μ	
86	Mar. 31...	*I*	*eL*	18-46	......	....	.....	N-S comp. shows scattered disturbances during preceding 3 hours.
			L	19-20 to 19-27	22	......	......	
			M	19-20	......	1	2	
			F	20-00	......	......	......	

The foregoing earthquakes are compiled from the 21 bulletins issued during the year. Every month one or more bulletins of the earthquakes of the preceding month are issued and sent to some fifty other earthquake stations, from the most of which we receive in return similar bulletins. This exchange of bulletins is essential for the study of earthquakes and the constitution of the interior of the earth. Unfortunately the nomenclature lacks uniformity at the various stations, and the data are far from being of equal value.

For our bulletins the Göttingen designations are adopted, as follows:—

Character of the earthquake—

I = noticeable. *II* = conspicuous. *III* = strong.
d = (terræ motus domesticus) = local earthquake (sensible or felt).
v = (terræ motus vicinus) = near earthquake (under 1,000 km.).
r = (terræ motus remotus) = distant earthquake (1,000 to 5,000 km.).
u = (terræ motus ultimus) = very distant earthquake (over 5,000 km.).

Phases—

P = (undæ primæ) first preliminary tremors.
S = (undæ secundæ) second preliminary tremors.
L = (undæ longæ) long waves (principal portion).
M = (undæ maximæ) (greatest motion in principal portion).
C = (coda) = trailers.
F = (finis) = end of visible disturbance.

Nature of the motion—

i = (impetus) = beginning.
e = (emersio) = appearance.
T = period = twice time of oscillation.
A = amplitude of earth movement, reckoned from zero line.
A_E = E-W component of *A* } measured in microns (μ).
A_N = N-S " *A* }

As *A* is not well adapted to express the severity of a quake, the sympol Δg has been introduced to denote the change of g (gravity). We have the general expression for acceleration $f = \frac{v^2}{r}$ where v = velocity and r = radius, which in the above notation = *A* in microns.

Again $v = \frac{2\pi A}{T}$, hence $f = \frac{4\pi^2 A}{T^2}$. As $\pi^2 = 10$ approximately, we may write $f = \frac{40 A}{T^2}$.

If we denote by gal the acceleration of 1 cm. per second per second, and by milligal the acceleration of 1/1000 cm. or 10 μ per second per second = $\triangle g$, then approximately $\triangle g = \frac{4 A}{T^2}$.

As g = 980 gals (for latitude 45°), hence approximately $\triangle g$ = the one millionth of g.

Earthquake Epicentres.

As very many earthquakes occur either in uninhabited areas or in the ocean, it is desirable when the disturbance has been world-wide to locate the epicentre. So far no one has succeeded in obtaining an accurate position for the epicentre from a single station except Prince Galitzin, of St. Petersburg.

It may be premised that the distance to the epicentre from any earthquake station provided with a sensitive seismograph and good time-scale, can be obtained pretty accurately, provided a good record has been obtained showing the various phases, especially the first and second preliminary tremors, for the speed of the longitudinal and transverse waves which respectively propagate these tremors, is pretty well known for varying distances, the speeds increasing with the depth up to the limit of about 1,600 km. depth. The surface or long waves have practically a constant velocity for all distances, being about 200 km. per minute, while the longitudinal waves, which are the fastest, attain a maximum of about 800 km. per minute, and the transverse waves a maximum of about 450 km. per minute.

From the difference of time of arrival of the first and second preliminary tremors we have then sufficient data for giving us the distance to the epicentre. And if we have the distances from three stations, preferably widely separated, the epicentre becomes fixed. However, there are always more than three stations available for finding the geographical position of the epicentre or place where the earthquake happened. To find the epicentre we may proceed in different ways. We may employ a large globe and describe circles with radii equal to the respective distances from the different stations, and note their intersections, which will never be exactly at a common point. Or we may solve by least squares, which takes considerable time; or lastly, we may obtain the position of the epicentre graphically. This last method it is intended to describe briefly, and give a practical application of it for the recent earthquake of January 22, 1910, near Iceland.

The principles of the method involved are well known, being those of stereographic projection; it is simply their application for this particular purpose. This method is nothing more or less than the projection of the circles of the first method on the plane of the equator, with the eye at one (south) of the poles.

In the stereographic projection, the projecting point is supposed to be at the pole of the primitive circle. In this projection all small circles are projected as circles. This particular feature makes this projection for our purpose available, which would not be the case were the projection an ellipse.

On our sphere we imagine a circle described from each station with a radius equal to the distance to the epicentre, *i.e.*, the epicentre must lie somewhere on the circumference of this circle. Let us for a moment consider the projection in order to find the quantities with which we have to deal.

In the accompanying Fig. 3, O is the point of projection, $A\ B$ the trace of the primitive plane upon which the projections are made. P is the station, having the latitude φ. $P\ F = P\ E$ are arcual radii or distance to epicentre, the kilometres being converted into arc (10,000 km. = 90°). $F\ E$ is then the orthographic projection of the small circle about P. This circle projected on the primitive plane will cut it in H and K, *i.e.*, $H\ K$ is its diameter, and the middle point of $H\ K$ or I is the centre of the projected circle, giving $H\ I$ and $I\ K$ as radii. $N\ I$ is the distance from the pole from which our circle is to be described, as we shall see presently.

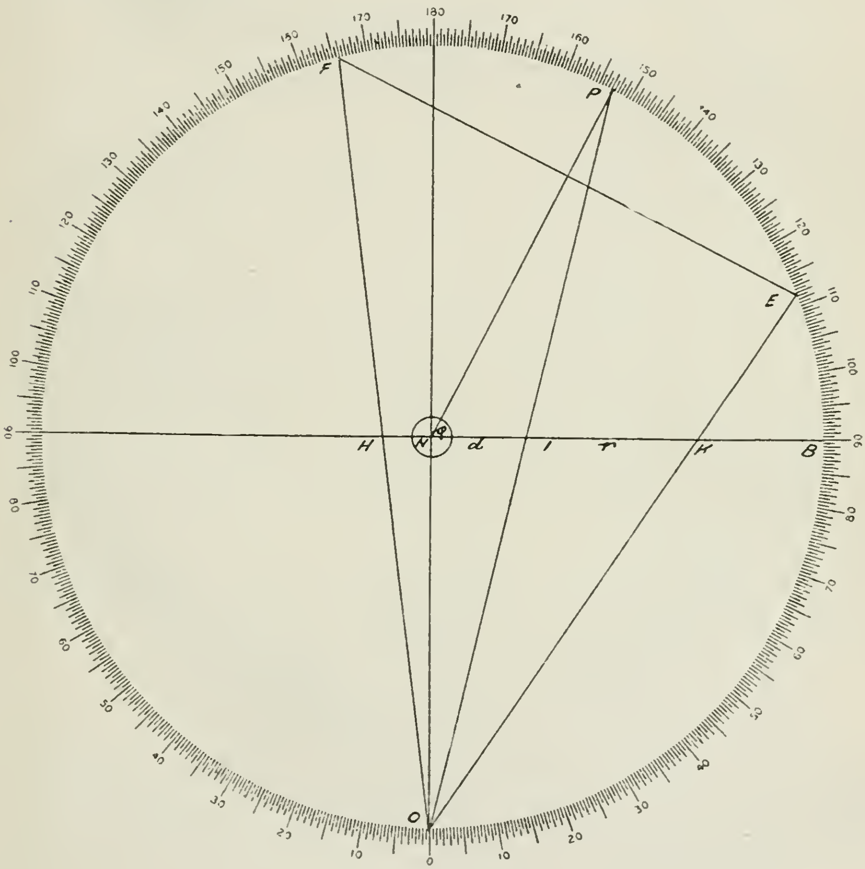

Fig. 3.

$H\ I$ and $N\ I$ are the two quantities that we require for the final construction and location of the epicentre,—and as seen above they can be found graphically.

From mathematical considerations, if we call the distance $P\ F$, $P\ E$ equal to Δ in arc, $H\ I$ the radius = r, = $I\ K$, and $N\ I$ the polar distance = d, ($N\ O$ = unity), then $d = \frac{\text{Cos}\ \varphi}{\text{Sin}\ \varphi + \cos \Delta}$ and $r = \frac{\text{Sin}\ \Delta}{\text{Sin}\ \varphi + \cos \Delta}$. These formulae are general, and by paying attention to the signs are applicable for either hemisphere. When the sum of $\sin \varphi + \cos \Delta$ is negative, d is negative and is measured in the opposite direction from the centre, *i.e.*, on the longitude line of $180° + \lambda$. The case may arise where $\sin \varphi + \cos \Delta = 0$, *i.e.*, one extremity of the diameter of the orthographic projection of the circle for locus of epicentre about a station coincides with the projecting point (O in the figure). Hence the stereographic projection of such extremity would be at infinity, and both d and r become infinite. Then the circle described by r would be a straight line at right angles to the longitude line of the station, and at a distance from the centre equal to $\tan \left\{ \frac{\Delta}{2} - \left(45° - \frac{\varphi}{2}\right) \right\}$, which in the figure corresponds to the point H, where $\frac{\Delta}{2}$ is greater than $45° - \frac{\varphi}{2}$ or $\Delta > 90° - \varphi$. In the other case the distance from the centre would be measured in the opposite direction. Most of the recorded earthquakes so far are in the northern hemisphere, so that the projection of the epicentre falls within the projection of the equator. Those in the southern hemisphere would of course fall without, as the one that was plotted for Korinchi in Sumatra does.

Although in many cases we can find d and r easily, graphically, when the projected points do not fall too far from the centre; however, when the point to be projected approaches the projecting point (O) it is more satisfactory to compute d and r. I have tabulated for earthquake stations whose records are utilized, the values of φ, λ, $\sin \varphi$ (in nat. No.) and $\cos \varphi$ (in log.). This combined with the printed forms we have (seen on a reduced scale in fig. 4), a circle graduated from 0° (Greenwich) to 180° in both directions, radius 10 cm., enables one to locate the epicentre from several stations in an hour or less. A circle of 15 or 20 cm. radius would give greater accuracy in plotting, but the one adopted is quite in keeping with the accuracy of Δ deduced from seismograms at present.

We shall proceed now to an actual construction, using three stations whose geographical co-ordinates are known, taking for illustration the earthquake of January 22, 1910 (fig. 6), of which the seismogram is shown:—

Ottawa, $\varphi = 45° 24'$, $\lambda = 75° 43'$ W, Δ = 4,120 km. = 37° 05'.
Hamburg, $\varphi = 53° 34'$, $\lambda = 9° 59'$ E, Δ = 2,100 km. = 18° 54'.
Cartuja, $\varphi = 37° 11'$, $\lambda = 3° 36'$ W, Δ = 3,400 km. = 30° 36'.

Constructing a figure as the preceding one with a radius for the primitive circle of 10 cm. radius, and laying off the latitude accurately as well as the arcual distance Δ or $P\ F$ and $P\ E$; then getting the intersection of $O\ F$ and $G\ E$ with $A\ B$, we find $H\ I$ and $N\ I$ in terms of the radius of the original circle.

We thus find for Ottawa, d = 4·65 cm.; r = 4·00 cm.
Hamburg, d = 3·40 cm.; r = 1·85 cm.
Cartuja, d = 5·45 cm.; r = 3·47 cm.

Now we shall draw another circle (fig. 4) with radius 10 cm., and draw three radii in it in their respective positions in longitude, *i.e.*, the angles between the radii express the difference of longitude between the respective stations. On each radius we lay off from the pole the respective distance d, and from each such point describe an arc with its corresponding value for r,—thereby obtaining the required intersections. Theoretically the intersections should be at a point, but in practice we find the intersections to form a very small triangle. We take its centre of gravity as the point sought for, the epicentre; measuring from the pole (centre of the primitive circle) to this point and expressing this linear measure in terms of the radius gives us the tangent of $(45° - \frac{1}{2}\varphi_0)$, where φ_0 is the latitude of the epicentre, for in the stereographic projection the radius of a parallel of latitude is projected into tan. $(45° - \frac{1}{2}\varphi)$.

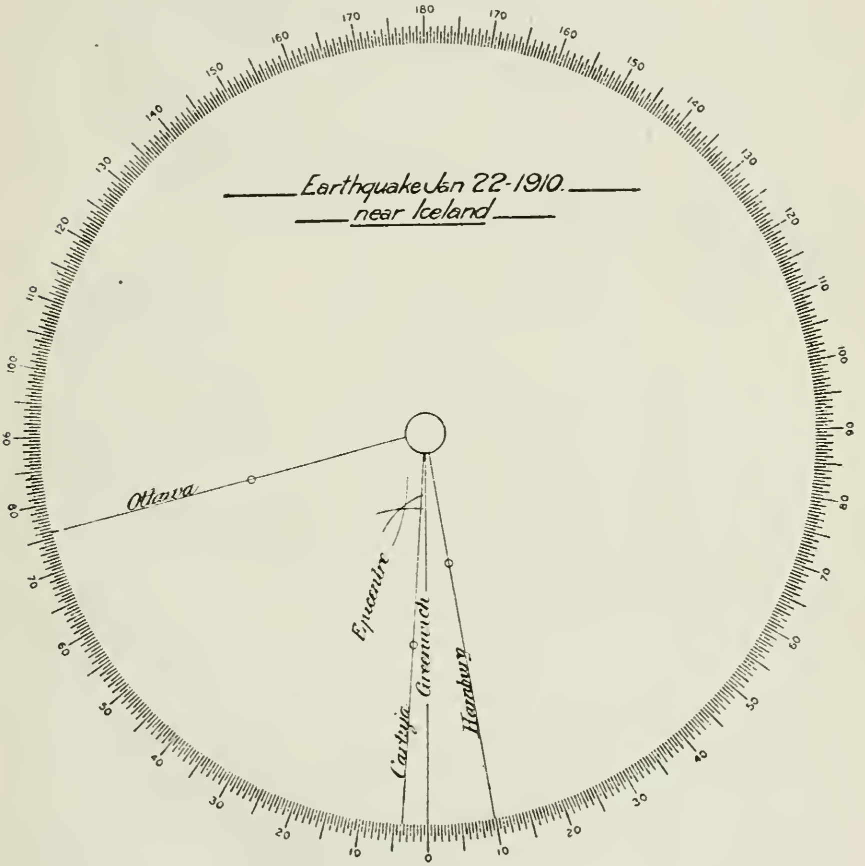

FIG. 4.

From a table of natural tangents we obtain the value corresponding to this tangent, *i.e.*, for $(45° - \frac{1}{2}\phi_0)$. Hence ϕ_0 is found.

For the longitude it only remains to measure with a good protractor the angle between our initial meridian (Greenwich) and the point found for the epicentre. We thus have found the geographical co-ordinates of the epicentre by a rapid graphical method, with quite satisfactory results, provided the plotting is done with care and not too small a scale is used. From the above we find $\varphi_0 = 67° 20'$, $\lambda_0 = 17° 15'$ W.

When this earthquake was plotted more than three stations were used, which gave a slightly greater value for ϕ_0, and of course of more weight, $\phi_0 = 67° 56'$, $\lambda_0 = 16° 45'$. The least square computation by Dr. Tams derived from six stations gave $\phi_0 = 67°\cdot9$, $\lambda_0 = 17°\cdot1$, practically the same as the above. Prince Galitzin gives for his values derived from the Pulkowa observations alone, $\phi_0 = 68°$, $\lambda_0 = 17°$.

International Seismological Association.

By your authority I attended the third meeting of the Permanent Commission of the above Association, as the delegate for Canada, held at Zermatt, Switzerland, August 30 to September 3, 1909.

As a compliment to the retiring vice-president, Professor Forel, well known for his study of the seiches of lake Geneva, the meeting was held in Switzerland, at the foot of the incomparable Matterhorn, the goal of all Alpine climbers, many of whom have there found an early grave. Zermatt is something like a variable star, it almost vanishes from gaze for about nine months of the year.

The meeting was well attended. Of the twenty-three countries forming the Association, twenty were represented, as follows: Austria, Belgium, Bulgaria, Canada, Chili, Denmark, England, France, Germany, Greece, Hungary, Italy, Netherlands, Norway, Portugal, Roumania, Russia, Servia, Spain and Switzerland. Besides the delegates, other scientists were present, making the total in attendance, 42.

Professor A. Schuster presided, and Dr. Hepites, of Bukarest, was elected vice-president for the remaining two years, when the general meeting will be held in July, 1911, at Manchester, England.

Mention may be made of several reports of committees appointed at The Hague meeting in 1907. The one on bibliography recommended that arrangements be made with the International Catalogue of the Royal Society for the publication in one volume of all papers on seismology.

The committee on 'Catalogue,' *i.e.*, for the publication of the catalogue for the earthquakes of 1906, held several meetings before a compromise was effected between different views on the character of classification, regional or chronological. Considerable expense is involved in the preparation of a catalogue, hence its contents should serve scientific ends especially.

From the report two years ago to this Association of The Hague meeting, it will perhaps be recalled that makers of instruments had been invited to submit for competition a simple seismograph, with magnification forty to fifty and costing in the neighbourhood of seventy-five dollars. The testing of the apparatus was to be done at the Central Bureau at Strassburg, and the award was entrusted to a committee of five members. Three instruments were submitted and subsequently tested. The committee on instruments, of which the writer is a member, found that the terms of competitions had not been rigorously adhered to; that the price set for an efficient instrument was too low and not in keeping with the precision required in seismological work of the present day; that, however, good work had been done by the manufacturers for the above seventy-five dollars; and that no prize be awarded, but instead the money, some $250, be equally divided between the three manufacturers, in a measure as compensation for their efforts. Emphasis was laid in the report on the fact that the first consideration of a scientific instrument is efficiency, the cost being a secondary consideration.

Nearly every country represented presented a report on its respective seismological service.

Of the numerous papers presented there were several of particular interest. Professor Hecker presented the results of his observations, extending over a period of nearly seven years, of the deformation of the earth under the influence of the moon. The instrument, or instruments, for two were set up, used was a horizontal pendulum, in short a seismograph, placed in a well some eighty feet deep to eliminate the heat effect of the sun. As the theoretical displacement of a pendulum through the attraction of the moon is a definite quantity, readily computed for an absolutely rigid earth, the actual displacement gives a measure of the yielding of the earth itself, *i.e.,* of the degree of rigidity. Hecker's observations confirmed previous determinations made, however by different methods, that the rigidity of the earth is somewhat greater than that of steel. The tide of the solid earth is from four to six inches. An interesting point brought out, too, was, that there is very little lag in this earth tide, *i.e.,* that 'high earth' corresponds to the transit of the moon for any place.

Another interesting paper was that of Prince Galitzin on the determination of the azimuth or direction of the epicentre from the comparison of the corresponding amplitudes of two horizontal pendulums at a single station, one mounted in the N.-S., the other in the E.-W. direction. He showed the inter-agreement of his deduced azimuth for a dozen known earthquake centres with the theoretically computed one.

The method of obtaining the distance to an epicentre has of course for some time been readily available from the time interval between the different phases of an earthquake record; for instance, between the arrival of the first longitudinal waves and the first transverse waves; or the first long waves.

Of any individual question or subject discussed, the one on microseisms elicited the most interest. These microseisms or earth tremors have been observed practically over the whole earth, and are quite distinct from pulsations produced by earthquakes. They last for hours and days, and have a period of about five seconds. The actual amplitude (half range) of the earth particles reaches 5 microns, or one two-hundredth of a millimetre.

The writer communicated the results of his investigation extending over several years, which shows that they are due in the first instance to areas of low barometer, surrounded by steep gradients, and in the second place, that such an area of low barometer is far more effective in producing microseisms when it is resting or passing over water, that is, the ocean. Experience shows that for the Atlantic coast the microseisms appear more strongly *after* the area of low has passed the recording station and reached the ocean. Per contra, in Europe the reverse should obtain, as in general atmospheric movement between Canada and Europe is easterly, that is, the microseisms there should show themselves *before* the low reaches the land.

A special committee was appointed to further investigate this interesting problem, and to that end it is probable that one or more instruments, especially designed for the purpose, will be set up on the seashore to record the pulsations of the water.

The present mareographs or tide-gauges are not adapted for that purpose, the time-scale being far too small, for one must be able to read at least to five seconds of time on the record. A thousand marks, or $250, was placed at the disposal of this committee.

The conference was successful in every respect. The members were all housed in the same hotel, and this enhanced the opportunity of 'heart to heart' talks, which are really the most valuable assets that meetings of scientific men offer.

Before leaving Zermatt we were given an excursion to the head of the valley—to Gornergrat. Here at the end of the electric toothed wheel railway, we stood at an elevation of over 10,000 feet (two miles), feasting on a panorama such as is reserved for few regions of our globe. Talleyrand has given us the epigram that 'Language was given man to conceal his thoughts.' The general belief is that 'language was given man to reveal his thoughts'; however, standing at Gornergrat, with the stupendous mountain chain from Mount Rosa to Dent Blanche, including the Matterhorn, together with the fields of glaciers before us, we find that language utterly fails to convey in words the scene presented and the thoughts aroused by that grand spectacle.

Before returning to Ottawa I visited a number of earthquake stations and observatories in Germany and England, gathering valuable information in the interests of varied fields of our own observatory.

The earthquake station at Strassburg, the Central Bureau of the International Seismological Association, is well provided with many forms of seismic instruments. As is well known, the object of an earthquake instrument or seismograph is to record the pulsations of the earth or movements of the earth particles. To effect this the horizontal pendulum is used, in which the bob or heavy mass is supposed to be stationary during an earthquake, but the frame and pier on which it is mounted respond to the vibrations of the earth. For the first impulse we undoubtedly get this ideal condition, but with continued pulsations, oscillations of the pendulum are induced so that our record becomes one compounded of the earth movement and that of the pendulum. To investigate this problem, of sifting the one from the other, a massive 'platform' was built at Strassburg upon which a seismograph can be placed for investigation of its behaviour. The platform is suspended within heavy and rigid columns; and motions can be imparted to it of varying amplitude and period by special mechanism. The smallest amplitude is a little over one micron, or one-thousandth of a millimetre (1/2500 of an inch). This motion is directly recorded on a revolving cylinder, and also by the seismograph mounted on the platform. The motion of the platform is to imitate the motion of the earth particles in a quake. From the comparison of the two records of the same phenomenon we obtain the effect and amount of vibration of the pendulum itself. The platform has but recently been completed, and we may look forward to important results accruing from the investigation of different instruments and of the same instrument adjusted to various periods.

With our modern earthquake instruments of precision we obtain splendid records of earthquakes, but the handwriting, except in its broad outlines, we are not yet able to read fully.

Before leaving Strassburg a visit was paid to the Meteorological station, of which Professor Hergesell is director. Outside of the ordinary meteorological observations, the upper air is studied, too, by means of balloons. These are of rubber, filled with hydrogen and provided with recording barograph, thermograph and hygrograph, the whole encased in an aluminium case and weighing about three pounds. The barograph is an aneroid, the thermograph is, of course, metallic, and the hygrograph is a hair hygrometer. For the latter it is found that blond human hair is best adapted for the purpose. The hair before use is treated with ether to remove the oil. The ascent of a balloon until it bursts takes from 30 to 45 minutes, reaching altitudes from 7,000 to 12,000 metres, say 4½ to 7½ miles. At that altitude, depending upon the isobars, is found the inversion stratum, *i.e.*, where a marked increase of temperature takes place with increase of height; for instance, the temperature being – 65° C. rises with a further ascent to – 55° C., or 10° C. (18° Fahrenheit) in the 'stratosphere.' As soon as the balloon bursts from decrease of pressure from without, the apparatus falls. To lessen the rapidity of descent and the force of impact when reaching the ground, the balloon is provided with a parachute, which opens as soon as the fall begins. The apparatus may fall anywhere within a pretty wide area, but as it contains a request for its return to the station, they have all with one or two exceptions been recovered, although a year or more may elapse before they are accidentally found in field or woods or even stream.

At Hohenheim, near Stuttgart, the earthquake station was visited. Here, in addition to the horizontal pendulum of the Omori type with air-damping, there is installed a Schmidt gravimeter for recording the vertical element of earthquakes. It has photographic registration, the light being supplied by a 4-5 c.p. Osram lamp fed from storage cells. It may be observed that as instruments recording the vertical component are generally dependent upon a spiral spring, the effect of varying temperature to which the instruments are subjected, is introduced, thereby changing the zero position of the light-spot or of the recording stylus. This difficulty has not yet been quite satisfactorily overcome. Very few earthquake stations have their own time service, but must rely on some nearby observatory. The comparison is made in various ways, in one case by regular visits to the observatory carrying a pocket chronometer; at others with a stop-watch in hand while listening to a signal sent by telephone; or again by sounder and telephone whereby the observatory clock-beats can be heard at the earthquake station while at the same time looking at the clock of the latter. In our own case, our standard mean-time clock controls the light of the photographic record, *i.e.*, the light is automatically cut off every minute, save the hour-minute, for two seconds. As the corrections to the clock are always less than a second, we need apply no correction to our time-scale on the seismogram.

A visit was paid to Munich, ground made classic through the labours of Lamont on terrestrial magnetism as early as 1836; the magnetic observatory, however, was not built till four years later. For field observations I found that Professor J. B. Messerschmitt used the Tesdorpf magnetometer outfit similar to ours. It was noticed that the magnets, when not in use, were kept between wooden hemi-cylindrical shells which were enclosed within a soft iron cylindrical box or tube. This is done to protect the magnets when travelling from the influences of dynamos and motors, whereby the constants of the magnets may be disturbed. This seems a wise precaution.

For the field observations, he prefers the pivot support instead of the fibre suspension for the determination of declination, as the former is less disturbed by the wind. For oscillations, a half-seconds mean-time pocket chronometer by Kittel is used instead of the usual box-chronometer. Generally only deflections are observed in the field, and these compared with similar ones before and after at the base station give data for deducing absolute values.

Observers in Europe have, as a rule, an advantage over us in giving the geographical co-ordinates for their magnetic stations in the field. The whole country being covered with a triangulation net to which is attached the cadastral survey, it is very easy to tie on to the latter and thereby obtain the required geographical position.

Although the electric street car line terminates not many hundred feet distant (about 200 m.) from the magnetic observatory, no serious effect has yet been noticed. This is undoubtedly largely because the line of return current passes in a direction opposite to that of the observatory. To the writer, however, the proximity of the observatory to the street cars seemed questionable for thoroughly reliable results.

Secular variation was discussed with Professor Messerschmitt. Unfortunately this subject is still in such a state that even interpolation can be made only within narrow limits and extrapolation is unreliable. There is at present little hope that the magnetic elements for a given place can be computed in advance, say for ten years, nor even for five years with any degree of accuracy, as the astronomer predicts eclipses and other celestial phenomena. This will ever remain so until we can explain the cause of terrestrial magnetism, and the laws that govern such cause. Messerschmitt uses the secular variation observed at the base-station, Munich, for other parts of Bavaria.

We may insert here an example of the uncertainty of continuance of the magnitude of the secular variation even for a short period of several years.

In 1901, Professor Haussmann made a magnetic survey of the Kingdom of Württemberg, having for base-station, Korntal, which by comparison observations was tied to the magnetic observatory at Potsdam. A year later another comparison was made, from which the annual change was found to be a decrease of declination of 4′·5.

Based on this, declinations for following years were published. At the close of 1909 a comparison was again made with Potsdam, where a continuous photographic record of the magnetic elements is obtained. From this it was shown that up to 1903 there was an annual decrease of from 4′·0 to 4′·2, which from 1904 increased to 7′·4 up to the beginning of 1910. Nor is the secular variation constant even between comparatively near stations, as shown from the data* of Ulm and Pforzheim, both in Württemberg and less than 70 miles apart:

Ulm..	1850, D = 16° 41′·1;	1885, D = 12° 36′;	1901, D = 11° 15′
Pforzheim...	1850, D = 17° 29′·6;	1885, D = 13° 18′;	1901, D = 11° 53′
Difference..	48′·5;	42′;	38′

Heidelberg revisited. Here at the Königstuhl, on whose summit (368 m.) is the astronomic observatory, a cordial greeting was given by Professor Max Wolf, who but a few days before (September 11) had rediscovered the famed and historic Halley's comet. The uninitiated in looking at the photographic plate and seeing a small hazy patch, devoid of tail, devoid of brilliancy, devoid of anything spectacular, would be inclined to say, 'Is that all?' Yes, that is all. But what a triumph of intellect and human skill does it signify! Let us not forget the names of Cowell and Crommelin, whose computations made it possible to point the telescope to the right spot in the sky for finding the wanderer. The photograph was obtained with the 720 mm. (28-inch) reflector, and an hour's exposure. The field covered was 1° 30′.

The isolation of an observatory on top of a mountain or high hill, as here, has its compensation for the enthusiastic astronomer (although not for the wife and family) that he gets more clear nights than in the valley; for example,

* Die magnetische Elemente in Württemberg im Jahre 1910, von A. Schmidt.

during the past year there were thirty-five more clear nights at Königstuhl than in the adjacent plain. When one views here the numerous domes and instruments, together with the very small staff of two or three, one deplores that some Mæcenas is not forthcoming to give the necessary financial support to so worthy an institution, and presided over by so devoted and eminent a scientist. Even the publication of observations is hampered for lack of funds. Among the galaxy of apparatus not noted on a previous visit some years ago, was the one for registering the discharge of atmospheric electricity. Two wires at right angles to each other on the roof intercept the wave, which is then led to the recording apparatus, which includes a coherer. The record on the revolving drum indicates the intensity only, but not the direction or where the discharge took place.

The earthquake station of Professor Zeissig, at Jugenheim, near Darmstadt, was visited, particularly to see the direct ink registration of the 1,200 kg. Wiechert seismograph; hitherto mechanical registration has been invariably on smoked paper. The registering pen for each component is a very fine glass capillary tube, the end of which is especially ground. The ink-well is in the axis of the pen and hence the pressure of the point is not affected by the ink supply. A red aniline ink is used and the pen gives a beautiful record. Specially smooth glazed paper is used to minimize the effect of friction, which in all mechanical registrations is one of the undesirable factors. The time-scale is 7·3 mm. per minute, with 3-minute breaks. The clock-work, controlled by a conical pendulum, runs very evenly and uniformly, so that the graduated glass scale can be applied with confidence, as I found myself, anywhere on the record. The advantage of the ink registration together with a continuous roll, lasting about three weeks, is that one not only sees the finished record but can cut off at any time a part for immediate examination, say of an earthquake. The ink registration has but recently been introduced, and Professor Zeissig was not yet in a position to express definitely the amount of friction of the recording pen. It will probably be found to be somewhat larger than for smoked paper. About the seismograph he has a suspended or hanging floor, so that walking about the instrument does not affect its zero. The station being within a few hundred feet of the railway line, every passing train leaves its record, which, however, can never be mistaken for an earthquake. As the professor said, 'I've got a check on every train and can tell whether it was on time or not.' The Jugenheim earthquake station is a model of neatness in every respect.

Frankfurt lying en route, a few hours' stay was made here to visit the 'Ila' (Internationale Luftschiffahrt Association). It happened that during that time Zeppelin returned from the military manœuvres in Württemberg with his huge balloon, Zeppelin III., and I with tens of thousands of other visitors had the pleasure of seeing this uncanny, unwieldy thing sail through the air, descend gracefully, and back into its shed with mathematical precision. It does not appear to the writer that this form for aerial navigation has a great future before it.

The earthquake station at Leipzig has one of the first of the Wiechert type of heavy (1,000 kg.) astatic inverted pendulums. Unfortunately it is in the heart of the city, with machine shops and other disturbing elements surrounding it. During the daytime, when industries are in full swing, the recording stylus behaves as if suffering from nervous prostration. At night and on Sundays there is more or less quiet. A neighbouring tall chimney when under the influence of wind plays havoc with the surrounding earth, giving at times deflections to the stylus of 5 cm. An interesting record is obtained here on Sundays, when a chime of four church bells rings, a record of the concussions is found on the seismogram.

For lack of time, and besides having visited the scientific institutions at Potsdam, near Berlin, two years ago, a visit was only paid to Steglitz, a suburb, where Fuess has just finished for us a high-class electric recording anemograph; recording direction, velocity and pressure. There are twelve wires for different pressures, four for direction, and one for velocity, making with the return wires, twenty all told, which will be led in a lead-covered cable from the tower, to be placed on the roof-walls of the Observatory, to the recording apparatus within the building. At the time, the instrument was just being tested and its constants determined, and from appearances it promises to give full satisfaction. I was told that in the Harz mountains during the winter there are times when trouble is had with the large hemispherical cups of the anemometer due to the formation of 'Rauhreif' on them. This is somewhat similar, I think, to our 'glare ice' in winter. The rauhreif forming on the back of the cups may have the effect of turning the cups by wind the wrong way. This has happened, too, on the Säntis in Switzerland. At this factory I saw also a duplicate of the special barometer made for Professor Hecker for his gravity observations at sea; relative gravity being obtained by comparison of the atmospheric pressure and the boiling point of water. The main difficulty to overcome in reading a mercurial barometer at sea is the effect of 'pumping,' *i.e.*, of the jumping up and down of the mercury due to the motion of the ship and water.

At the Kiel Observatory the acquaintance of the director, Professor Harzer, was renewed. The meridian circle with its housing is probably the most modern amongst this class of instruments. Its constants and idiosyncrasies have now been studied and determined and the results are now in press. When asked, if he had to build anew after his experience, whether he would make any changes, he gave a negative answer, which speaks well for the efficiency of instrument and housing. What strikes one immediately on entering the transit house is the very wide opening, two metres, in the roof. The building is of sheet iron with hollow walls. The difference of the temperature within and without is generally within a range of 1° C., the greatest recorded being 1½° C. The value of such uniformity is only too well appreciated by an observer. His azimuth marks, one north and one south, are about 60 m. distant, while there is a *mire* 7 km. (about 4½ miles) distant, available, however, only in the daytime. The annual rate of the standard clock (Strasser and Rhode) follows strictly a sine curve, and has no distinctly diurnal change of rate. The clock is under constant pressure. Although a driveway is close to the Observatory, no tremors are noted in the mercury when taking nadir observations. This is undoubtedly attributable to the sandy ground in the whole neighbourhood.

I was informed of an interesting observation, and that was that there had been a slow change in azimuth and in one direction. But this was not a change of direction of the instrument only, but of the azimuth marks as well; in short, a 'scholle' or block of the earth had slowly twisted about.

Continuing the journey homeward, we pass through the stirring city and seaport of Hamburg, where a brief call was made at the Seewarte (marine observatory). Here amongst other things all the ships' compasses are tested, and declination charts prepared covering the earth for use of navigators especially. The secular variation obtained at the base station, Wilhelmshaven, near the mouth of the Weser, is used for all the German coast stations. When we come to deal with a country of the dimensions of Canada we require the observed secular variation for many stations scattered over the Dominion, in order to deduce the declination for a given time at intervening stations.

A small brass screw of a declinometer was shown me, which had caused some mischief. It was found to contain some iron, and had produced an error of 10′ in declination, illustrating how carefully all parts of magnetic instruments require examination in order to insure reliable results.

At Hamburg there is one of the best equipped earthquake stations, being the donation of a private citizen. It suffers, however, somewhat from the proximity of vehicular traffic. The time service for the station is elaborate and excellent; and the seismograms are studied with great minuteness.

At the adjoining city of Altona the workshop of Kittel was visited, to inspect the mean-time half-seconds pocket chronometer being made for us for observing, in the field, oscillations of the magnet. The use of such a timepiece is an innovation. Hitherto such observations were made with a box-chronometer, all of which beat half-seconds, and which ordinarily pocket chronometers do not. I found the chronometer completed and ready to be sent to the marine observatory for testing for rate at different temperatures.

London was reached the following day, and during the short stay here a visit was paid to the magnetic observatory at Richmond, where, too, the instruments for the meteorological service are tested. Some of the magnetic records of the South-polar expedition of the *Discovery* a few years ago were examined with much interest, especially those of declination, which showed large values for the diurnal variation. It was learned that in dealing with the magnetic elements for Great Britain, the secular variation was assumed to be the same for an area of about 100 miles radius.

The great magnetic storm of September 25 occurred during my stay in London, the manifestations of which were observed over the whole world, and have given rise to a renewed discussion of the origin of these storms. When the Cimmerian citadel is stormed by Lodge, Arrhenius, Birkeland, Hale, Störmer, Bauer and Chree, the effect of 'light-pressure' should soon show itself.

A few days before sailing for Canada, Shackleton's small ship, or steam yacht, the *Nimrod*, anchored in the Thames along the embankment, and the opportunity was taken to visit the now historic vessel. The ordinary traveller would say, 'cramped a bit.' To me one of the interesting results of her Antarctic explorations was that the south magnetic pole had been reached (January 16, 1909).

$\phi = -72° 25'$.
$\lambda = 155° 16'$ E.
Alt., 7,000 feet.

After viewing in a neighbouring building the large collection brought back, it is gratifying to find that a British expedition has returned from the polar regions—from the Antarctic—laden not only with glory, which at best is only ephemeral, but with a rich harvest of scientific facts and specimens whereby our knowledge of the earth and of the earth's history is increased for the benefit of mankind.

TERRESTRIAL MAGNETISM.

The magnetic survey of Canada was continued during the season of 1909, and the field of observation extended from Quebec along the north shore of the St. Lawrence to Blanc-Sablon, near the strait of Belle Isle, a distance of approximately 750 miles. Observations were taken at 33 stations, at each of which the three elements—declination, inclination and horizontal intensity—were determined. At each station observations were taken of the diurnal variation, the observations extending from the eastern elongation in the early morning to the western one in the early afternoon. The instruments used were the Tesdorpf magnetometer and Dover dip circle, described in previous reports. Observations were taken at the magnetic observatory at Agincourt, before and after the field observations, so that the latter are thoroughly standardized.

The observer, Mr. C. A. French, was fortunate in observing at the time of the severe magnetic storm of September 25, the disturbances of which were world-wide. A deflection of fully 10° in declination was observed on that day, the details of which are given in another place.

The territory covered by the magnetic survey this year had hitherto very few magnetic observations, so that the results obtained are the more valuable. It will be observed in the table that follows that some of the stations are affected by local attraction, for the declination does not change with the longitude as one theoretically expects.

It has been found that the maps published giving the magnetic meridians with the respective declinations at the various places of observation are much appreciated by surveyors, engineers and others, instead of simply giving the declination in tabular form, so that in the present report a map covering the lower St. Lawrence with the magnetic stations is appended.

In the memorandum of instructions given to the observer the order of observations, in general, is:—

1. Azimuth.
2. Declination.
3. Dip.
4. Oscillations.
5. Deflections.
6. Deflections.
7. Oscillations.
8. Dip.
9. Declination.

The mean of the times for dip, oscillations and deflections will be approximately the same when observing in the above order.

The details of the field work are given by Mr. French, as follows:—

'The instruments used on the Magnetic Survey during the season 1909 consisted of a six-inch Troughton and Simms transit, No. 433; half-seconds mean-time chronometer, Bond 511; Tesdorpf magnetometer, No. 1977, for dip, horizontal intensity and declination determinations; and the Dover dip circle, No. 145, for dip and relative horizontal intensity.

'Before entering upon the field work, comparisons of the two instruments, Tesdorpf No. 1977 for declination and horizontal intensity, and Dover No. 145 for the instrumental constants, were made with the standard instruments at the Agincourt Magnetic Observatory. The results will be given with the comparisons made in October.

'Having concluded the work at Agincourt, I proceeded, by way of Ottawa, to Quebec, accompanied by Mr. J. W. Menzies, who assisted me at twenty-five stations situated on the north shore of the river and gulf of St. Lawrence between Les Escoumains and Blanc-Sablon.

'After the yacht *St. Valier*, which had been chartered for transportation and living purposes, had been provisioned, we left Quebec on May 27, and on May 31 arrived at Les Escoumains, the first station to be occupied.

'Before entering upon a description of the work at each station, a few remarks, applicable to the work in general, may here be made.

'As the time signals are never sent over the telegraph line on the north shore, it was impossible to make chronometer comparisons during the summer. I endeavoured, at Bersimis, to arrange to have time signals sent, but owing to the condition of the wire for two days at least nothing was accomplished. A comparison was made at the Canadian Pacific Railway telegraph office in Quebec on May 26, and again at Sydney, September 3. For all computations, in which time was a factor, the rate was considered constant, and which amounted to ·36 second per day gain. Between September 6 and September 27, there was a losing rate of ·15 second per day. The conclusion, that the rate is constant, does not appear logical, for there may have been at first a greater and later in the season a smaller rate than was assumed. But the graph, appended below, showing the comparison of the half-seconds chronometer with a pocket chronometer, shows only a slight departure from a constant differential rate. The conclusion arrived at is that the error in time and longitude due to an error of clock correction is small. A comparison of results of longitude, obtained during the season, with maps shows only, if any, slight differences. It was probably assuming too great a risk to carry but one chronometer besides the pocket chronometer, for had the half-seconds chronometer gone out of commission it would have been necessary to depend solely on the pocket chronometer (not beating half-seconds) for time, and almost impossible to have made accurate observations of oscillations. Determinations of azimuth, longitude and latitude throughout the season were confined almost exclusively to sun observations. In only two or three instances was it necessary to remain in a place a longer time than was actually required for magnetic determinations, and then only for latitude. With one or two exceptions, azimuth observations were obtained both in the forenoon and afternoon.

'The adopted declination was obtained from the mean of observations taken at eastern elongation, which occurs about 7.30 a.m., and western elongation at about 1.30 p.m. It was customary to obtain two such days' results at every station, though at a few stations only two afternoon elongations and one morning elongation were obtained, while at a few places additional results were obtained. The time of the mean absolute declination is about 10.30 a.m. In addition, several observations were taken between eastern and western elongation, also one or two after western elongation, to show not only the daily swing of the needle but also any irregularities in its behaviour due to a magnetic disturbance, if one existed. It had been my intention to utilize the deflection readings for declination, thus increasing the number of determinations, but it was found they were not altogether satisfactory, hence are not included in the results.

'Horizontal intensity was obtained absolutely from deflections and oscillations with magnet erect, the mean-time being between 10 and 11 a.m., and another set with magnet inverted, the mean-time in this case occurring between 2 and 3 p.m. In general there was a decided increase in horizontal intensity obtained in the afternoon over that in the forenoon.

'The accompanying table contains some of the stations occupied in 1909, the first six in September and the remaining in June and early part of July, the latitude, longitude, local mean-time of observation, with the value of the horizontal force corresponding to it, and the difference between the afternoon and forenoon values.

Station.	Latitude.		Longitude		Time.		H. (C. G. S.)	Time.		H. (C. G. S.)	Diff. H (p. m.) H (a. m.)
	°	′	°	′	h.	m.		h.	m.		
Quebec	46	48	71	15	11	00	·14784	2	30	·14821	·00037
St. Joachim	47	03	70	52	10	51	·14535	2	18	·14593	·00058
Les Eboulements	47	27	70	23	10	35	·14093	2	20	·14122	·00029
Murray Bay	47	38	70	09	10	46	·14097	2	15	·14103	·00006
St. Simeon	47	51	69	52	10	21	·13687	1	35	·13732	·00045
Tadoussac	48	08	69	43	10	48	·13905	2	08	·13435	·00035
Les Escoumains	48	21	69	33	....	....	....	3	20	·13879	....
Portneuf	48	36	69	08	10	30	·13121	2	40	·13150	·00029
Cape Colombier	48	51	68	54	11	30	·13325	3	20	·13355	·00030
Bersimis	48	56	68	40	9	40	·12828	4	45	·12852	·00024
Manikuagan	49	11	68	16	11	15	·13105	2	50	·13156	·00041
Godbout	49	19	67	38	11	15	·12963	3	42	·12992	·00029
Pentecôte	49	47	67	12	11	30	·12908	3	00	·12945	·00037
Seven Islands	50	13	66	25	11	41	·12658	4	38	·12688	·00030
Moisie river	50	12	66	07	11	10	·12730	3	02	·12747	·00017
Pigou	50	16	65	37	11	56	·13343	2	54	·13377	·00034
Shallop	50	17	65	10	11	10	·12708	4	03	·12817	·00009

'It was the rule to obtain two such days' observations for horizontal intensity.

'At most of the stations a value of horizontal intensity was obtained relatively, by Lloyds' method, to a base station which, in this case, was Agincourt. The instrument, Dover No. 145, is an ordinary dip circle, having two additional needles, the poles of which are never reversed, and the frame, which carries the microscopes, is fitted to receive and retain one of the needles for deflecting the suspended needle. One of the needles is an ordinary dipping needle which may be called, for sake of distinction, No. 3, and the other has a small hole near one end, in which a small weight, which acts in opposition to the magnetic force of the earth, may be placed. This needle may be designated No. 4. The observations consist of two processes; first, the loaded needle, No. 4, is placed on the agate planes, and a series of readings taken with face E. and W. for each of the two positions circle E. and W. No. 3 is substituted for No. 4 which is placed in position on the frame, and used as a deflector to No. 3. Readings are taken with the N. end of No. 4 pointing alternately north and south, circle east. Should time permit, it would be better to take readings with circle west also.

'At the base station let

F_0 = known total intensity.

θ_0 = angle of dip.

η_0 = angle of dip of loaded needle.

$\theta_0 - \eta_0 = \mu_0$.

μ'_0 = angle of deflection of No. 3.

'For any other station let

θ = angle of dip.

η = angle of dip of loaded needle.

$\theta - \eta = \mu$.

μ' = angle of deflection of No. 3.

'The total intensity will be given by

$$F = A\sqrt{\frac{\text{Cos}\,\eta}{\text{Sin}\,\mu\ \text{Sin}\,\mu'}} \quad \text{where } A = F_0\sqrt{\frac{\text{Sin}\,\mu_0\ \text{Sin}\,\mu'_0}{\text{Cos}\,\eta_0}}$$

'*A* is the instrumental constant, which was determined at the base station. The method is practically independent of the value of the magnetic moment of the needle, hence the temperature, if it remain nearly constant, may be left out of consideration. I do not consider it possible to obtain results of the same degree of accuracy, employing this method, as those obtained absolutely, with Tesdorpf No. 1977, and for this reason the adopted values for all stations were obtained from the absolute determinations.

'Two dips were usually taken each day and four dips, at least, at each station. Both the Tesdorpf and Dover dip circles were used.

'The field work was commenced at Les Escoumains, May 31. This station was completed after two and one-half days, the results appearing satisfactory. I did not obtain a value for horizontal intensity in the forenoon, which was probably a mistake, but at the time I did not consider the diurnal variation of horizontal intensity so important, as it appears to be, judging from the results of the season's work. A small correction might be applied to the adopted value. The correction, obtained from the results given above, would be -15γ, or $-\cdot00015$, applied to the afternoon determinations. This would reduce the adopted value to ·13864.

'Portneuf, at the mouth of the Portneuf river, was reached about midnight, June 4. The results reveal no signs of a disturbance during the two days' observations at this place. The first day was cloudy, which made astronomical work impossible, besides making observing tiresome, but fortunately the second day was all that could be desired.

'We arrived at cape Colombier about noon, June 7, but not in time to get an observation at western elongation, for, owing to low water, it was impossible to reach a suitable place without some delay. The programme was varied slightly at this station. Two dips were taken during the afternoon of the 7th, and a relative intensity observation with Dover No. 145. Two more dips were taken during the morning of the 8th, and a complete set, magnet erect and magnet inverted, for absolute horizontal intensity both morning and afternoon, besides the usual number of declination determinations. Before leaving on the 9th an eastern elongation was taken; also an absolute declination at 10.30, but, as they did not appear altogether satisfactory, are not included in the results.

'We reached Bersimis on the evening of June 9, and set up the outfit the following morning in time for an eastern elongation. The first day was very windy, but as the station was well sheltered the inconvenience resulting was not serious. The work was concluded June 11. No observations for dip were obtained at this and the remaining eastern stations with Tesdorpf No. 1977 owing to the lower end of the needle being hidden behind the standards, but the desired number were secured with the Dover.

'The work was begun at Manikuagan, June 13, by taking a western elongation followed by a set for horizontal intensity, and an absolute declination. Magnetic observations were continued the following day, but owing to rain and clouds no astronomical work was done until June 15, when an azimuth in the morning and a latitude at noon were obtained. On the same evening Godbout was reached. The weather was fine for the first day's work and the needle seemed steady, but the range between morning elongation and 10.30 a.m. was 15′, with practically no change before 1.30 p.m., the approximate time of western elongation. During the night the tent was blown down, which prevented an eastern elongation being taken the following morning. The wind and clouds made observing exceedingly difficult the second day. The work was considered finished, but bad weather made sailing out of the question, hence we did not leave Godbout until June 19, and were forced to go as far as Cawee island for shelter, returning to Pentecôte the morning of June 21. The two days spent at this place were favourable for observing, though the needle showed evidence of a disturbance. On the evening of the second day there was an auroral display.

'One day was occupied in reaching Seven Islands, where two days were spent in observing. The horizontal intensity was obtained by combining the mean of three morning with one afternoon determination. This was, with the exception of the first station, practically the only departure made from the ordinary method of making observations. The range of declination or the diurnal variation here was below normal, being less than 10′.

'The usual complement of observations was taken at Moisie river during June 26 and 27, and as it was necessary to remain over for a latitude observation, a number of sets for declination were taken June 28. The results appear quite normal.

'There appeared to be no unsteadiness of the needle during the two days, June 30 and July 1, spent at Pigou, but the range of declination on the whole was below normal, especially on the first day, when it was only 5′. There was a decrease in westerly declination between $7^h\,36^m$ and $8^h\,44^m$ a.m. June 30, which does not occur under normal conditions. Rain fell all the second day, July 1. After taking a morning elongation and an absolute declination, we left for Shallop, July 2, arriving there about 5 p.m. Two extra dips and an extra set of deflections and oscillations for horizontal intensity were taken the first day, so that the work was concluded the second day with an eastern and western elongation. The range of declination at this station was about 8′.

'The 5th of July was spent in reaching Thunder river, where two days of good weather enabled us to complete the work. The range of declination here was above normal, being approximately 19′, otherwise the results were satisfactory. Owing to adverse winds, we were forced to remain at Thunder river until the morning of July 9, arriving, however, at Riv. St. Jean in time to get an eastern elongation. A difference of 5′ between maximum and minimum dip was obtained, which is rather large.

'Eskimo point was reached July 12, and observations taken on three days following. There is a difference of 8° in declination between Riv. St. Jean and Eskimo point, which is evidence of considerable local attraction, to which reference is made in the "St. Lawrence Pilot." The condition of the weather did not warrant us leaving Eskimo point until the 18th.

'We arrived at Piashti bay July 19, about 8 a.m., and remained until the 21st. Considerable annoyance was caused by flies and mosquitos. The declination here was 30° 12′·6 west, as compared with 35° 24′·5 west at Eskimo point. At this and all the remaining eastern stations, except two, considerable difficulty was experienced in setting up the tent owing to the rocky nature of the coast line.

'Natashkwan was reached July 21. The first day, though not suitable for astronomical work, was satisfactory as regards magnetic results. There was a display of the aurora the 22nd, but the only evidence of any disturbance which so often accompanies it, was an increase in declination of about 5′ over the corresponding value on the preceding morning. Three complete sets for horizontal intensity were obtained, besides three days' observations for declination and dip. Owing to bad weather it was impossible to leave Natashkwan until the 28th, on which day there was a vivid display of the aurora. The observations taken at Kegashka on the 29th reveal no signs of a disturbance. The second day at this place, the work was discontinued before getting the last set of oscillations and deflections owing to the wind. Observations for horizontal intensity with Dover No. 145 were discontinued at this and the remaining eastern stations, owing to the fact that the loaded needle, when at rest, was so nearly horizontal that it was hidden behind part of the frame-work supporting the vertical circle. Up to this time there had been an apparent decrease in the angle of inclination of this needle, which could only be explained by a decrease in the magnetic moment of the needle, for there was not sufficient variation in the total intensity of the earth's field to account for it. The inclination of the loaded needle at Agincourt in May, 1909, was 35° 18′·7, and in October, 1909, it was 23° 21′·6. From this it is evident that there was a decrease in the magnetic moment of the needle during the summer. This does not alter the value of the horizontal intensity, obtained by this method, since it is independent of the magnetic moment of the needle.

'La Romaine was reached on July 31, in time to get a latitude observation at noon, and a western elongation, besides a complete set of oscillations and deflections, and a dip. The declination was 35° 45′·4 west, being over 5° greater than the value obtained at Kegashka and 9° in excess of that at Wapitagun, at the next station, where work was begun on August 2, and finished the following day. There was an auroral display on August 2. The needle showed some signs of a disturbance, as the two days' results considered together do not show the regularity that one desires in making observations. On August 3 there was no change in declination between 7.30 and 9.15 a.m., and the range between eastern and western elongation was 9′·2, a quantity slightly below normal, while on the 4th the range was 18′·7, a quantity above normal, though the morning elongations on the two days differed less than 1′.

'We completed the work at Harrington on August 6, having begun at noon August 5, but owing to bad weather we did not arrive at Mutton bay until the 13th, where two complete days' observations were obtained. There was no apparent disturbance, though the range of declination on the first day exceeded that on the second day by about 4′. Fog delayed us one day.

'We spent two days on Outer island, near the mouth of St. Augustin river, but the observations on the second day were discarded, as the sets for declination showed the variation to be very irregular.

'Rocky bay was begun on the afternoon of August 20, and completed the 21st, except for an eastern and western elongation on the 22nd. Latitude was obtained by observing α Lyræ and α Aquilæ at culmination.

'Salmon bay was completed after spending the afternoon of August 22, and August 23 under favourable conditions.

'The next and final station in the east was on Greenly island, near Blanc-Sablon. Though, during the observations, the needle showed no signs of unsteadiness, the results, when comparison was made, were not altogether what might be expected under ordinary conditions, as may be seen from the table below:—

August 26.		August 27.		August 28.	
Time.	Declination.	Time.	Declination.	Time.	Declination.
h m.	° ′	h. m.	° ′	h. m.	° ′
7 30	33 27·1 W.	7 30	33 27·7 W.	7 30	33 24·4 W
10 30	.. 36·3	11 15	.. 34·1	11 09	.. 33·1
1 35	.. 29·3	1 35	.. 32·5	1 30	.. 32·5

'The yacht, in charge of Captain DesLauriers, started on the return trip to Quebec on August 26, Mr. Menzies and myself leaving by way of Newfoundland and Sydney, August 30. The observations at the remaining six stations were made by myself, Mr. Menzies having returned to Ottawa. Owing to certain repairs being made to the outfit, no observations were taken until September 7. The declination results taken on Sept. 8 at Quebec are not included in the results owing to the unsteadiness of the needle, which was also manifest on the 9th and 10th but not to such an extent. The sets taken at different times compared very favourably, allowing for diurnal change of declination. It may be well to explain the nature of this unsteadiness. The observer finds that between one reading and another, not more than a minute apart, there is often a difference of 2′, or, it may be, when he thinks there is a coincidence between direct and reflected image, the needle will abruptly swing 0′·5, 1′ or even 2′ to right or left. This would seem to be due to the proximity of the electric cars.

'September 11 to 13 were sufficient to give satisfactory results at St. Joachim. This included a determination of horizontal intensity with Dover No. 145.

'I arrived at Les Eboulements, September 15, and secured the desired number of observations on September 16 and 17, so that Murray Bay was reached September 18. Elongations and astronomical observations were taken September 19. Only one complete set for horizontal intensity with Tesdorpf No. 1977 was secured, concluding the work on the 21st. The declinations of the last day are not included in the final results as there appeared to be a disturbance. There was an auroral display at night.

'At Tadoussac, morning and afternoon elongations were obtained on two days, but only one complete set for horizontal intensity with Tesdorpf No. 1977.

'The results obtained at St. Simeon on September 24 were very satisfactory, though, owing to the dullness of the weather, no determination of horizontal intensity with Tesdorpf No. 1977 was made. On resuming the work the following day, September 25, about 7 a.m., 75th meridian time, it was evident there was a disturbance, for in eight minutes there was a change of declination amounting to 6° 18′. Below is a copy of readings taken during the day, showing the effects of the disturbance, represented graphically by fig. 5.

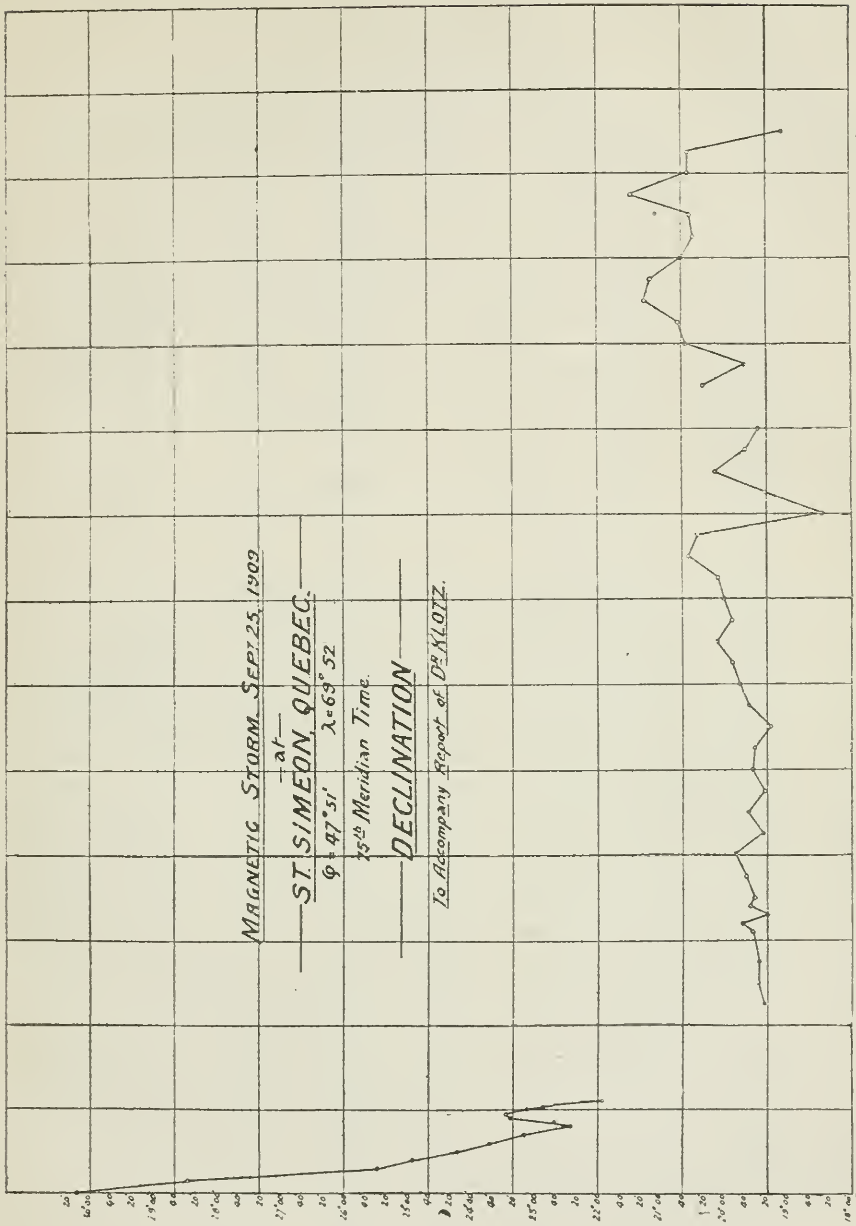
MAGNETIC STORM SEPT. 25, 1909
—at—
ST. SIMEON, QUEBEC.
φ = 47°51' λ = 69°52'
75th Meridian Time
DECLINATION
To Accompany Report of Dr. KLOTZ.

FIG. 5.

ST. SIMEON.

READINGS on magnet No. 10, magnetometer No. 1977, during part of the storm of September 25, 1909.

Time 75th Mer.	Dec. W.	Time 75th Mer.	Dec. W.	Time 75th Mer.	Dec. W.	Time 75th Mer.	Dec. W.
h. m.	° ′	h. m.	° ′	h. m.	° ′	h. m.	° ′
7 10 a. m.	30 13·2	8 45	19 23·2	9 50	19 17·0	1 00	20 19·3
13	28 29·1	50	29·1	55	19 37·0	05	19 39·3
16	25 26·8	55	28·7	10 00	19 46·9	10	20 35·1
18	24 55·1	9 02	34·5	05	19 52·4	15	20 43·2
20	24 12·8	04	46·5	10	20 6·4	20	21 15·1
22	23 43·1	06	19·1	15	19 50·7	25	21 10·5
24	23 9·3	08	36·5	20	20 0·4	30	20 39·1
26	22 27·2	10	33·1	25	20 6·8	35	20 31·0
28	23 22·4	15	41·0	30	20 36·5	40	20 32·5
29	23 27·0	20	49·1	35	20 27·1	45	21 29·0
30	23 6·8	25	24·7	40	18 27·1	50	20 34·4
30·5	22 52·5	30	38·7	45	19 21·1	55	20 34·7
31 0	22 41·1	35	22·7	50	20 9·1	2 00	19 05·0
7 32·0	21 55·1	40	33·0	55	19 40 5	....	....
....	....	45	32·7	11 00	19 27·1	....	....

'I concluded the work on the 26th with a determination of horizontal intensity, though there still existed a slight unsteadiness of the needle.

'This ended the field work for the season. On returning to Ottawa, observations were taken between September 30 and October 8 in the observing hut. Nine observations for declination were taken between 9.45 a.m. on October 1 and 7.30 a.m. October 2, and eleven between 7.40 a.m. October 5, and 4.00 a.m. October 6, which give a fair value of the daily variation. A number of determinations of horizontal intensity was made on October 1, 2, 5 and 6 to show diurnal variation, also any abrupt change in the value due to the proximity of the electric car line (distant 1,492 feet) depending on whether the cars were running or not. There was a slight unsteadiness of the needle during readings taken throughout the day, which was almost entirely absent during the early morning when the cars were not running. There was no abrupt change either in the horizontal intensity or in declination, hence we may take the adopted values from observations taken during the day. The mean westerly declination for October, 1909, exceeds the mean of April and May by 4′·6, and the latter is 5′·7 in excess of that obtained in November, 1908. The horizontal intensity obtained in October is considerably less than what it was in April and May, 1909. Below are the values of the intensity determined in April–May, and October, with the Agincourt values corresponding to the same instant. A comparison of these values will suffice to show that the change of intensity in Ottawa during the summer was not due to local causes. The last column gives the differences between the corresponding values at the two places:—

Date.	Agincourt.		Ottawa.		Agincourt observations reduced to instant of Ottawa observations.		
1909.	L. M. T. h.	H. (C. G. S.)	L. M. T. h.	H. (C. G. S.)	T. h.	H. (C. G. S.)	H.A – H.O.
April 15........	11	·163251	11·40	·15163	11·40	·16326	·01163
	12	·163278	....	....	....	....	....
	13	·163296	13·50	·15173	13·50	·16331	·01158
	14	·163314	....	....	....	....	....
" 16.	10	·163274	10·08	·15168	10·08	·16327	·01159
	11	·163170	....	....	....	....	....
	12	163188	....	....	....	....	....
	13	·163247	....	....	....	....	....
	14	·163296	14·15	·15169	14·15	·16330	·01161
	15	·163337	....	....	....	....	....
" 17..........	10	·163242	10·06	·15149	10·06	·16324	·01175
	11	·163247	....	....	....	....	....
	12	·163219	11·50	·15151	11·50	·16323	·01172
" 20........	10	·163075	10·23	·15143	10·23	·16307	·01164
	11	·163039	....	....	....	....	....
	12	·163080	....	....	....	....	....
	13	·163193	....	....	....	....	....
	14	·163251	14·46	·15177	14·46	·16329	·01152
	15	·163337	....	....	....	....	....
" 21..........	11	·163075	11·54	·15148	11·54	·16307	·01159
	12	·163071	12·46	·15171	12·46	16310	·01139
	13	·163121	....	....	....	....	....
" 24........	3	·163368	3·07	·15194	3·07	·16337	·01143
	4	·163377	4·16	·15192	4·16	·16338	·01146
	5	·163377	....	....	....	....	....
	6	·163386	....	....	....	....	....
	7	·163377	7·33	·15169	7·33	·16337	·01158
	8	·163341	8·40	·15174	8·40	·16332	·01158
	9	·163305	....	....	....	....	....
" 28..........	12	·163324	12·54	·15191	12·54	·16330	·01139
	13	·163287	13·56	·15196	13·56	·16332	·01136
	14	·163341	....	....	....	....	....
" 29.........	3	·163341	3·50	·15190	3·50	·16336	·01146
	4	·163368	4·54	15199	4·54	·16338	01139
	5	·163386	....	....	....	....	....
	6	·163341	....	....	....	....	....
	7	·163359	7·06	·15199	7·06	·16336	·01137
	8	·163314	7·55	·15192	7·55	·16333	01141
May 6	14	·163371	14·51	·15198	14·51	·16342	·01144
	15	·163456	15·55	·15211	15·55	·16352	·01141
	16	·163546	....	....	....	....	....
" 7	4	·163461	4·28	·15185	4·28	·16346	·01161
	5	·163461	....	....	....	....	....
	6	·163501	6·11	·15193	6·11	·16350	·01157
	7	·163461	7·30	·15185	7·30	·16345	·01160
	8	·163411	8·03	·15185	8·03	·16342	·01157
Oct. 1...........	10	·162272	10·52	·15076	10·52	·16230	·01154
	11	·162312	....	....	....	....	....
	14	·162662	14·13	·15118	14·13	·16266	·01148
	15	·162812	....	....	....	....	....
" 2	4	·162962	4·36	·15143	4·36	·16296	·01153
	5	·162947	....	....	....	....	....
	6	·162957	6·57	·15117	6·57	·16271	·01154
	7	·162612	....	....	....	....	....
" 5...........	9	·162827	9·03	·15124	9·03	·16283	·01159
	10	·162762	10·24	·15101	10·24	·16275	·01174
	11	·162707	....	....	....	....	....
	13	·162717	....	....	....	....	....
	14	·162787	14·05	·15124	14·05	·16278	·01154
	15	·162862	15·46	·15148	15·46	·16288	·01140
	16	·162907	....	....	....	....	....
" 6	4	·162987	4·37	·15159	4·37	·16297	·01138
	5	·162962	....	....	....	....	....
	6	·162982	6·28	·15160	6·28	·16298	·01138
	7	·162982	....	....	....	....	....

'Observations were made at Agincourt on October 14 and 15, for the determination of corrections to be applied to the values of declination and horizontal intensity, obtained with Tesdorpf No. 1977, also, for the instrumental constant of Dover No. 145.

'The following table will show the results of these comparisons, including those made in May:—

Date.	δ *H*	δ *D*	Log *A*
		′	
May, 1909	− ·00147 H	+1·9	9·56440
October, 1909	− ·00061 H	+1·65	9·56920
Mean	− ·00104	+1·8	9·56680

Where δH = correction to be applied to the observed horizontal intensity, δD = correction to be applied to the observed declination (westerly declination is negative). Log A = instrumental constant of Dover No. 145.'

Determination of Temperature Coefficient q for Magnet No. 46, Magnetometer No. 1977.

'Observations for the determination of the temperature coefficient q, of Magnet No. 46, Tesdorpf No. 1977, were taken at Agincourt, October 22, 1909. The method of deflections was adopted for this purpose, and a magnetometer, belonging to the observatory at Agincourt, fitted for this purpose was used. The readings taken on this magnetometer will appear under 'Z^{13}.' Whenever a reading was taken on Z^{13} a corresponding reading was taken by Mr. Wm. Menzies, the officer in charge of the observatory, on the standard declinometer.

'A series of readings were taken before, and after; those taken with magnet No. 46 deflecting, so that a correction could be applied for changes in declination. These appear opposite, "Before Series I" and "After Series III." Magnet No. 46 was then placed in a wooden box, lined with copper, and then surrounded with ice. A thermometer was fitted into the end of the box, in such a way that one end was partly inside the magnet and the other end sufficiently far outside the box to enable one to take readings of the temperature throughout the series. Six readings were taken with magnet No. 46 deflecting, and appear opposite "Series I." The ice was then melted by pouring in hot water and was drawn off through a hole in one end. The box was then filled with hot water, the mean temperature of which during the series of twelve readings appearing opposite "Series II," was 111°·35 F. The magnet was again surrounded with ice, and the readings taken are opposite "Series III." All corrections applied to the readings of Z^{13}, in the computation, correspond to differences between the individual and the mean readings of the standard declinometer in Series I, II and III. The observations and computations appear below. The value of q was found to be equal to ·000424. The former value obtained at Agincourt was ·00045.

'In the determination of horizontal intensity by the method of oscillations and deflections, the correction to be applied to the magnetic moment of the magnet reduces to a correction dependent on the difference between the temperature of the oscillations and deflections. Where these temperatures do not differ by more than 5°, which rarely happens, the difference obtained by using $q = \cdot 000424$ or $q = \cdot 00045$ amounts to less than $\cdot 00007\,H$.

'The value of the temperature coefficient used throughout the computations was ·000424, which was applied directly to $\frac{M}{H}$ and $M\,H$.

—	t.	Magnetic Declination. Reading.	Magnetic Declination. Correct'n to Mean.	Correct'n in scale div. of Z^{18}.	Reading on Z^{18} Observed.	Reading on Z^{18} Corrected.	Mean Corrected.
Series I.	32·0	506·25	·36	·46	68·8	69·26	69·18
	·0	·3	·31	·39	·7	09	
	·0	·2	·41	·52	·7	·22	
	·0	·3	·31	·39	·8	·19	
	·0	·25	·36	·46	·7	·16	
	·0	·25	·36	·46	·7	·16	
Series II.	113·3	506·4	·21	·26	78·3	78·56	78·46
	112·5	·5	·11	·14	·4	·54	
	112·0	·4	·21	·26	·5	·76	
	119·0	·4	·21	·26	·3	·56	
	111·8	·5	·11	·14	·3	·44	
	111·3	·5	·11	·14	·3	·44	
	111·1	·6	·01	·01	·4	·41	
	111·1	·6	·01	·01	·3	·31	
	110·9	·5	·11	·14	·2	·34	
	110·5	·3	·31	·39	·1	·49	
	110·0	·3	·31	·39	·0	·39	
	109·8	·5	·11	·14	·1	·24	
Series III.	32·0	507·2	– ·59	– ·74	70·3	69·56	69·57
	·0	·3	– ·69	– ·84	·4	·53	
	·0	·25	– ·64	– ·81	·3	·49	
	·0	·25	– ·64	– ·81	·4	·59	
	·0	·3	– ·69	– ·87	·5	·63	
	·0	·3	– ·69	– ·87	·5	·63	

DETERMINATION of Temperature Coefficient q for Magnet No. 46 at Agincourt Magnetic Observatory, October 22, 1909.

t.	Z^{18}	Standard.	
Before Series I.	551·7	506·6	t=Temperature.
	·6	·6	
	·7	·65	Z^{18} = Needle used with No. 46 in deflections.
	·6	·65	
	·7	·7	Standard = Needle used in standard Declinometer.
	551·66	506·64	
After Series III.	554·4	507·4	
	3	·5	
	·4	·6	
	·5	·6	
	·4	·6	
	554·4	507·54	

TABLE for converting scale divisions of Standard instrument to scale divisions of Z^{18} instrument.

—	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
0.	·00	·13	·25	·38	·51	·63	·76	·89	1·01	1·14
1.	1·27	1 39	1·52	1·65	1·77	1·90	2·03	2·15	2·28	2·41
2.	2·53	....	....	....	....	....	....	....	....	....

1 Scale division = 1′·01176.

Series.	t (F)	Z^{18} readings
I..	32·0	69·18 }
III..	32·0	69·58 }
II..	111·35	78·46

$t—t_0$=79·35 ; Corr. diff. in decl. =9·08.

	Before Series I.	After Series III
Standard reading..	506·64	507·54
Mean of Series I, II and III........................	506·61	506·61
Correction to mean..	—·03	— ·93
Reduced to scale of Z^{18}........................	—·04	—1·18
Z^{18} reading..	551·66	554·40
Z^{18} corrected..	551·62	553·20
Z^{18} deflected..	69·18	69·58
Angle of deflection..	482·44	483·6

Mean angle of deflection 483·04 scale divisions = 488′·72 = 8° 08′·72.

'The magnetic moment of a magnet diminishes slightly for an increase of temperature, and

$$M_t = M_{t_0} [1 - q (t - t_0)].$$

Where q = temp. coefficient.

t = higher temperature.

t_0 = zero or lower temperature.

$$\frac{M_t}{M_{t_0}} = \frac{\tan u'}{\tan u}$$

$$\frac{M_t - M_{t_0}}{M_{t_0}} = \frac{\tan u' - \tan u}{\tan u} = - q (t - t_0).$$

If u' and u are small, $u' - u$ may be written for the numerator $\tan u' - \tan u$. Under these conditions, the expression for q is the same as that deduced for the sine magnetometer:

$$- q (t - t_0) = \frac{u' - u}{\tan u}$$

$$q = \frac{u - u'}{(t - t_0)} \cot u = \frac{s\ d\ L}{t - t_0}$$

where $u - u' = d$ measured in scale divisions.

$s =$ value of 1 scale division in minutes of arc.

$L =$ the arc of 1′ in terms of radius.

$u =$ angle of deflection at lower temperature.

$u' =$ angle of deflection at higher temperature.

$t =$ higher temperature.

$t - t_0 = 79{\cdot}35.$

$u = 8^\circ\, 08'{\cdot}72.$

$u - u' = 9{\cdot}08$ scale divisions.

$\log q = \log \cot u + \log s + \log d + \log L - \log (t - t_0).$

log cot u	·84429
" s	·00507
" d	·95809
" L	6·46374
Co log $(t - t_0)$	8·10045
log q	6·37164

$q = {\cdot}0002353$

q for 1° C. = ·000424

'Appended is a summary of magnetic results obtained during the season of 1909:—

Station.	Latitude.		Longitude		Date.	Declination.		Dip.		Hor. Int.	Diurnal Variation.
	°	′	°	′	1909	°	′	°	′		′
Quebec........	46	48	71	15	Sept. 9..	18	18·8W	76	1·0	·14792	11·3
St. Joachim	47	03	70	52	" 12..	18	10·8W	76	11·0	·14562	13·7
Les Eboulements....	47	27	70	23	" 16..	19	30·2W	76	33·0	·14108	15·0
Murray Bay.......	47	38	70	09	" 19..	20	5·9W	76	34·2	·14100	12·5
St. Simeon..........	47	51	69	52	" 24..	19	53·9W	76	52·1	·13705	10·6
Tadoussac.........	48	08	69	43	" 22..	20	17·1W	77	17·0	·13420	8·5
Les Escoumains.....	48	21	69	33	June 1.	22	6·6W	76	51·5	·13879	12·2
Portneuf..........	48	36	69	08	" 5..	20	47·2W	77	28·5	·13137	17·6
Cape Colombier.....	48	51	68	54	" 8..	23	44·5W	77	21·5	·13340	13·5
Bersimis....	48	56	68	40	" 10..	21	0·0W	77	54·0	·12840	14·5
Manikuagan....... .	49	11	68	16	" 14..	25	18·0W	77	30·1	·13124	16·2
Godbout............	49	19	67	38	" 16..	24	30·9W	77	37·3	·12978	16·6
Pentecôte rivec......	49	47	67	12	" 21..	25	51·3W	77	40·3	·12920	15·2
Seven Islands.......	50	13	66	25	" 24..	27	2·9W	77	51·4	·12670	8·9
Moisie river.......	50	12	66	07	" 27..	28	26·7W	77	51·2	·12745	13·5
Pigou..............	50	16	65	37	" 30..	28	44·2W	77	3·4	·13365	7·9
Shallop.	50	17	65	10	July 3..	30	16·8W	77	43·1	·12807	7·4
Thunder river.	50	16	64	50	" 6..	27	52·8W	78	5·2	·12263	19·5
Riv. St. Jean.	50	17	64	24	" 9..	27	38·7W	77	9·5	·13370	11·7
Eskimo point......	50	15	63	42	" 14..	35	24·5W	76	36·1	·13850	13·7
Piashti bay..........	50	17	62	52	" 19..	30	12·6W	77	0·5	·13355	14·6
Natashkwan.......	50	11	61	56	" 23..	29	35·1W	76	48·6	·13498	13·1
Kegashka..........	50	11	61	20	" 29..	30	17·9W	76	43·9	·13482	10·8
La Romaine........	50	12	60	44	" 31..	35	45·4W	77	32·2	·12705	16·0
Wapitagun..........	50	13	60	04	Aug. 3..	26	10·9W	76	7·0	·13208	14·0
Harrington Hbr	50	29	59	33	" 6..	31	19·2W	76	23·9	·13684	15·5
Mutton bay.........	50	47	59	06	" 14..	30	13·5W	76	52·0	·13522	12·8
St. Augustin........	51	10	58	33	" 18..	35	17·8W	76	28·9	·13536	13·3
Rocky bay....	51	19	58	05	" 21..	31	16·1W	76	34·1	·13359	15·5
Salmon bay....	51	25	57	39	" 23 .	30	37·9W	76	29·2	·13449	13·2
Blanc-Sablon (Greenly island).........	51	23	57	13	" 27..	33	29·0W	76	0·9	·13962	8·0
Ottawa....	45	24	75	43	April 22..	12	56·2W	75	37·8	·15171	13·2
Ottawa.	45	24	75	43	Oct. 4..	13	0·8W	75	42·5	·15127	11·7

It will be observed that the daily variation for the different stations varies from 7′·4 to 19′·5, and this minimum and maximum occurs at neighbouring stations, Shallop and Thunder river.

As we approach either of the two magnetic poles, the dip in general increases and the force for the horizontal component (declination) decreases. As the diurnal variation is due to external causes, these are more effective with the decreased horizontal component, so that (in the northern hemisphere) the more northerly stations have in general a greater diurnal variation than more southerly ones.

The empirical formula $d = 2'{\cdot}58 \ \mathrm{Sec}^2 \ \phi$ *gives an approximate value of this variation in which d = diurnal variation, and ϕ = magnetic latitude, obtained from the relative $\tan \phi = \frac{1}{2} \tan I$, where I is the inclination or dip at the respective place.

The greater the dip at a place, the greater is the diurnal variation to be expected.

If we take the mean of the dips of the preceding 33 stations we obtain 76° 55′·5, and the mean of the diurnal variations is 13′·0.

If we apply the above equation for d for the above mean dip, we have d = 14′·5 as the value between eastern and western elongation of the magnetic declination.

The accompanying map shows the position of the stations occupied during the season of 1909, with the accompanying direction of the magnetic meridian at the respective stations.

The following are the descriptions of the stations occupied along the north shore of the St. Lawrence during 1909:—

Quebec.—Occupied the United States Coast and Geodetic station of 1905. 'It is on the Plains of Abraham, in the portion formerly used as a race course, in line with the rear wall of the jail, also in line with the north corner of the jail and a church spire. The precise point is marked by an inch stake driven flush with the ground in the middle of a depression about 3½ feet in diameter. It is 168·4 feet from the boundary stone at the intersection of two fences. The following true bearings were determined:

Church spire, 38° 30′·7 East of South.
Church spire, 27° 52′·9 West of South.'

Redetermined the reference points.
Church spire north of river (R.O.), 27° 51′·8 West of South.
Church spire south of river, 10° 56′·2 West of South.
Church spire south of river. 38° 31′·2 East of South.

St. Joachim.—The station is about half a mile north of the railway depot in the second field, the property of Mr. Filion, north of a large stone building which is on the southwest corner of the intersection of two roads. About three-quarters of the church may be seen from the station, to the west of the stone building. The precise point is 79 feet, in a northerly direction, from a stake driven flush with the ground in the centre of a gateway at the south end of the field. The point, stake and spire of the church are in line.

* U. S. Coast and Geodetic Survey Report, 1902, p. 51.

True bearings of the following points were obtained:

Pole on centre of large red barn, 84° 31′·1 East of North.
Smoke-stack on saw-mill, 104° 33′·3 East of North.
Spire on church (R.O.), 149° 54′·9 East of North.
Lighthouse on Orleans island, 163° 9′·9 East of North.

Les Eboulements.—The station is on the east side of the road about three-eighths of a mile from the wharf, being in the southwest corner of the second field south of Mr. Cimon's house. The point is 14 feet north from a stake two inches in diameter and four inches above ground close to the south fence and 33·5 feet east from a stake two inches in diameter and four inches above ground close to the west fence along the east limit of the public road.

The following true bearings were determined:

Flagpole on Mr. Cimon's house (R.O.), 11° 04′·0 West of North.
Tower of church in the village, 53° 27′·2 East of North.
Soil: Clay loam.

Murray Bay (Pointe-à-Pic).—The station is near the northwest corner of an irregular enclosure at the back of the Warren hotel. A stake two inches in diameter, driven flush with the ground, marks the point, which is 33·7 feet east of the west fence, and 30 feet south of the north fence. It is in line with the east side, and north of a planing mill. A short distance to the east is a bed of gravel. The English church spire may be seen above the fourth house to the north of the hotel.

The following true bearings were obtained:

North gable of planing mill, 166° 8′·9 East of North.
Spire on Catholic church (R.O.), 159° 17′·2 East of North.
North gable of Chateau Murray, 153° 22′·7 East of North.
Spire on English church, 34° 52′·1 East of North.
Soil: Sandy loam, containing considerable quantity of stones.

Tadoussac.—The station is located in the northwest corner of a field adjacent to the Saguenay hotel. The point is marked by a stake two inches in diameter driven flush with the ground, and is 146 feet north of the hotel and 46 feet west of the east fence. Rocks constitute the north boundary of the field.

True bearings of the following points were determined:
Pole on middle of house (R.O.), 40° 52′·1 East of North.
Top of outer lighthouse on west side of Saguenay, 159° 25′·6 East of North.
Top of inner lighthouse on west side of Saguenay, 171° 44′·2 East of North.
Pole on freight shed at wharf, 178° 16′·1 East of North.
Soil: Practically nothing but granite rock in the vicinity of the station.

St. Simeon.—The station is located on the flat north of the road leading from the wharf, and is in line with the westerly end of the Belley hotel. The point is marked by a stake two inches in diameter driven so as to project two inches above ground, and is 15 feet west of the road along the beach and 385 feet in a westerly direction from the end of the wharf.

True bearings of the following points were determined:
Pole on front of Belley hotel (R.O.), 179° 4′·8 East of North.
Top of shed on wharf, 135° 30′·5 East of North.

Lighthouse on point on north shore of St. Lawrence, 33° 21′·9 East of North.

Soil: Sand.

Les Escoumains.—The station is located to the southwest of the wharf near a sandy beach. On three sides of the beach, including a small strip of grazing land, is a fence. The point is in a small clearing adjacent to the southeasterly corner of this enclosure, and is marked by a four by four-inch stake projecting six inches above ground, which is 7 feet from the fence and 27 feet from the edge of a large rock at the end of the fence.

The reference object is a chimney on a small frame house about 1,200 feet distant; bears 121° 22′·0 West of North.

Soil: Loose gravel and sand, with considerable quantities of granite rock near.

Portneuf.—The station is on the western side of the harbour, and about 740 feet almost due south of the Government wharf. It is in a small enclosure, being about 10 feet west from the fence on the easterly side and about 20 feet east of the foot of a steep bank which constitutes the westerly portion of the enclosure. A small grove of spruce trees covers a portion of the bank on either side of the station. The point is marked by a post two by four inches driven so as to project three inches above the surface. Magnetic observations were made at a point 12 feet west of the station and in line with top of lighthouse.

True bearings of the following points were determined:

Top of lighthouse on east side of harbour (R.O.), 115° 20′·8 East of North.

Smokestack on mill near wharf, 41° 18′·6 East of North.

Smokestack on mill in northern part of town, 14° 44′·6 East of North.

Soil: Loose sand. No rocks visible.

Cape Colombier.—The station is located on the north shore of an inlet which is opposite the north side of Cape Colombier. It is near the eastern end of a clay bank and about 100 feet south of the Government telegraph line, which runs along the foot of a high bank. There is a growth of small spruce trees to the north and west of the station. The point is marked by a stake four inches in diameter projecting three feet above ground. Magnetic observations were made in a slight depression 22 feet west of the station and in line with gable of house on the bank.

True bearings of the following points were determined:

First telegraph pole on the bank to the northeast of the station, 78° 28′·5 East of North.

West gable of house on the bank (R.O.), 83° 39′·9 East of North.

Cross over grave on Cape Colombier, 11° 59′·5 West of South.

Soil: Sand, containing traces of iron. The rock in the vicinity showed no effect on magnet.

Bersimis.—The station is located on the west side of the harbour in a depression, about 50 feet in diameter, in a sandy point to the south of the village. It is about 450 feet in a northeasterly direction from the southern extremity of the point, 125 feet east of the westerly side and 175 feet west of high-water mark on the easterly side.

True bearings of the following points were determined:

Western section of range, 29° 30′·7 East of North.

Spire on church (R.O.), 33° 17′·3 East of North.

Eastern section of range, 54° 04′·9 East of North.

Soil: Sand, bearing traces of iron. There are no rocks in the vicinity.

Manikuagan.—The station is in a small field and about 300 feet southwest of the last house, overlooking the beach, in the southwestern part of the village. There is a deep ravine on the easterly and westerly sides of the field. The point is 18 feet southwest of the ravine on the easterly side, 45 feet northwest of the bank adjacent to the beach measured parallel to the easterly fence, and is marked by a four-inch by four-inch stake driven flush with the ground. The magnetic observations were made 12 feet southwest of the station, and in line with the cross on the Catholic church porch.

The bearings of the following points were determined:

Cross on porch of Catholic church (R.O.), 57° 01′·1 East of North.

West gable of house north of and close to saw-mill, 109° 27′·7 East of North.

West gable of saw-mill, 120° 13′·3 East of North.

Gable of house near mouth of the river and on southerly side, 131° 09′·8 East of North.

Soil: Clay loam. No rock visible within 1,000 feet.

Godbout.—The station is in a field belonging to Mr. Napoleon Comeau. In the southeastern part of the field and about 500 feet distant is the post office and dwelling house, also another dwelling house. The point is marked by a post two inches in diameter driven so as to project one inch above the surface, and is 49·8 feet east of the west fence and 74·8 feet south of the north fence. Magnetic observations were made 15 feet north from the station and in line with range at the south of the village.

True bearings of the following points were determined:

Top of cross in southern end of village, 194° 13′·6 East of North.

Top of range in southern end of village (R.O.), 192° 48′·7 East of North.

Gable of house in southeast corner of field, 161° 56′·3 East of North.

Soil: Sand, containing small particles of iron. No rocks within a mile.

Pentecôte river.—The station is about 12 feet east of the bank of the Pentecôte river, in a small field owned by Mr. Louis Gauthier. The field is opposite and west of the fifth house, which is in a southerly direction from the telegraph office. A narrow strip of land on the west side of the field is covered with a growth of small spruce trees, and the station is on the northeasterly side of a small clearing in this strip. The magnetic observations were made 18 feet in a southerly direction from the station, which is marked by a four-inch by four-inch stake driven so as to project one foot above ground, and in line with the spire of the church.

True bearings of the following points were determined:

South gable of last house southwest of village, 5° 33′·6 West of North.

Iron chimney on mill, 19° 24′·5 East of North.

Spire on church (R.O.), 33° 04′·4 East of North.

Soil: Loose sand. No rocks in vicinity of station.

Seven Islands.—The station is in the second field, in a northerly direction from Mr. Francis Gallienne's house. The point is on the easterly side of a roadway running through the middle of the field, and is 28 feet north of the fence on the south side and 63 feet west of the fence on the east side of the field. A stake two inches in diameter driven flush with the ground marks the point.

True bearings of the following points were determined:

Spire on church (R.O.), 148° 7'·2 East of North.

East gable of post office, 81° 23'·0 West of North.

Spire on Indian Mission church, 50° 42'·4 West of North.

Soil: Loose sand, with traces of iron.

Moisie river.—The station is on a slight elevation to the north of the village, being in the northeast corner of a field belonging to Mr. Charles Fournier. It is about 200 feet west of the storm signal station, which is in the field adjacent. The spire of the Catholic church may be seen over the middle of the first house to the north and east of the station (magnetic). This house is the only one of several in the same enclosure as the observing station, and has its sides shingled. The point is marked by a stake two inches in diameter projecting two inches above ground, and is 34 feet in a westerly direction from the easterly fence, and 16 feet in a southerly direction from the fence on the northerly side of the field.

True bearings of the following points were determined:

West gable of house on opposite side of river, 1° 46'·3 East of North.

West gable of small house near storm signal post, 90° 25'·9 East of North.

Spire of Catholic church (R.O.), 129° 33'·1 East of North.

Chimney on post office building, 146° 2'·6 East of North.

Soil: Sand.

Pigou.—The station is at the extreme eastern end of a cleared piece of land adjacent to the beach, and is about 1,000 feet east of Mr. Peter Wright's house. To the south and east there is a mass of granite rock which extends eastward along the shore. The point is marked by a three by three-inch stake set so that eight inches project above ground.

The east chimney of Mr. Peter Wright's house, which bears 70° 9'·7 West of North, was taken as the reference object.

Soil: Sand, but granite rock near.

Shallop.—The station is about 25 feet from the beach at the northeast corner of a small bay at the mouth of the Shallop river, and 10 feet south of a fence which is on the south side of a field enclosing a church, a red house, a yellow house, a small log house, besides several barns. The sandy beach extends up to this fence about 50 feet to the west of the station.

The reference point is a chimney on the first house to the northwest of a large frame house on the west side of the river.

The point is marked by a post three inches in diameter which projects six inches above ground.

True bearings of the following points were determined:

Chimney on house (R.O.), 79° 40'·4 West of North.

Chimney on first log house east of river on same elevation as church, 61° 45'·5 West of North.

Bottom of cross on church tower, 35° 10'·9 West of North.

Soil: Sand; granite rock in vicinity of station.

Thunder river.—The station is northwest of the harbour, in a small field belonging to Le Boutellier Bros., which is the second north from the St. Lawrence. It is about 200 feet west of a small barn and about 1,000 feet east of the telegraph office. The point is marked by a stake three inches in diameter projecting eight inches above ground, and is 115·5 feet west of the east fence and 127·5 feet north of the south fence. The soil is sandy, but there is considerable rock in the vicinity, and a portion of rock is exposed about 20 feet to the northeast.

True bearings of the following points were determined:

Top of belfry on Le Boutellier Bros. storehouse, 97° 29′·5 East of North.

Spire on Catholic church (R.O.), 101° 52′·7 East of North.

West gable of landing stage on west side of harbour, 115° 6′·2 East of North.

East gable of telegraph office, 99° 17′·2 West of North.

North gable of storm signal house, 58° 37′·3 West of North.

Riv. St. Jean.—The station is in a large field on the westerly side of the river and the easterly side of a small bay which becomes dry at low tide. The property belongs to Mr. Sirois and is leased by Mr. Richardson. There is also in the field a dwelling house, store and storehouse. The Catholic church is northeast of the station in an adjacent field. The point is marked by a stake two inches in diameter driven flush with the ground, and is 30 feet in a northeasterly direction from another stake which projects eight inches above ground, set one foot from the fence, and which is in line with the station and a large cross on the opposite side of the bay.

True bearings of the following points were determined:

Small pole on belfry of fish house on westerly side of river, 146° 25′·3 West of North.

Cross on bank on northwesterly side of river and southwesterly side of bay (R.O.), 143° 13′·7 West of North.

Cross on church, 71° 36′·9 East of North.

West gable of telegraph office, 90° 1′·5 East of North.

Soil: Sand and gravel, but bank adjacent to station shows clay about 15 feet below surface.

Eskimo point.—The station is in a large field, overgrown with small spruce trees, near the north end of the street passing in front of the Catholic church, and is almost in line with the west end of the church. The fences on both sides of the street near the end diverge gradually, until they run approximately at right angles to the direction of the street. A line joining the station and a large crucifix in the cemetery passes slightly to the north of the centre of the main entrance. The point is marked by a stake two inches in diameter driven so as to project six inches above ground. It is 475 feet west of the entrance to the cemetery, 82·5 feet northwest of the fence on the easterly side of the street and 82·5 feet northeast of the fence on the westerly side.

True bearings of the following points were determined:

Top of crucifix in cemetery, 63° 42′·3 East of North.

West gable of telegraph office, 145° 42′·5 East of North.

Spire on church (R.O.), 1° 12′·6 West of South.

East gable of house opposite church, 7° 23′·8 West of South.

Soil: Sand.

Piashti bay.—The station is on the northeastern side of the bay, being 16 feet west of a rocky cliff 10 feet high, which runs for some distance in a northerly and southerly direction. It is about 125 feet north of the high-water mark and 150 feet east of the high-water mark. The church may be seen to the east of a small log house, the southeast corner of which is 74 feet in a northwesterly direction from the station. The station is marked by a stake three inches in diameter and two feet high, held in position by a mound of stones.

True bearings of the following points were determined:

Pole on point on western side of entrance to bay, 30° 49′·9 West of South.

East chimney of red house on rocky peninsula east of river (R.O.), 58° 56′·2 West of North.

East gable of telegraph office, 25° 1′·4 West of North.

Chimney on church, 1° 4′·1 West of North.

Natashkwan.—The station is about 100 feet from the high-water mark near the northwestern extremity of Wood island, being opposite a small peninsula on the west side of which is the western harbour. It is about 1,150 feet northeast of the lighthouse, which is also on Wood island, and 125 feet north of east from a granite monument lettered 'C.R.C. 1866.' With the exception of a patch of small trees, which covers the northeastern part of the island, and some moss, there is no vegetation on the island. The point is marked by a stake supported by a mound of stones.

True bearings of the following points were determined:

Top of lighthouse on Wood island (R.O.), 40° 32′·1 West of South.

Top of cross on Beacon islet, 60° 46′·1 West of North.

South gable of landing stage, marked C.R.C., at northeast corner of western harbour, 00° 0′·3 West of North.

Spire on church on mainland, 81° 40′·5 East of North.

Kegashka.—The station is near the northeastern extremity of Kegashka island, being about 200 feet west from high water on the eastern side and 200 feet south of high water on the northern side. It is slightly to the west of a rocky ridge, which runs parallel to the east shore for about 500 feet. To the west of the station, there is a growth of dwarf spruce trees and immediately surrounding it, the rock is covered with moss. From the station it is impossible to see the houses situated on the island, but a house with shingle sides located on a rocky prominence to the north of the narrow channel, separating the island from the mainland, may be seen over a small fish building. The point is marked by a stake three inches in diameter, held in position by a mound of stones.

True bearings of the following points were determined:

Beacon on Kegashka point (R.O.), 16° 50′·1 West of South.

Chimney on house on hill north of channel separating the island from the mainland, 83° 40′·5 West of North.

La Romaine.—The station is located on an island lying on the north side of the harbour, and east of the southeastern extremity of the mainland. The island is southeast of and across a bay from the village. The point is almost in the centre of the island, on a level strip of land about 50 feet north of a ridge of rock which runs, for the most part, the entire length of the island, and is about 20 feet south of a large boulder which lies in a small excavation. The point is marked by a stake four by four inches, tapering at the top and projecting six inches above ground.

True bearings of the following points were determined:
Chimney on telegraph office, 50° 23′·2 West of North.
Chimney on frame house painted blue (R.O.), 33° 55′·1 West of North.
Chimney on church, 9° 4′·2 West of North.
Soil: Layer of sand on rock.

Wapitagun.—The station is on the southeastern part of Wapitagun island, being on that section of the island which lies adjacent to the south side of Wapitagun harbour. There is a small island to the east, on which is a range for service to boats entering the harbour by the eastern passage. Both sections of the range may be seen over the southeastern portion of the island on the south side of the harbour, the southerly one being slightly to the left of a mass of rock which is 45 feet southeast of the station. On the westerly and southwesterly side, and about 10 feet distant from the point, is a rocky cliff about 15 feet in height, which rises gradually to a height of about 40 feet. The western extremity of a small inlet is about 25 feet northeast of the station, which is marked by a stake four inches in diameter and projects two feet above the surface.

True bearings of the following points were determined:
Bottom of north section of range, 79° 30′·8 East of North.
Bottom of south section of range (R.O.), 93° 45′·6 East of North.

Harrington.—The station is located on a low piece of land, the property of the Grenfell Mission, lying to the north of the hospital and doctor's residence. It is on a slightly elevated portion somewhat east of the middle of the field, and is 450 feet north of the English church. The point is marked by a two by three inch stake driven flush with the ground.

True bearings of the following points were determined:
North gable of English church school, 44° 52′·1 East of South.
Spire on English church (R.O.), 35° 41′·6 East of South.
North gable of doctor's residence, 24° 29′·5 East of South.
Northeast corner of hospital, 0° 48′·7 West of South.
Soil: Layer of decayed moss and grass on gravel.

Mutton bay.—The station is located near the northwest extremity of the harbour, being about 1,000 feet north of the last house on the west side. It is about 300 feet south and west of the narrowest part of the channel between the harbour and a bay lying beyond. There is a large boulder 15 feet south and west from the point. None of the houses on the west side of the harbour are visible from the station, and only the tops of a few south of the English church on the east side can be seen. The point is approximately in line with a row of telegraph poles on the west side of the hill to the north and east of the village.

True bearings of the following points were determined:
North gable of small house on east side of harbour, 59° 31′·9 East of North.
Last telegraph pole on hill east of station, 73° 53′·5 East of North.
Cross on English church (R.O.), 109° 8′·5 East of North.
Practically nothing but granite rock.

St. Augustin (Outer island).—The station is near the northeast extremity of Outer island, on a gravel beach adjacent to Scole cove. Dog island may be seen to the east of a small island which is distant about 500 feet. The point is 8 feet from high-water mark, and is on the outer edge of a small ravine, which extends a short distance inland, and is covered with dwarf spruce trees. Two frame houses may be seen on Dog island, and a line joining the station and houses passes over a low rocky island on which, at first sight, the houses appear to stand. The point is marked by a stake two feet high and three inches in diameter, surrounded by stones.

The west gable of the east house on Dog island, which bears 17° 30′·3 East of North, was taken as the reference object.

Soil: Small stones and sand covering granite rock.

Rocky bay.—The station is located on Mr. John Belbin's property, about 50 feet from high-water mark on the south side of a small cove, which is on the eastern side of Rocky bay and about 300 feet easterly from several frame houses. Surrounding the station for a short distance, the rock is covered with a layer of sand about a foot in depth. The point is marked by a stake two inches in diameter projecting 18 inches above ground.

True bearings of the following points were determined:

Chimney on Mr. Belbin's house, 75° 26′·8 West of North.

Pole on vacant frame house (R.O.), 63° 36′·6 West of North.

Southerly gable of telegraph office on opposite side of cove, 49° 43′·3 East of North.

Salmon bay.—The station is located about 200 feet west of Mr. Jeremiah Dunn's house and post office. It is 155 feet in an easterly direction from a flagpole, which is on the highest point at the northwest extremity of the mainland, opposite which is Salmon island. This flagpole, the station and another flagpole on the hill to the east of the post office, are almost in line. A post 2½ inches in diameter, projecting 18 inches above ground, marks the point.

True bearings of the following points were determined:

South gable of Mr. McAllister's house, 78° 45′·5 East of North.

Flagpole on hill east of post office (R.O.), 85° 17′·5 East of North.

Chimney on small frame house, 22° 57′·0 East of South.

Flagpole on hill to west of station, 79° 18′·3 West of South.

Blanc-Sablon (*Greenly island*).—The station is located on Greenly island in a slight depression almost in the centre of a plateau which lies between two coves, one on the southerly and the other on the northerly side, and two hillocks on the easterly and westerly sides. The nearest of Job Bros. & Co.'s fish buildings is 400 feet to the northeast, but owing to a slight elevation this cannot be seen from the station. There is a mound about 10 feet in height approximately 25 feet to the south. A stake two inches in diameter and six inches above ground marks the point.

True bearings of the following points were determined:

Bottom of flagstaff on hill east of Job Bros.' rooms, 74° 17′·7 West of South.

Bottom of weather vane on Greenly island lighthouse (R.O.), 5° 05′·9 West of South.

East gable of small observation house, 46° 01′·5 West of North

Soil: Sand.

Addendum.

In looking over some old volumes of the Royal Society, London, I came across a paper presented by Halley to the Society, and it is thought that extracts from it may be of interest. To them are added a few other notes.

In the evolution of the knowledge of terrestrial magnetism the following important epochs may be noted:—

Columbus towards the close of the 15th century establishes the fact, that the needle does not point due north and south, and that its deviation therefrom differs for different places.

Three-quarters of a century later, in 1576, Robert Norman discovers dip or inclination.

In 1634, Gellibrand discovers that through lapse of time the pointing of the needle changes at a given place, that is, secular variation.

And in 1722, Graham, the well-known clockmaker of London, discovered by a long series of observations the diurnal variation of the compass.

Halley (1656-1742) paid a great deal of attention to terrestrial magnetism before he assumed the office of Astronomer Royal in succession to Flamsteed, and it may be interesting to make some quotations from a paper presented by him to the Royal Society, in Philosophical Transactions, No. 195 (1692), and taken from Hutton's abridged edition, Vol. III., p. 470. The title is: 'On the change of the Variation of the Magnetic Needle, with an Hypothesis of the Structure of the Internal Parts of the Earth.'

'Having published, in those Transactions No. 148, a theory of the variation of the magnetic needle, in which, by comparing many observations, I came at length to this general conclusion, viz.: that the globe of the earth might be supposed to be one great magnet, having four magnetical poles or points of attraction, two of which near each pole of the equator; and that in those parts of the world, which lie near any of those magnetical poles, the needle is chiefly governed thereby; the nearest pole being always predominant over the more remote. And I there endeavoured to state and limit the present position of those poles on the surface of our globe. Yet I found two difficulties not easy to surmount: the one was, that no magnet, I had ever seen or heard of, had more than two opposite poles; whereas the earth had visibly four, and perhaps more. And secondly, it was plain that these poles were not, at least all of them, fixed on the earth, but shifted from place to place, as appeared by the great changes in the needle's direction within this last century of years; not only at London, where this discovery was first made, but almost all over the globe of the earth; whereas it is not known, or observed, that the poles of a loadstone ever shifted their place in the stone, nor, considering the compact hardness of that substance, can it easily be supposed.'

As we see, Halley's difficulty of interpreting the phenomena was that he conceived the magnetic phenomena to be due to four poles instead of two, for there are only two as far as declination is concerned; the other two poles of which we now speak are those of maximum total intensity. In order to give a plausible, if not quite satisfactory explanation, to account for the secular variation, he conceives the earth to be made up of two concentric spheres revolving in nearly the same time. In his words: 'Now supposing such an internal sphere, having such a motion, we may solve the two great difficulties in my former hypothesis. For if this exterior shell of earth be a magnet, having its poles at a distance from the poles of diurnal rotation; and if the internal nucleus be likewise a magnet, having its poles in two other places distant also from the axis; and these latter, by a gradual and slow motion, change their place in respect of the external, we may then give a reasonable account of the four magnetical poles, as also of the changes of the needle's variation. The period of this motion being wonderfully great, and there being hardly a century since these variations have been duly observed, it will be very hard to bring this hypothesis to a calculus. . . . . . Hence and from other of like nature, I conclude, that the two poles of the external globe are fixed on the earth, and that if the needle were wholly governed by them, the variations would be always the same, with some little irregularities on the account just now mentioned; but the internal sphere having such a gradual translation of its poles, influences the needle, and directs it variously, according to the result of the attractive or directive power of each pole; and consequently there must be a period of the revolution of this internal ball, after which the variations will return again as before. But if it shall in future ages be observed otherwise, we must then conclude, that there are more of these internal spheres, and more magnetical poles than fans, which at present we have not a sufficient number of observations to determine, and particularly in that vast Mar del Zur, which occupies so great a part of the whole surface of the earth.'

The riddle of secular variation is not much nearer solution to-day than it was in the days of Halley. About a century and a half after Halley, the illustrious Gauss applied his mathematical skill to terrestrial magnetism, and put the subject on a mathematical and scientific basis. Especially did his labours result in expressing the terrestrial magnetic force or intensity in absolute units, in contradistinction to the relative values that had obtained before. Gauss was essentially a mathematician and not a physicist. To show the state of knowledge with reference to secular variation in the time of Gauss, we may cite the following extract.

In the closing words of a letter in 1832 by Gauss to Schumacher, the former says regarding secular variation: 'I have always considered those vast changes as something most remarkable. Terrestrial magnetism is without doubt not the result of the presence of a pair of large magnets in the vicinity of the earth's centre, which by degrees move away many miles from their position, but is the result of all the polarized iron particles, and especially of those that lie nearer to the surface than to the centre. Yet, what shall one think of the vast changes that have taken place within a few centuries? Cordier's hypothesis of a relatively thin crust has always appealed to me as explanatory for the above phenomenon. Of course, in that case the magnetic elements can have their seat only there, and the thickening of the crust from a former fluid state would then readily explain the large variation in terrestrial magnetism, which otherwise remains a great riddle. The circumstance, too, that the so-called principal magnetic poles lie in the coldest regions, where we may take for granted that the crust is thickest, seems to point in that direction.'

Wiechert, who gives the above quotation in the Göttingen 'Festschrift, 1906,' adds, 'that it is a consolation for many a scientist who is so painfully aware of his own inability to explain things, that Gauss could entertain such naive notions. It is to be noted, however, that Gauss wrote these words in a private letter, and that he was very cautious in weighing every word that was intended for publication.'

GRAVITY.

During the past season no member of the staff was available for making gravity observations.

I have the honour to be, sir,

Your obedient servant,

OTTO KLOTZ.

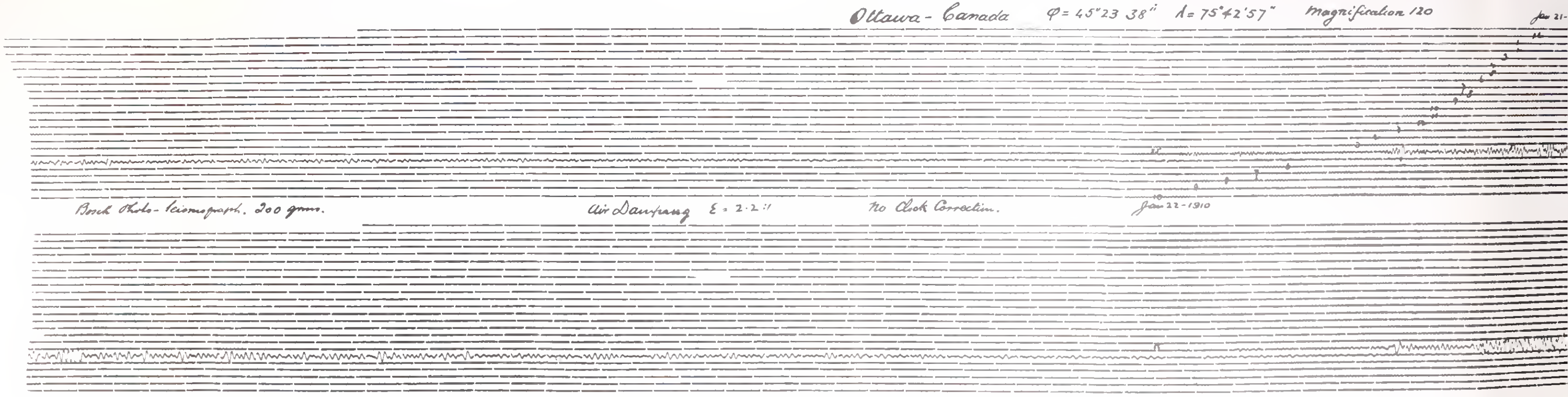

Fig. 6. EARTHQUAKE NEAR ICELAND

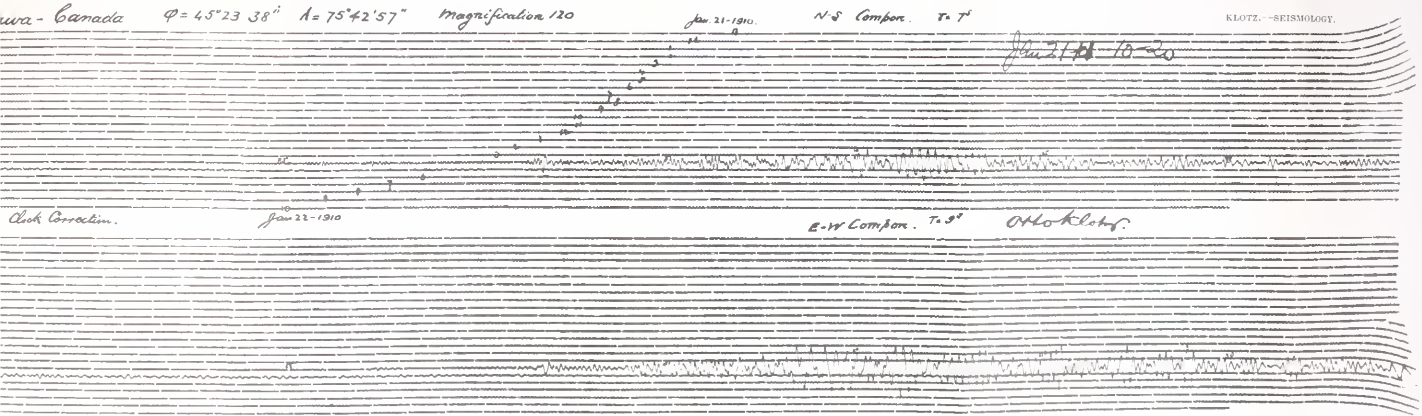

Fig. 6. EARTHQUAKE NEAR ICELAND


QUEBEC
GULF OF ST LAWRENCE
NEW BRUNSWICK
PRINCE EDWARD ISLAND
CAPE BRETON ISLAND
NOVA SCOTIA
MAINE
ATLANTIC OCEAN
Pentecôte River
Godbout
Manikuagan
Bersimis
C. Colombier
Portneuf
Les Escoumains
Tadoussac
St. Simeon
Murray Bay
Les Eboulements
St. Joachim
Ottawa
Seven Islands
Moisie River
Pigou
Shallop
Thunder River
River St. Jean
Eskimo Pt.
Piashti Bay
Natashkwan
Kegashka
La Romaine
Harrington Har.
Mutton Bay
St. Augustin
Rocky Bay


C
Blanc Sablon
Salmon Bay
Rocky Bay
St. Augustin
Mutton Bay
Harrington Har
Wapitagun
La Romaine
Kegashka
Natashkwan
Piashti Bay
GULF
OF
ST LAWRENCE
NEWFOUNDLAND
NOTRE DAME BAY
WHITE BAY
TRINITY BAY
FORTUNE BAY
CABOT STRAIT
EDWARD
AND
CAPE BRETON
ISLAND
ATLANTIC
OCEAN
Department of the Interior
ASTRONOMICAL BRANCH
MAGNETIC DECLINATION
OBSERVED IN
1909
Accompanying report of Dr Otto Klotz to the Chief Astronomer
Scale 35 miles to one inch

APPENDIX 2.

REPORT OF THE CHIEF ASTRONOMER, 1910.

ASTROPHYSICAL WORK

BY

J. S. PLASKETT, B.A.

CONTENTS.

ILLUSTRATIONS.

APPENDIX 2.

ASTROPHYSICAL WORK, BY J. S. PLASKETT, B.A.

OTTAWA, ONT., March 31, 1910.

Dr. W. F. KING, C.M.G.,
Chief Astronomer,
Department of the Interior,
Ottawa.

SIR,—I have the honour to submit the following report upon the work carried on in the Astrophysical Division, and in other departments of the work of the Observatory, under my direction during the past year.

I am pleased to be able to give a very favourable report of the zeal and industry of my assistants in the work. Without such effective co-operation as they are giving, the quantity and quality of the work reported would necessarily be much decreased.

I propose to give in this introduction a brief synopsis of what has been accomplished under my direction, leaving for later presentation the complete details, tables, measurements, &c. For convenience in the treatment and discussion, it will be classified under the following headings:—

1. Stellar Spectroscopy.

This includes measurements of stellar radial velocities, determination of the velocity curves and elements of the orbits of spectroscopic binary stars, and allied investigations.

2. Solar Research.

This subdivision embraces work on the sun with the coelostat telescope and grating spectroscope, solar photographs with the equatorial telescope, and other work along similar lines.

3. Micrometric Work.

This includes the measurement of the position angles and distances of double stars and the positions of comets; there is also included under this heading, comet and stellar photography, and the observation of occultations of stars by the moon.

4. Mechanical Work.

This includes the work of the mechanicians and carpenter in the construction of new and the repair and alteration of existing instruments.

Stellar Spectroscopy.

As in previous years, the greater part of my own time and the whole time of Messrs. Harper, Cannon and Parker has been given to this work, and very satisfactory progress has been made. During the past twelve months, from April 1, 1909, to March 31, 1910, 910 star spectra have been obtained on 144 nights, the total number on record at present being 3,368. In addition to these, numerous test spectra used in determinations of focus and in other investigations have been made.

The measurement of the 910 star spectra, which are mostly of spectroscopic binaries under investigation, is practically completed, and in addition other spectra remaining from the previous year have been measured, bringing all such work practically up to date.

From these and previous measurements have been obtained the velocity curves and orbits of seven spectroscopic binaries:

B.D. − 1°·1004,	by W. E. Harper.
φ Persei	" J. B. Cannon.
τ Tauri	" T. H. Parker.
α Draconis, ε Herculis, η Boötis	" W. E. Harper.
ι Orionis	" J. S. Plaskett.

For the last four stars, previous orbits by the same writers had been obtained and published, the present orbits being in the nature of corrections resulting from further measures, from the application of least squares solutions or from different discussions of the original data. Furthermore, many additional plates of the spectroscopic binary β Orionis, discovered and discussed by myself in my last report, have been obtained and measured, but the data available are not yet complete enough to permit of any discussion at present.

In seven other spectroscopic binaries,

7 Camelopardalis
ν Orionis
ω Ursæ Majoris
93 Leonis
ε Ursæ Minoris
γ Aquarii
θ^2 Tauri

many plates have been obtained and measured, and work in obtaining the velocity curves is well under way. There are nine other binaries on our programme, in most of which, however, only a few plates have been obtained. Some plates of early type stars not known to be binaries have been secured for discovery purposes, as well as a number of Arcturus for a special investigation.

The new single-prism spectrograph, which had just been completed at the time of my last report, has been in continuous use ever since, and the good opinions then formed of its performance, its efficiency, accuracy, and convenience have been confirmed and strengthened by experience. No effect that can be attributed to flexure or temperature displacements has ever been observed, and the lines in star spectra with long exposures are as well defined as those with the shortest exposures.

As soon after this instrument was completed as possible, a short-focus camera was made for the three-prism spectrograph, the Zeiss-Tessar, tests of whose performance were described in the last report, being used at first as objective. Lately, however, the Ross special homocentric has been substituted, giving better definition although with slightly more curvature of field, and this objective is now in regular use. The short-focus three-prism spectrograph is used in stars having spectra of solar type, while the single-prism instrument is used on early type stars.

A separate relay box and heating attachment was installed so that, in case both instruments were required on the same night, each might be maintained at constant temperature, and the change from one to the other effected in five minutes or less without disturbance of temperature conditions.

Soon after the new single-prism was brought into use, it was found that the spectra obtained were weaker at the violet end than could reasonably be attributed to the increased absorption of the larger prism employed, and a special investigation to determine the cause was undertaken by myself. After finding that it was not due to incorrect focal position of the slit, to imperfect adjustment of the guiding arrangement, or to faulty guiding, it was finally located as due to a slight error in collimation of the correcting lens. Further tests showed that the system was very sensitive to changes in collimation, a movement of 1/100 of an inch causing a sensible difference in distribution of the density regions in the spectra. The effect of faulty collimation was shown to be a kind of dispersion of the star image, the image in blue light being displaced to one side of that in violet. Consequently, as the guiding is on the most luminous part of the image, the blue-green, the image in violet light may be off the slit, resulting in a spectrum weak in the violet region. For remedy, the correcting lens was made adjustable transversely, and the best readings for the two spectrographs in different positions of the telescope were determined experimentally. A very marked improvement in the spectra resulted, not only extending the measurable region farther into the violet but giving much more uniform intensity throughout.

The investigation on the effect of increase of slit width on the accuracy of velocity determinations, discussed in my 1907-8 report, but only briefly referred to last year, has been finally completed by extending the measures so far as spectra of early type stars are concerned to two different dispersions, the new single-prism spectrograph, 33·4 tenth-metres per millimetre, and the three-prism short-focus, 17·5 tenth-metres per millimetre at $H\gamma$. Moreover, ten spectra at each of the four slit widths used in the previous tests have been made of Arcturus, a solar type star, with the new single-prism spectrograph and the plates measured on the spectro-comparator, which presumably essentially eliminates the effect of loss of purity. The results of the whole investigation confirm and extend those previously obtained, and furnish convincing proof that at least equal accuracy is obtainable for all spectral types with a slit 0·051 mm. wide (·002 inches) as with narrower slits, 0·025 to 0·030 mm., which are the widths usually employed, but that with slits wider than this, systematic errors due to asymmetric position of the nucleus of the star image within the slit jaws begin to appear. As the exposure time required is approximately inversely proportional to the slit width, the practical value of these results can be readily appreciated.

A further investigation of a somewhat similar nature has been undertaken and practically completed—the relative accuracy obtainable with different dispersions—with results of a similarly unexpected nature and of an equally important character. A number of spectra of Arcturus, a star with numerous sharply defined lines, were made with three different dispersions, three-prism long-focus, 10·1 tenth-metres per millimetre, three-prism short-focus, 20·2 tenth-metres per millimetre, and single-prism, 33·4 tenth-metres per millimetre at $H\gamma$. Instead of finding, as would naturally be expected, that the probable error of a plate for the last dispersion is three times that of the first, it was found to be only increased from about 0·5 to 0·7 km. per second. As the exposures required in the two cases are about as 1 to 5, it is apparent that stars nearly two magnitudes fainter may be secured with existing telescopes without much loss of accuracy. As the stars within easy reach of three-prism instruments are now practically completed, this result appears to offer an easy and effective means of extending accurate radial velocity determinations to fainter stars.

A full description and discussion, with measures and tables of the spectroscopic binary orbits determined and of these three investigations, will be found in detail below.

Solar Research.

In this division of the work, in charge of Dr. R. E. DeLury, I am not able to report such satisfactory progress. In my last report, a full description with focal curves, &c., of the performance of the plane grating used in the solar spectrograph was given by Dr. DeLury. This showed the possession of some peculiar properties, with the result that even when half the surface was occulted only poor definition could be obtained. A number of plates of opposite limbs of the sun for the determination of the solar rotation were secured, and measurements of some of these, though showing relatively large accidental errors due to the poor definition of the lines, gave no evidence of systematic displacements and there is no doubt that satisfactory results can be obtained with a good grating. Dr. DeLury also made several plates of spot spectra, but here also the poor definition is a great hindrance.

We have been in correspondence with Mr. J. Y. Lee, who is working with Professor Michelson, of the University of Chicago, in ruling large gratings. They have ruled for us a surface slightly over five inches square, which gives practically perfect definition in four orders. The only defect in this grating is a little astigmatism, but this will not likely be sufficiently great to introduce any difficulties in its use for the purposes for which it is intended. This grating has been sent to us for trial, and its suitability for our purpose will hence shortly be determined. If not found satisfactory, a new one will be ruled, and consequently the chances of being in a position within a month or two to do effective work seem good.

Dr. DeLury has made direct photographs of the sun's surface for a record of spots, &c., on every clear day. These photographs have been made with an enlarging camera on the 15-inch telescope, but it is proposed, as soon as a suitable attachment with exposing shutter can be made in the workshop, to use the 9-inch image given by the coelostat telescope for this purpose. It is hoped in this way to secure better definition in the photographs.

Micrometric Work.

The 15-inch equatorial telescope is available on three half-nights per week for visual observations, and is used chiefly for micrometrical observations of the position angle and distance of double stars. Mr. R. M. Motherwell has direct charge of this and allied work, such as the positions of comets and the observations of occultations of stars by the moon. In addition, he has charge of all the stellar and comet photography with the Brashear star camera.

The observing weather during the past year has been poor, a very good example of this being given by the fact that of the 53 occultations of stars by the moon of which the data were computed by him, only four were successfully observed. For the same reason, not many double star measures have been obtained. A full list of these measures, of measures of the position of Halley's comet, and of the occultations observed is given below.

In an appendix to my last report appeared a full description by Mr. Motherwell, of tests of the 8-inch Brashear camera objective for spherical and chromatic aberration and astigmatism. He there showed that the halos appearing around the star images were due to negative aberration of 3·6 mm. After the further tests described in that appendix, the objective was sent back to Allegheny for refiguring, and upon its return last July was again tested. The aberration was found to be reduced to 0·5 mm., and the star images had become sharply defined without any trace of the previously appearing halo. As the objective had originally, for its type, an unusually flat field it now performs admirably, and should give excellent photographs of Halley's comet this coming spring.

During August and September about fifteen plates of the region in which the comet was to appear were made, but as later appeared, it was too faint to show on plates made with lenses of the portrait type. As is well known, it was discovered on reflector plates, and it was not for some time later that any image was obtained on portrait lens plates. Since its discovery a number of photographs at suitable intervals have been made, the last two showing a faint tail nearly a degree long. It is now nearly in conjunction with the sun and cannot be photographed for a week or more. Arrangements are being made to have it photographed every night after it becomes sufficiently bright.

In order to get photographs of the whole extent of the tail, not possible with the Brashear camera, which only gives an angular field of 5½° radius, a special Zeiss-Tessar objective of 12 inches focal length and aperture ratio of *f* 3·5 was ordered by you, and this is now mounted on a special adjustable camera attached to the tube of the 15-inch telescope near the objective. This lens has not yet been tested, but a Tessar of 12 inches focus *f* 4·5, obtained on trial by courtesy of the Topley Company, gave very good definition, and there seems no doubt that the faster lens will also perform satisfactorily. This should enable satisfactory photographs to be obtained in the minimum exposure time, which is essential when the comet is near the sun.

The comet 1910*a*, which was conspicuous about the end of January, was photographed successfully by Mr. Motherwell on every night that was clear, during the interval it was visible, and reproductions of some of these will appear below.

The difficulty here in the use of the stellar camera in photographing comets or regions of the sky is its method of mounting. Its attachment to the tube of the equatorial, which is employed as a guiding telescope, prevents the use of the latter in other work. The provision of a separate mounting and dome for the photographic equipment would allow a marked increase in its use and efficiency.

A great deal of Mr. Motherwell's time is occupied in looking after instruments, both observatory and surveying, which are under his charge. A careful record by means of a card catalogue is kept of each instrument, which enables information as to its whereabouts, condition, &c., to be at once obtained.

Mechanical Work.

The mechanical division has time and again proved itself an indispensable adjunct to the work of the Observatory, and this still holds good. Probably relatively more of the time of the two mechanicians, Messrs. Mackey and Lucas, has been spent during the past year in repair and alteration work than in the construction of new instruments, but both are equally necessary and useful.

Besides the repair work, which embraces all types of the instruments in general use (theodolites, levels, cameras, &c.) in surveys, as well as the instruments directly used in the Observatory, much new work has been completed.

The most important has been probably the remodelling, improvement, and alteration of many parts of the meridian circle. In order to ensure the accurate working of the transit micrometer, all the moving parts had to be carefully scraped and refitted and the registering arrangement remodelled. The micrometer microscopes for reading graduations also all required refitting. New direct simple counterpoising attachments were constructed and attached in place of the original complex arrangements, which did not work satisfactorily, and other work in connection with the truing and fitting of the circles was performed.

Numerous minor attachments to the spectrographs have been made, as well as a short-focus camera for use with the three-prism instrument. The new Tessar camera lens has been mounted adjustably on the telescope tube, and new gears and shaft to reduce the periodicity of driving of the telescope have been made and applied. The arms of the clock governor, which has always revolved too quickly, were lengthened and the driving of the telescope brought into a very satisfactory condition, much lessening the labour of guiding besides producing more accurate work.

The work of the carpenter, Mr. F. J. Dunn, frequently in connection with that in the machine shop, has been satisfactory, and much new work in addition to repairs has been completed.

General.

Attendance at the Saturday open nights, at which visitors are allowed a view of interesting objects in the heavens through the equatorial telescope, has not shown any decrease. On the contrary, last September when Mars was in opposition there must have been on several Saturday evenings upwards of 200 visitors present. A great deal of interest is also now being evinced in the present apparition of Halley's comet, and there is no doubt that the purpose of instituting these open nights, of increasing the interest in and knowledge of astronomy, is being served.

In this connection there is no doubt that the lectures, mostly by members of the Observatory staff, on different aspects of astronomy, given under the auspices of the Royal Astronomical Society of Canada during the winter months also help materially to increase the interest in science. The benefits accruing from the afternoon lectures and discussions at the Observatory are too well known to you to need referring to here.

The work of my division has been well represented in the proceedings of societies and in astronomical periodicals during the past year.

At the May, 1909, meeting of the Royal Society of Canada, seven papers on astrophysical subjects were presented, and several others have been published in the Astrophysical Journal and the Journal of the Royal Astronomical Society of Canada. The following embraces the major publications of the year:—

The following papers read before the Royal Society of Canada, May, 1909:

1. A New Single-Prism Spectrograph, by J. S. Plaskett.
2. Slit Width and Errors of Measurement in Radial Velocity Determinations, by J. S. Plaskett.

3. The Spectroscopic Binary β Orionis, by J. S. Plaskett.
4. The System of ϵ Herculis, by W. E. Harper.
5. Aberration of a Stellar Camera Objective, by R. M. Motherwell.
6. Convection and Stellar Variation, by R. E. DeLury.
7. The Orbit of α Coronæ Borealis, by J. B. Cannon.

The first, second and sixth of these papers were published in full in the Royal Society Transactions, 1909. the others in abstract.

The following papers have appeared in astronomical periodicals during the year:

1. Camera Objectives for Spectrographs, by J. S. Plaskett. Astrophysical Journal, XXIX, p. 290, May. 1909.
2. The Design of Spectrographs for Radial Velocity Determinations, by J. S. Plaskett. Journal R.A.S.C., III, p. 190, May-June, 1909.
3. The Spectroscopic Binary β Orionis, by J. S. Plaskett. Astrophysical Journal XXX, p. 26, July, 1909.
4. The Ottawa Spectrographs, by J. S. Plaskett. Journal R.A.S.C., III, p. 287, July-August, 1909.
5. Two Curiously Similar Spectroscopic Binaries, by J. S. Plaskett and W. E. Harper. Astrophysical Journal. XXX, p. 373, December, 1909.
6. Convection and Stellar Variation, by R. E. DeLury. Journal R.A.S.C., III, p. 344, September-October, 1909.
7. The System of ϵ Herculis, by W. E. Harper. Journal R.A.S.C., III, p. 377, September-October, 1909.
8. The Spectroscopic Binary α Coronæ, by J. B. Cannon. Journal R.A.S.C., III, p. 419, November-December, 1909.
9. Photographs of Comet 1910a and Halley's Comet, by R. M. Motherwell. Journal R.A.S.C., IV, No. 1, January-February, 1910.

At the August meeting of the Astronomical and Astrophysical Society of America, held at Williams Bay, which I had the privilege of attending, three papers were presented:

1. The Width of Slit, giving Maximum Accuracy, by J. S. Plaskett.
2. The Effect of Faulty Collimation of the Correcting Lens on the Star Image, by J. S. Plaskett.
3. The Photographic Doublet of the Dominion Observatory, by R. M. Motherwell.

Also at the Winnipeg meeting of the B.A.A.S., you kindly presented a joint paper:

1. Two Curiously Similar Spectroscopic Binaries, by J. S. Plaskett and W. E. Harper.

Thus, altogether through various media 20 papers bearing on the work of the Astrophysical Division were issued during the past twelve months, and those not previously given in my reports will be presented, generally in slightly different form, in detail below.

THE SPECTROGRAPHS.

Only minor changes have been made in the spectrographs since my last report. In it was described the new single-prism spectrograph, which had just been completed and partially tested by March 31. The favourable opinion then formed of its performance has been fully substantiated by a year's experience. So far as can be judged on examination or by measurement, no effect of displacement or broadening of the lines due to flexure or temperature changes is evident in even the longest exposure spectra. Tests for flexure showed that even the maximum amount, that due to revolution of the spectrograph through 180° in its own plane from camera above to camera below, was quite immeasurable and practically unnoticeable in special test spectra.

The one disadvantage noticed in the new instrument and mentioned in the last report, as compared with the single-prism form of the previous spectrograph, the weakness of the spectra towards the violet, proved upon further investigation to be due to faulty collimation of the correcting lens and not to any property or defect of the spectrograph itself. This question of the collimation of the correcting lens will be treated at greater detail under a separate heading and need not be further referred to here. Suffice it to say, when correct collimation was ensured, the difficulty entirely disappeared and spectra equally intense at the violet end as with the other spectrograph were obtained with a considerable saving, 25 per cent, about, of exposure time.

Some slight alterations in detail for greater convenience in operation have been made, but otherwise the instrument remains unchanged and is essentially the same as when first constructed, a year's experience having failed to show any points where improvements could be made. The invariability of camera focus with changes of temperature, noticed in the last report, effects a great convenience and saving of time. The daily tests necessary with the other instrument are now quite unnecessary, as several tests over the range of temperature reached have all resulted in the same focal setting.

Owing to the direct and shorter path from slit to guiding telescope, the star image is more distinct and can be kept central upon the slit more accurately and easily than previously, and although the bent telescope used for guiding is not in so convenient a place, its use has not entailed any difficulty.

The three-prism instrument has been used almost entirely with a short-focus camera. The Zeiss 'Tessar' objective, whose performance was reported last year, was mounted in a separate camera as soon as possible, and used in further work on β Orionis and on some solar type spectroscopic binaries. Later the Ross special homocentric, also tested last year, was also mounted, and further comparative tests of the two objectives showed that although the former gave a somewhat flatter field the defining power of the latter was superior, and it was substituted in the more recent work. A separate relay box with batteries, relays, resistance, indicator lamps, and attaching wires complete, was constructed and placed in the recess occupied by the tower clock. Thus the temperature of the spectrograph not in use may be maintained constant for any desired time before it is required, and the instrument may be exchanged upon the telescope with the minimum of labour and no disturbance of temperature conditions.

Before proceeding to discuss the radial velocities obtained during the year, it has seemed desirable to present in detail the work done in furtherance of the more efficient performance of the spectrographs and in determining the conditions under which the most accurate measurements may be obtained. Consequently, I will now give the results of three investigations referred to in the introduction, each presented in a separate and complete form under the headings:

The Collimation of the Correcting Lens.
The Effect of Slit Width.
The Accuracy of Radial Velocity Determinations.

The Collimation of the Correcting Lens.

When the new single-prism spectrograph was brought into use, it was noticed that the star spectra obtained were unusually weak in the violet. Although the absorption of the new prism of 51 mm. aperture is somewhat greater than that of the one previously in use (35 mm. aperture), this difference is by no means sufficient to account for the difference in intensity at the violet in the two cases.

In many star spectra, the lines to the violet of H_δ are important, and the best measures obtained are frequently those of the K line. Moreover, greater accuracy should be obtained in this part of the spectrum on account of the greater linear scale. It was hence important to discover, if possible, the cause of and the remedy for this difficulty.

It was necessary when the new spectrograph was attached to the telescope, to make some changes in the attachment of the correcting lens, and there was a possibility that the distance of the lens from the focus had become changed and the form of the colour curve altered sufficiently to throw the image in violet light considerably beyond the slit. However, a redetermination of the colour curve by Hartmann's method of extra-focal exposures showed that the minimum focus was about λ 4325 and that the focal points for light at λ 3930 and λ 4700 were each about three millimetres beyond that at λ 4325, and moreover, that the position of the slit was the most favourable for obtaining uniform intensity of the photographed spectrum from H_β to K.

These two possible causes having thus been disposed of, the next tested was the guiding apparatus. The visible image, produced by the combination of visual objective and correcting lens, consists of a more or less condensed nucleus of blue-green light surrounded by an extended penumbra or halo of reddish light, and the guiding is done by the blue-green nucleus while the slit is rendered partly visible by the penumbra. It is not possible, owing probably to chromatic aberration, to get both sharp at the same time, and there is usually considerable parallax due partly to this cause and partly to the fact that the visual blue-green image is really a millimetre or more beyond the slit. It is possible, therefore, although the image may be kept apparently central, that its effective part is really to one side or other of the slit, producing diminished intensity of spectrum. However, a careful readjustment of the reflecting prisms and guiding apparatus produced no perceptible improvement.

A test was then made to determine whether guiding with the image apparently above or below the slit would have any effect; this was performed as follows: After the governors had been so adjusted that the star image drifted the width of the star window along the slit in 20 seconds, four spectra of the bright star α Aquilæ were made, with an exposure on each of 60 seconds, three times drifting, side by side on the one plate. In the first of these the star image was kept bisected by the (as seen in the guiding telescope) upper edge of the slit opening; in the second, the image was kept central; in the third, bisected by the lower edge; and in the fourth, kept entirely below and just touching the lower edge of the slit. The result of this test is shown in Fig. 1 at *A* where *a, b, c, d,* represent the four positions in guiding. It will be noticed at once, that the point of maximum intensity moves towards the violet as the image is moved down. A little consideration renders it evident that this effect is due to a sort of dispersion of the image, that the violet part of it falls, more than the width of the slit, above the blue-green. This cannot be detected by the eye on account of the very low visual intensity of the violet light. As a matter of fact, the guiding must be almost entirely done by the image formed by light of wave-lengths between λ 4600 and λ 4900. To the violet of this region, it is too faint, and to the red, the image is too far out of focus for any effect on the eye. It is evident from the figure, that it is only when the image formed by this light is, apparently, entirely below the slit, that the maximum intensity in the violet is obtained, and that in consequence the violet image is on the slit.

Such dispersion of the image may be assigned to one or more of three causes:

(*a*) To faulty squaring on of the objective.
(*b*) To atmospheric dispersion.
(*c*) To imperfect collimation of the correcting lens.

A test of the objective showed it to be in correct adjustment, and moreover, throwing it considerably out of square had no appreciable effect on the appearance of the image, or on spectra made under the same conditions as before.

That it was not wholly due to atmospheric dispersion was at once proved by the same test, as described above, on α Aquilæ, applied near the zenith where a similar effect was produced.

That incorrect collimation of the corrector was the principal cause was finally shown when, after a change in collimation, the test gave a different arrangement of the intensity in the four spectra. The correcting lens, which was specially designed,* has an aperture of 4 inches and is placed 59 inches within the focus. It is mounted in a tube, whose lower end is held in a flange which screws into the telescope adapter, while near the upper end a guide ring holds it central. It was carefully collimated with both the old and the new spectroscope by pointing the telescope to the zenith, removing the objective and hanging a steel piano wire centrally through the objective cell, the correcting lens cell, the slit and the collimator lens cell. It is possible, that after collimation, there may have been some movement of the spectroscope before it was finally rigidly fastened into position, which was sufficient to produce the observed effect, for, as will be seen later, a displacement of a millimetre is sufficient to produce marked changes in the distribution of intensity in the spectrum.

Some further tests showed the necessity for having the collimation of the correcting lens made adjustable. Consequently, the upper end of the tube was made moveable, transversely to the slit, by applying a screw of $\frac{1}{16}$-inch pitch, with a divided head, to the guiding ring above mentioned. No longitudinal

* Report of Chief Astronomer, 1908, page 73.

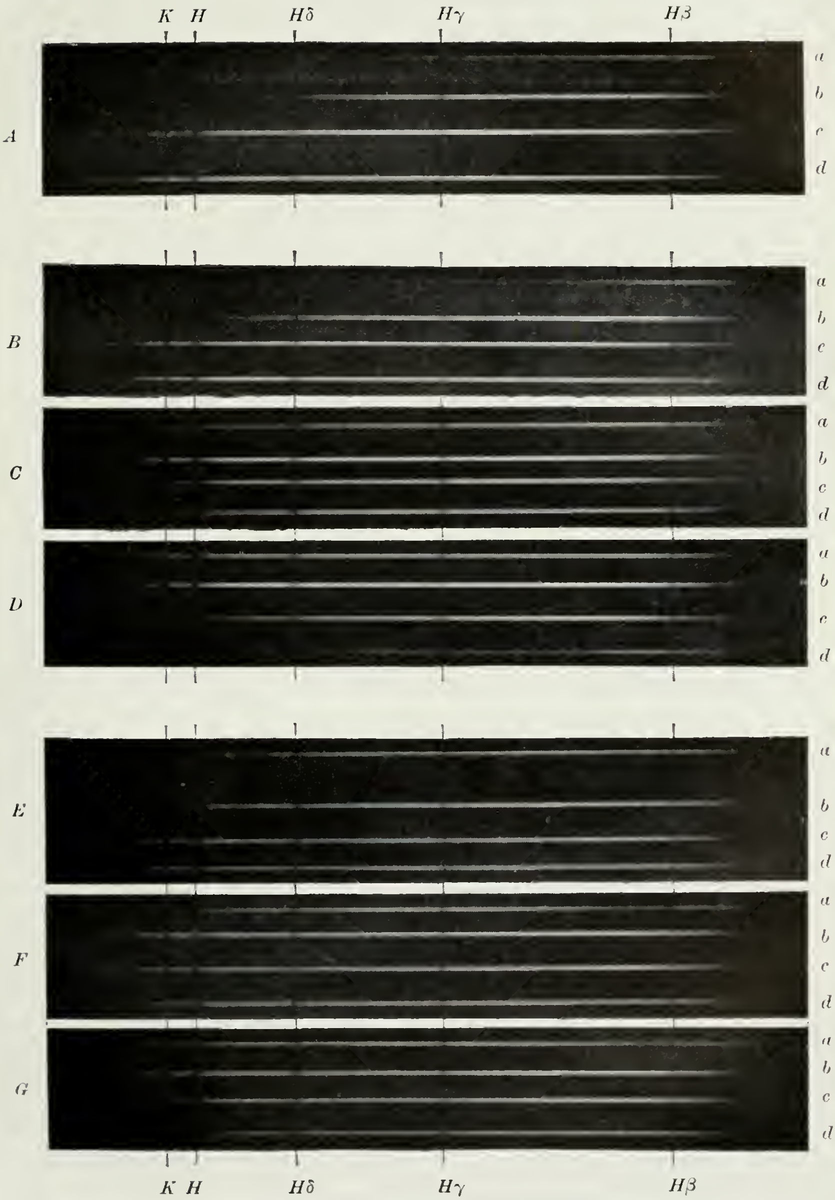

FIG. 1—Tests of Collimation of Correcting Lens.

adjustment was provided, as any dispersion along the slit will not tend to throw any part of the image to one side or other of the slit opening.

A series of tests similar to the one described above were then made at different settings of the adjusting screw of the corrector tube, and it was soon discovered that the correcting lens was very much more sensitive to changes in collimation than had been imagined. Figure 1 shows tests at three settings, *B*, 1·6; *C*, 2·0; *D*. 2·4, of the adjusting screw; the distance between successive positions being ·025. The spectra are of the star α Aquilæ and the exposures, which are of 60 seconds each, were made with the star near the meridian and the telescope west of the pier. The slit was 0·051 mm. wide and the image was guided so that *a, b, c, d,* refer to the same positions as at *A*.

The criterion for determining the best position of the correcting lens must evidently be the intensity towards the violet end of the spectrum for, owing to the greater photographic effect in the blue-green and the expanded image there due to the form of the colour curve of the corrector, a slight asymmetric position of the image on the slit will have little effect on the intensity. It will be noticed then that *c* in *B*, *b* in *C*, and *a* in *D* are the spectra which have the greatest extension and intensity in the violet, and are evidently therefore the positions where the violet part of the image was central on the slit. Hence in position *B*, setting 1·6, the violet image was apparently above, in position *D*, setting 2·4, apparently below the blue-green image on which guiding is necessarily performed, while in *C*, setting 2·0, they are superposed as the greatest intensity in the violet is given where the image is kept central.

C at setting 2·0 of the corrector screw is therefore the position, not necessarily (as the star is not at the zenith) of exact collimation of the correcting lens, but the position where the dispersion produced by the atmosphere is just counteracted by the opposite dispersion caused by a slight departure of the corrector from exact collimation.

If we now look at the lower part of the figure, spectra made in a similar way of the same star near the meridian, but with the telescope east of the pier, where *E* is at setting 0·8, *F* 1·2, and *G* 1·6, we find that the best position *F* is at a setting of the correcting lens 0·8 revolution, ·05 inch distant from the best position west of the pier.

As the atmospheric dispersion acts in the same direction in each case, the change in collimation must be due to flexure of the tube of the telescope, which is sufficient to displace the correcting lens at the declination + 8·6°, 1/40 of an inch, from the line joining the centre of the objective and the slit. This is not unreasonably large when we consider that the correcting lens is 59 inches from the slit. A further test on α Cygni, which at the meridian is only half a degree from the zenith, showed the best position of the corrector to be at setting 1·6 midway between the other two.

Consequently, assuming this change of collimation to be due to flexure and that approximately this is proportional to the sine of the zenith distance, a table of the corrector settings for every ten degrees of zenith distance, from 0° to 70°, and for different hour angles, was computed and will be used, after some further tests at intermediate points and at large hour angles for every spectrum taken.

The necessity of this is very clearly shown by the marked dispersion of the image indicated in *B, C, D,* and *E, F, G,* for a difference of position of the correcting lens of ·025 inch. Indeed further tests showed that a change of collimation of only ·01 inch can be easily recognized by the distribution of intensity in the spectra, and it is evident that, for the best results, we must ensure very exact collimation. These tests show that a photographic correcting lens for visual objectives has no field, that it must be used along the axis. If the cone of light from the objective, which is 3·9 inches in diameter, falls even ·01 inch to one side of the centre of the correcting lens, the star image is dispersed in such a way that the image in violet light falls to the same side of the blue-green image, and estimating from the tests made, the dispersion or separation of the blue-green and violet images is approximately ·002 inch for each ·03 inches the corrector is moved.

These experiments have seemed worth recording, as showing how very carefully the corrector must be collimated, even to such an extent that the departure from collimation due to flexure of the telescope tube must be accurately compensated. It is convincingly demonstrated by the figure that a departure from collimation of only ·025 inches will much increase, nearly double, the exposure time required for the violet end of the spectrum. Moreover, there is a further even more important consideration, that systematic displacement of the lines is less likely to occur under accurate collimation. Uniform illumination of the collimator lens by light of every wave-length (necessary to prevent possible systematic displacements) can only be produced when the images in light of all the wave-lengths used fall centrally on the slit.

Effect of Slit Width.

In my reports of 1906-7, page 170, and of 1907-8, page 86, the result of some experiments upon the effect of increasing the width of slit upon the accuracy of radial velocity determinations, which are here referred to as Series I and II, was described and discussed. The investigation was continued and is now completed, and the final conclusions reached. Series III of the work was done in the beginning of 1909, though scarcely in time to be included in the last report, and Series IV during the year just closed. Both these Series will be discussed here, while a summary of that previously reported will, for the sake of completeness, be included.

It was shown in experiments* upon the dimensions of the star image, as focussed upon the slit of the spectroscope, that the actual effective diameter of this image is very much larger than that called for by the diffraction theory. The latter states that the diameter of the central disc in $H\gamma$ light for a 15-inch objective is 0.57″, while photographic determinations of the diameter of star images and the widths of spectra and trails show a minimum diameter and width of about 2″. In this connection Newall's conception of tremor discs† serves to give an explanation of this enlargement in diameter as due to atmospheric tremor, and considers that the image consists in effect of a central 'core' about 2″ in diameter surrounded by an outlying penumbra of a diameter of about 8″ or 10″. In my opinion this enlargement occurs in two ways: 1. The actual diameter of the central diffraction disc is increased by atmospheric disturbance. 2. It is displaced in all directions from its true position. There results then in photographic action, whether on the actual star images or on their spectra, the integrated effect of such enlargement and displacement, giving generally a minimum diameter of about 2″. The standard slit width, 0·025 mm. (·001 inch), is with our telescope equivalent to about 0·9 seconds, and it is evident that much star light will be lost at the slit. Actual experiments for

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* Report of Chief Astronomer, 1907-8, p. 79-82.
† M.N., LXV, p. 608.

different slit widths, as described in the report cited above, showed that the exposure time required for star spectra of equal intensity was very approximately inversely proportional to the slit width until this reached about 0·13 mm. (·005 inch). The saving in time and increase in output possible with the use of wider slits is therefore very marked, and the purpose of the whole investigation is to determine what effect the widening of the slit will have upon the accuracy of the radial velocity measures.

Every spectroscopist engaged in radial velocity work must have noticed the very marked increase in breadth and diffuseness of the spectral lines, both absorption and emission, as the slit is widened, and must have felt convinced that when the slit had reached a width of 0·051 mm. (·002 inch) the extreme limit for accurate measurement had been attained. If the slit is made 0·076 mm. (·003 inch) the lines become so diffuse as to appear quite hopeless for accurate measurement, although as will appear later such is not entirely the case. In view of the above considerations, the discussion has throughout been limited to four slit widths, 0·025, 0·038, 0·051 and 0·076 mm., 1, 1·5, 2 and 3 divisions of the slit micrometer head as usually graduated in America.

As the relative accuracy of measurement of stellar spectra at different slit widths cannot be determined theoretically, the only recourse is to make a number of spectra at each of the above slit widths, measure and reduce the plates, and thus obtain the probable errors.

Consequently, as has been indicated above, plates for this purpose have been obtained at four different times with different spectrographs and conditions, forming four series or parts of this investigation, of which the first two have been already dealt with in the 1906-7 and 1907-8 reports, respectively. A summary of the results of the third has been given in a paper to the Royal Society of Canada, published in their transactions for 1909, p. 209. The detailed measures of this latter and of the fourth part, with a discussion of the results of the whole investigation, will be given here. A summary of the conditions prevailing in each series necessarily comes first:—

Series I—

Spectrograph.—Brashear Universal (Adapted). Linear dispersion at $H\gamma$ 19·0 tenth-metres per mm.

Slit widths.—0·025, 0·038, 0·051, 0·063, 0·076 mm.

Plates.—Five plates at each slit width.

Star.—β Orionis.

Measures and results published in 1906-7 Report, pages 170-185.

Series II—

Spectrograph.—Ottawa Spectrograph. Collimator focus in each case, 525 mm.

(*a*) Single-prism form—Brashear 'Single Material' Camera Objective, 525 mm. focus. Linear dispersion, 30·2 tenth-metres per mm.

(*b*) Three-prism form—Zeiss 'Chromat' Camera Objective, 525 mm. focus. Linear dispersion, 10·1 tenth-metres per mm.

(*c*) Three-prism form—Ross Homocentric Camera Objective, 275 mm. focus. Linear dispersion, 18·2 tenth-metres per mm.

Slit widths.—(*a*) 0·025, 0·038, 0·051, 0·076 mm.
(*b*) 0·025, 0·038, 0·051, 0·076 mm.
(*c*) 0·025, 0·051, 0·076 mm.

Plates.—Six plates at each slit width.
Star.—β Orionis.
Measures and results published in 1907-8 Report, pages 86-99.

Series III—
Spectrograph.—New Single-prism and Ottawa Three-prism.
(*a*) New Single-prism, collimator 51 mm. aperture 765 mm. focus, Brashear 'Single Material' Camera Objective, 455 mm. focus. Linear dispersion at $H\gamma$, 33·4 tenth-metres per mm.
(*b*) Three-prism Ottawa Spectrograph, Zeiss Tessar Camera Objective, 300 mm. focus. Linear dispersion, 17·5 tenth-metres per mm.
Slit widths.—0·025, 0·038, 0·051, 0·076 mm.
Plates.—Ten plates at each slit width in (*a*); six plates at each slit width in (*b*).
Star.—β Orionis.

Series IV—
Spectrograph.—New Single-prism Spectrograph. Collimator 51 mm. aperture 765 mm. focus. Camera 455 mm. focus. Linear dispersion 33·4 tenth-metres per mm.
Slit widths.—0·025, 0·038, 0·051, 0·076 mm.
Plates.—Ten plates at each slit width.
Star.—α Boötis.

The reason for the division of the work into parts at different times has been chiefly due to changes in the instrumental equipment. After Part I had been obtained with the Brashear spectroscope, the combined single and three-prism spectrograph was constructed, and as the results with the Brashear instrument were not felt to be conclusive it was decided to make tests with the new instrument. In divisions (*a*) and (*b*) of Part II, the focal lengths of collimator and camera were equal to one another, and the minimum width of the line would be the width of the slit. If the collimator were longer than the camera, the width of the image of the slit would be diminished in the same proportion and the conclusions reached in (*a*) and (*b*), Part II, would not necessarily be valid. In (*c*), however, where the camera was of shorter focus, the objective was so imperfect that little confidence was felt in the results arrived at, and when the new single-prism spectrograph was completed and when a satisfactory short-focus objective was obtained for the three-prism instrument, the investigation was repeated in these two cases (Part III) where the ratio of collimator and camera was 5 to 3 in (*a*) and 7 to 4 in (*b*). In all the above cases the spectra were of the early type star β Orionis, in which the star lines measured were only moderately sharp, and in order to make the work more complete another series, IV, with the solar type star α Boötis was also obtained. The large number of sharply defined lines available in stars of this class might, it was felt, have some influence on the results previously reached. The plates in the latter case were measured with the spectro-comparator, for reasons to be discussed presently.

In considering the errors of measurement introduced by widening the slit, a little consideration will show that they may be ascribed chiefly at any rate to three causes:—

(*a*) To the loss of purity necessarily resulting from widening the slit, with the increasing difficulty of identification of the components of blends and determination of the effective wave-length.

(*b*) To the increased breadth and diffuseness of the spectral lines, and consequent probable increase of the accidental errors of measurement.

(*c*) To systematic displacements of the lines as a whole, with consequent error in the velocity, due to asymmetric position of the nucleus or 'core' of the star image within the slit opening.

In order to avoid the complications introduced where questions of purity enter, the early type star β Orionis, in which all the lines are single, was used in the first three series, while in the fourth series, although α Boötis was used in which very complex blends of lines would appear as the slit was widened, the plates were all measured with the spectro-comparator, where no knowledge of accurate wave-lengths is necessary and in which, consequently, no errors due solely to loss of purity can enter. In all four series, therefore, case (*a*) may be omitted from consideration. and we need only discuss the effects of (*b*) and (*c*) on the accuracy of the results.

It is evident that these two sources of error are in a sense entirely independent of one another. The former, (*b*), that due to the increased width and diffuseness of the spectral lines as the slit is widened, evidently only affects the settings on the lines, is wholly accidental in character and may be evaluated, relatively at any rate, by obtaining the probable error of the velocity determination for a single line in the usual way. The latter, (*c*), a systematic displacement of the star lines as a whole with respect to the comparison lines, will evidently not appear in, and cannot be determined from, the measures of single plates. If due to errors of guiding, whereby the nucleus of the star image is not maintained central within the slit jaws, the displacements on different plates will probably be of an accidental character, and may be evaluated by discussing the velocities of a sufficient number of plates at each slit width. Such measured velocities will evidently be also affected by the accidental errors of setting on the lines, and what will be obtained by this procedure will be a measure of the total errors of the velocity determination at each slit width, which is of course in the final analysis what we wish to obtain.

In determining (*b*), the accidental error. the procedure in the first three series has been as follows: After all the plates at any one slit width for any dispersion had been measured and reduced, this reduction being performed by a modification of Hartmann's method fully described in my 1906-7 Report, page 95, the weighted mean velocity of each plate was determined and the residuals in kilometres per second for each line obtained. It has seemed preferable, instead of obtaining the probable error of a single line from each plate, to combine the residuals from all the plates at any one slit width and from these derive the probable error of an average line at this width. This is much simpler and, owing to the small number of lines measured, more reliable than that obtained by discussing each plate separately.

The errors under (*c*) are obtained by treating the mean velocities of all the plates at each slit width, and obtaining the probable error of a single plate in the well known way. Such a method assumes necessarily either the constant velocity of the star observed or such a slow rate of change, that during the interval over which the plates at any one slit width were obtained such change is negligible. When the star β Orionis was chosen as a test object on account of its brightness and the moderate sharpness of its single lines, it was not known to have a variable velocity. Indeed, this was only discovered in consequence of the work done in Series II of this investigation. However, the total range of velocity in β Orionis is so small and the period 21·9 days so long, compared with the interval occupied in making a set of plates at any one slit width, that no appreciable error is introduced by using the star. As previously mentioned, the plate velocities used in obtaining this probable error are each affected by an accidental error as well, and the final values, although of a composite nature, nevertheless accurately represent the total errors to be expected at the different slit widths and form the final criterion of comparison.

In series I and II from four to seven lines were measured on each plate, but the discussion of the measures showed that the quality for measurement of three of these lines, λ 4481, λ 4472 and λ 4341, was so much superior to the others, that much better results were obtained from their use alone than when combined with the others measured. Consequently in Series III only these three, due to magnesium, helium and hydrogen, respectively, have been measured. Generally speaking, four comparison lines have been measured on each plate, and the reduction of the measures made as stated above. By this means the labour involved was reduced to a minimum. All the plates in series III and IV have been made and measured by myself, to make the results directly comparable with one another.

As in Series II, it has been thought necessary to give only the velocity values for each star line in each plate measured, saving considerable space over that required ordinarily. The measures of Series III now follow:—

NEW SINGLE-PRISM SPECTROGRAPH.

SLIT 0·025 mm.

Plate Number.	4481·400			4471·676			4340·634			Mean Velocity	Res.
	Wt.	Vel.	Res.	Wt.	Vel.	Res.	Wt.	Vel.	Res.		
2432	2	37·83	7·60	1	38·47	6·96	2	56·52	11·09	45·43	1·25
2433 a	2	35·92	7·58	1½	31·89	11·61	2	53·98	10·48	43·50	0·68
2433 b	3	41·78	3·31	1	45·56	0·47	2	49·81	4·72	45·09	0·91
2433 c	2	46·12	2·20	1½	45·56	2·76	2	52·59	4·27	48·32	4·14
2434	2	37·20	1·91	2	34·80	4·31	1½	47·39	8·28	39·11	5·07
2435 a	2	37·20	0·26	1	28·10	9·36	1½	44·04	6·58	37·46	6·72
2435 b	1½	39·74	4·28	1½	39·49	4·53	2	50·62	6·60	44·02	0·16
2436 a	2	35·29	11·21	2	54·29	7·79	2	49·93	3·43	46·50	2·32
2436 b	1½	46·12	4·20	1	46·44	3·88	1½	57·10	6·78	50·32	6·14
2438 a	2	32·87	3·74	1½	42·02	5·41	1½	36·18	0·43	36·61	7·57
2438 b	2	59·49	9·87	1	40·12	9·50	2	44·50	5·12	59·62	5·44

Mean Velocities 40·82 41·02 49·69 44·18

NEW SINGLE-PRISM SPECTROGRAPH.

Slit 0·038 mm.

Plate Number.	1481·400.			4471·676			4340·634			Mean Velocity	Res.
	Wt.	Vel.	Res.	Wt.	Vel.	Res.	Wt.	Vel.	Res.		
2440 a	2	36·56	2·39	2	43·16	4·21	1½	36·52	2·43	38·95	4·22
2440 b	2	45·35	2·18	1½	43·66	0·49	1½	39·76	3·41	43·17	0·00
2440 c	2	37·20	5·40	2	49·86	7·26	1½	40·11	1·49	42·60	0·57
2441 a	2	27·01	11·24	2	34·68	3·57	2	53·05	14·80	38·25	4·92
2441 b	2	41·02	5·31	1½	54·67	8·34	1½	45·08	1·25	46·33	3·16
2441 c	2	33·32	9·31	2	44·17	1·54	2	50·39	7·76	42·63	0·54
2442 a	2	40·38	5·35	1½	60·37	14·64	2	40·11	5·62	45·73	3·44
2442 b	2	41·02	4·92	1½	50·24	4·30	1½	48·20	2·34	45·94	3·23
2442 c	2	42·29	2 61	1½	53·41	8·51	2	41·12	3·78	44·90	2·27
2443	2	43·56	0·34	½	49·48	6·26	1½	40·68	2·54	43·22	0·05
Mean Velocities		38·77			47·63			43·81		46·17	

NEW SINGLE-PRISM SPECT..OGRAPH.

Slit 0·051 mm.

Plate Number.	4481·400			4471·676			4340·634			Mean Velocity	Res.
	Wt.	Vel.	Res.	Wt.	Vel.	Res.	Wt.	Vel.	Res.		
2458 a	2	44·84	3·21	1½	44 17	2·54	2	36·52	5·11	41·63	2·90
2458 b	1½	32·10	12·22	2	52·14	7·82	1½	46·12	1·80	44·32	0·69
2458 c	3	39·11	2·18	1½	49·99	8 70	2	38·03	3·26	41·29	2·34
2459 a	2	43·82	0·67	1	61·76	17·27	2	36·52	7·97	44·49	0·86
2459 b	2	37·83	6 91	1	58·60	13·86	2	44·73	0·01	44·74	1·11
2459 c	1½	41·66	6·43	1	54·04	5·95	2	49·93	1·84	48·09	4·46
2460 a	2	38 47	5·21	1	58·47	14·79	2	41·49	2·19	43·68	0 09
2460 b	2	39·11	4·71	1	49·11	5·29	2	45·89	2·07	43·82	0·19
2460 c	2	37·83	4·51	½	48·09	5·75	2	45·42	3 08	42·35	1·29
2461	2	46·12	4·16	1	33·16	8·80	2	42·19	0·23	41·96	1·67
Mean Velocities		40·20			50·93			41·53		43·63	

NEW SINGLE-PRISM SPECTROGRAPH.

Slit 0·076 mm.

Plate Number.	4481·400			4471·676			4340·634			Mean Velocity	Res.
	Wt.	Vel.	Res.	Wt.	Vel.	Res.	Wt.	Vel.	Res.		
2462 a	1½	32·74	5 70	1	42·02	3·58	2	40·92	2·48	38·44	2·90
2462 b	1½	49·94	6·27	½	56·19	12·52	2	35·83	7·84	43 67	2·33
2462 c	1	48·66	7·05	1	49·36	7·75	2	34·21	7·40	41·61	0·27
2463 a	2	44·20	7·86	1½	39·49	3·15	2	26·12	9·22	36·34	5·00
2463 b	1½	45·48	7·39	½	57·21	4 34	2	57·33	4·46	52·87	11·53
2463 c	2	39·75	4·13	1	24·30	19·58	2	57·79	13·91	43·88	2·54
2464 a	2	40·38	2·96	1	38·85	1·43	2	33·75	3·67	37·42	3·92
2464 b	1½	35·92	0·42	½	23·41	2·93	2	39·88	3·54	36·34	5·00
2464 c	2	32·10	10·73	1	49·61	6·78	2	50·16	7·33	42·83	1·49
2465	2	41 02	0·94	1½	30·63	9·45	2	46·23	6·15	40·08	1·26
Mean Velocities		40·57			39·76			42·22		41·34	

THREE-PRISM, CAMERA 300 mm. FOCUS.

Slit 0·025 mm.

Plate Number.	4481·400.			4471·676.			4340·634.			Mean Velocity	Res.
	Wt.	Vel.	Res.	Wt.	Vel.	Res.	Wt.	Vel.	Res.		
2470 a	3	35·24	7·27	2	43·49	0·98	2	52·44	9·93	42·51	1·16
2470 b	2½	42·26	0·57	1½	41·08	0·75	1½	45·52	2·74	42·83	0·84
2471 a	2	42·89	0·34	2	41·08	1·47	1½	44·06	1·51	42·55	1·12
2471 b	2	39·41	4·59	2	41·77	2·23	1½	53·08	9·08	44·00	0·33
2472 a	3	39·27	6·25	2	51·73	6·21	1½	50·05	4·53	45·52	1·85
2472 b	3	34·55	10·06	3	49·67	5·06	1½	54·59	9·98	44·61	0·94
Mean Velocities		38·56			39·78			50·20		43·67	

THREE-PRISM, CAMERA 300 mm. FOCUS.

Slit 0·038 mm.

Plate Number.	4481·400.			4471·676.			4340·634.			Mean Velocity	Res.
	Wt.	Vel.	Res.	Wt.	Vel.	Res.	Wt.	Vel.	Res.		
2489 a	2	45·67	1·72	½	30·92	13·03	1	47·03	3·08	43·95	5·32
2489 b	2	30·06	9·66	1	40·34	0·62	½	41·15	1·43	39·72	1·09
2490 a	2	34·20	4·65	1½	40·61	1·76	1	45·51	6·66	38·85	0·22
2490 b	2	28·64	3·38	1	28·04	3·98	½	53·49	21·47	32·02	6·61
2495 a	2	44·97	0·05	1½	43·84	1·08	1	46·44	1·52	44·92	0·03
2495 b	2	50·19	1·29	1½	50·72	1·78	1	43·59	5·31	48·90	3·95
2496 a	2	34·55	8·51	1	51·73	8·67	1	45·40	2·34	43·06	1·89
2496 b	2	42·68	0·26	1½	48·02	5·08	1	35·85	7·09	42·94	2·01
Mean Velocities		38·87			43·19			44·45		38·63, mean of first four. 44·95, mean of last four.	

THREE-PRISM, CAMERA 300 mm. FOCUS.

Slit 0·054 mm.

Plate Number.	4481·400.			4471·676			4340·634.			Mean Velocity	Res.
	Wt.	Vel.	Res.	Wt.	Vel.	Res.	Wt.	Vel.	Res.		
2486 a	2	38·72	2·47	2	41·44	0·25	1½	44·17	2·98	41·19	0·33
2486 b	2	37·67	1·14	1½	34·77	4·04	1	47·14	8·33	38·81	2·05
2487 a	2	38·37	3·77	1	45·22	3·08	1	46·62	4·48	42·14	1·28
2487 b	2	46·71	1·03	2	43·84	1·84	1	47·32	1·64	45·68	4·82
2488 a	2	40·80	1·84	1	31·82	7·14	1	42·43	3·47	38·96	1·90
2488 b	2	35·94	2·42	3	39·72	1·36	1	39·11	0·75	38·36	2·50
Mean Velocities		39·70			39·89			44·44		40·86	

THREE-PRISM, CAMERA 300 mm. FOCUS.

Slit 0·076 mm.

Plate Number.	4481·400.			·4471·676.			4340·634.			Mean Velocity	Res.
	Wt.	Vel.	Res.	Wt.	Vel.	Res.	Wt.	Vel.	Res.		
2474 b	2	35 45	4 63	1½	42·11	2·03	1½	44·23	4 15	40 08	3·91
2474 c	1½	31·42	9·45	1½	48·98	8·11	1	42·89	2·02	40·87	3·12
2476 a	2	30·03	12·15	1½	44·86	2 68	1½	55·70	13·52	42·18	1·81
2475 a	2	41·64	6·15	1½	47·27	0·52	1½	56·51	8·72	47·79	3·80
2475 b	2	42·19	2·16	1½	40·95	3·40	1½	50·63	6·28	44·35	0·36
2475 c	2	41·85	6·82	1½	55·85	7·18	1½	50·58	1·91	48·67	4·68
Mean Velocities		37·34			46·67			50·51		43·99	

In the tables just given it will be seen, that the velocities from each line measured and the weighted mean velocity of the three lines are given in the vertical columns. The residual from each line, obtained by subtracting the velocity given by that line from the mean velocity of the plate, is given in adjacent columns, while the residual in the last column is obtained by subtracting each plate velocity from the mean velocity of the plates in the set.

From these residuals the probable error of an average line is readily obtained, and also the probable error of a single plate representing the errors due to cases (*b*) and (*c*) above. These probable errors are tabulated below.

PROBABLE ERRORS SERIES III.

Dispersion.	Slit Width mm.	Probable Error Line of Average Weight.	Probable Error Single Plate.
Single-Prism Camera, 455 mm. Focus	0·025	± 3·32 km.	± 3·14 km.
	·038	3·00	1·86
	·051	3·21	1·47
	·076	4·05	3·32
Three-Prism Camera, 300 mm. Focus	0·025	± 2·81	± 0·84
	·038	2·96	1·88
	·051	1·65	1·87
	·076	3·66	2·43

A discussion of these results will more conveniently be postponed until the values from Series IV have been obtained.

The fourth series of measures were made upon spectra of the solar type star α Boötis, with the new single-prism spectrograph. All the previous work had been performed using as test object β Orionis, in whose spectrum only a few single lines are measurable, and these only moderately sharp. α Boötis on the contrary has a large number of sharp well defined lines, and it was felt that the investigation would be incomplete without determining the effect of widening the slit upon the accuracy of radial velocity measures in this case.

The original method of obtaining velocities of solar type spectra—by measuring linear positions of star and comparison lines by a micrometer microscope and determining wave-lengths by an interpolation formula—is not only laborious, but depends for its accuracy upon correct identifications and accurate knowledge of the wave-lengths of the star lines employed. It is also evident that as the slit is widened and the purity of the spectrum lessened, the difficulties of identification become greater and the purely accidental errors of pointing become complicated by other effects.

To avoid such difficulties the spectra secured were all measured on the spectro-comparator, and as by this means no accurate knowledge of wave-lengths is required the errors became limited to those due solely in this case, to the accidental errors occurring in the placing of the lines, stellar and comparison, of the star spectrum in coincidence with those of the fundamental solar spectrum.

The method of measurement with the spectro-comparator was described in my last year's report, page 177, and is also briefly referred to in the current report, page 111, and need not be again detailed here. In the present series, generally speaking, nine regions, whose centres were at wave-lengths distributed between λ 4100 and λ 4600, were measured on each plate, and the probable error of an average region has been determined in two ways. The differences of the displacements at each region with red to right and red to left, corrected for the systematic difference always present on reversal, will evidently give by the usual treatment the probable error of an average region. This probable error is the purely accidental part in the estimation of the coincidences. Other errors also of an accidental character are liable to occur, such as irregular arrangement of the silver grains or distortion of the film, the forming of the coincidences of lines not exactly in the centre of the region with a resulting error due to the incorrect value of the velocity constant by which the displacement is multiplied, and to other causes. A measure of the total accidental error of a single region is evidently obtained from a treatment of the mean velocities for each region.

The measures of the 40 plates of α Boötis used in this series are given in Appendix F, but in order to render the method readily understood a sample measurement will be given here:—

α BOÖTIS 3147 c.
STANDARD 3171.

1910, January 25.
G. M. T. $21^h 57^m$

Observed by } J. S. P.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·021	− ·028	− ·007	− ·0028	− ·0245	− 32·16	− 0·95
6	25	26	1	+ 32	255	32·10	− 0·89
7	26	30	4	+ 2	280	33 87	− 2·66
8	26	29	3	+ 12	275	32·00	− 0·79
9	27	29	2	+ 22	280	31·31	− 0·10
10	25	30	5	− 8	275	29·62	+ 1 59
11	23	30	7	− 28	265	27·57	+ 3·64
12	26	33	7	− 28	295	29·53	+ 1·68
13	33	35	2	+ 22	340	32·74	− 1·53

− ·270 .... − 31·21
232

502 log = 9·70070
log f = 1·79244

log v = 1·49314
v = − 31·13
Radial Velocity = − 5·43

Vo = + 0·26
Va = + 25·37
Vd = + 0·07

+ 25·70

In this table the first column gives the number of the region as indicated by dots on the standard or fundamental solar spectrum. The second and third columns, d_1 and d_2, give the displacements as measured with red to right and left respectively, while the fourth column gives their difference, and the sixth their mean. The fifth column, δ, gives the residuals between the mean value of $d_2 - d_1$, and the separate differences, and from these residuals the probable error of setting on a single region is obtained. The seventh column gives the velocities obtained from the region by multiplying the mean displacement in revolutions by the velocity per revolution determined, as described in last year's report. The eighth column gives the residuals from the mean velocity from which the total probable accidental error is obtained.

It is not possible to give these measures in a compact form, as in Series III, so I will content myself with giving a summary for each slit width of the velocity and the probable errors for each plate.

NEW SINGLE-PRISM SPECTROGRAPH.

SLIT 0·025 mm.

Plate Number.	Number of Regions.	Velocity.	Probable Errors of Single Regions.		
			Errors of Setting.		Total Accidental Errors in kms.
			Revolutions.	Kilometres.	
3147 c	9	−5·43	± ·0008	± 0·90	± 1·30
3148 a	11	7·56	·0007	0·76	1·52
3148 b	11	6·84	·0010	1·08	1·21
3148 c	11	6·19	·0006	0·65	1·80
3149 a	9	5·49	·0008	0·90	1·83
3149 b	9	4·44	·0011	1·23	1·31
3149 c	9	4·87	·0012	1·34	1·79
3150 a	9	4·44	·0007	0·78	1·25
3150 b	9	4·41	·0011	1·23	1·87
3150 c	9	5·99	·0007	0·78	1·45
Means	....	− 5·57	± ·00087	± 0·97	± 1·53

Probable Error Single Plate ± 0·61 km.

SLIT 0·038 mm.

Plate Number.	Number of Regions.	Velocity.	Probable Errors of Single Regions.		
			Errors of Setting.		Total Accidental Errors in kms.
			Revolutions.	Kilometres.	
3272 a	9	−6·21	± ·0011	± 1·23	± 0·91
3272 b	9	6·98	·0008	0·90	1·64
3272 c	9	5·96	·0006	0·67	1·17
3273 a	9	6·83	·0011	1·23	1·63
3273 b	9	7·76	·0011	1·23	1·39
3273 c	9	5·22	·0010	1·12	1·80
3274 a	9	5·22	·0009	1·01	1·06
3274 b	9	6·83	·0008	0·90	1·45
3274 c	9	6·15	·0011	1·23	0·86
3275 a	9	5·90	·0013	1·46	1·36
Means	....	−6·31	+ .00098	± 1·10	± 1·33

Probable Error Single Plate ± 0·54 km.

Slit 0·051 mm.

Plate Number.	Number of Regions.	Velocity.	Probable Errors of Single Regions.		
			Errors of Setting.		Total Accidental Errors in kms.
			Revolutions.	Kilometres.	
3238 b	9	−5·51	± ·0008	± 0·90	± 1.16
3238 c	9	6·20	·0009	1·01	1 61
3239 a	9	5·58	·0009	1·01	1·00
3239 b	9	5·64	·0008	0·90	1·68
3239 c	9	5·64	·0005	0·56	1·15
3240 a	9	4·34	·0012	1·34	1·35
3240 b	9	5·08	0010	1·12	0·93
3240 c	9	5·51	·0012	1·34	1·79
3280 c	9	8·07	·0009	1·01	1·71
3281 c	9	4·23	·0005	0·56	0·69
Means	....	−5·58	± ·00087	± 0·98	± 1·31

Probable Error Single Plate ± 0·71 km.

Slit 0·076 mm.

Plate Number.	Number of Regions.	Velocity.	Probable Errors of Single Regions.		
			Errors of Setting.		Total Accidental Errors in kms.
			Revolutions.	Kilometres.	
3276 a	9	− 2·74	± ·0010	± 1·12	± 1·48
3276 b	9	10·54	·0020	2 24	3·60
3276 c	9	13·22	·0020	2·24	2·77
3277 a	9	14·89	·0021	2·35	3·02
3277 b	9	6·95	·0021	2·35	3·32
3277 c	9	11·73	·0007	0·79	2·65
3278 a	9	4·54	·0017	1·90	2 27
3279 a	9	11·92	·0017	1·90	1·41
3279 b	9	1·62	·0019	2·13	2·45
3279 c	9	3·61	·0026	2·90	1·58
Means	....	− 8·18	± ·0018	± 1·99	± 2·46

Probable Error Single Plate ± 3·23 km.

Collecting these values together, we have the following table:—

Probable Errors, Series IV.

Slit Width.	Mean Velocities.	Probable Errors of Single Regions.		Probable Errors Single Plate.
		Error of Setting.	Total Accidental Error.	
0·025	−5·57	±0·97	±1·53	±0·61
·038	−6·31	1·10	1·33	0·54
·051	−5·58	0·98	1·31	0·71
·076	−8·18	1·99	2·46	3·23

In the probable errors of a single region, it is seen as would naturally be expected that the values in the column headed 'Error of Setting' are somewhat less than those under 'Total Accidental Error,' as the latter include as stated above other errors than those of the estimation of coincidences. In the summary of errors, the latter (the total errors) will be used as being more similar to and obtained in the same way as the errors of a single line in the three earlier series.

For convenience of reference the values obtained in all four series will be tabulated here. It may be well to repeat that in Series II, from four to seven star lines of β Orionis were measured and in Series III only three. In Series II, it was found on comparing values that better accordance was obtained when the three best lines, λ 4481, 4472, 4341, were used than when other lines were combined with them, and consequently the results from the use of these three lines only are given in Series II. The same three lines were also used in Series I, which accounts for the slightly different values from those previously published.

PROBABLE ERRORS OF SINGLE AVERAGE LINE.

Series.	Instrumental Constants.			Probable Errors at Slit Width.			
	Spectrograph.	Camera Focus.	Tenth Metres per mm.	0·025.	0·038.	0·051.	0·076.
I	Brashear Univ'l.....	375	18·6	±2·75	±2·91	±4·11	±6·30
IIa	One-Prism	525	30·2	4·6	2·5	2·4	4·4
IIb	Three-Prism........	525	10·1	2·3	2·1	2·5	2·1
IIc	"	275	18·2	2·9	....	2·9	3·8
IIIa	One-Prism	455	33 4	3·32	3·00	3·21	4·05
IIIb	Three-Prism........	300	17·5	2·81	2 96	1·65	3 66
IV	One-Prism	455	33·4	1·53	1·33	1·31	2·46

PROBABLE ERRORS OF SINGLE PLATE.

Series.	Instrumental Constants.			Probable Errors at Slit Width.			
	Spectrograph.	Camera Focus.	Tenth Metres per mm.	0·025.	0·038.	0·051.	0·076.
I	Brashear Univ'l.....	375	18·6	±2·78	±0 63	±2·95	±4·18
IIa	One-Prism	525	30·2	1·7	2·7	3·0	7·7
IIb	Three-Prism.... ...	525	10·1	1·5	1·3	0·7	0·9
IIc	"	275	18·2	2·1	....	3·0	2·9
IIIa	One-Prism	455	33·4	3·14	1·86	1·47	3·32
IIIb	Three-Prism........	300	17·5	0·84	1·88	1·87	2 43
IV	One-Prism	455	33·4	0·61	0·54	0·71	3·23

If each of these series are weighted according to their relative dependability and in conformity with the number of lines measured and plates used, and the weighted means are then obtained, we have a measure of the relative accuracy at the four slit widths used depending upon 49 plates each. The following were the weights selected for the different series:—

Series.	Weight.	Series.	Weight.
I	1	IIIa	3
IIa	2	IIIb	2
IIb	2	IV	4
IIc	1		

The weighted means of the probable errors are given in the following table:—

Mean Probable Errors.

—	At Slit Widths.			
	0·025.	0·038.	0·051.	0·076.
Single line...	2·74	2·31	2·33	3·49
Single plate...	1·65	1·44	1·62	3·47

The errors of a single line give the relative values of the accidental errors of measurement at the different slit widths, while the errors of a single plate give relative values of the total error, accidental and systematic, under the same conditions. The former indicates the effect upon the measurements of the increasing breadth and diffuseness of the lines, while the latter, although including this also, shows how far any possible asymmetric position of the nucleus of the star image, within the widened slit opening, affects the resultant velocities.

Let us consider first of all the purely accidental part of the effect of increased slit width. We notice in the detailed results for each series, that taken as a whole, there appears to be no increase as the slit is widened from 0·025 to 0·051 mm., indeed the mean values show a decrease from ± 2·74 to ± 2·33 kms. per second. In the cases where the focal length of the camera is less than that of the collimator (IIc, IIIa, IIIb, and IV) and where, consequently, there would be less increase in the breadth of the lines due to increased slit width than where camera and collimator were of the same focus, one would expect that such cases would give a more favourable showing in the probable errors, but this is not distinctly shown, although there are some evidences, as for example if we compare Series I with III and IV. Considering the mean values we may evidently take it as well established, that so far as accuracy of measurement is concerned, there is certainly no advantage to be gained in using a slit narrower than 0·051 mm., indeed in most cases this width gives a minimum value to the probable error of measurement. These values show just as unmistakably that an increase of slit width from 0·051 to 0·076 mm. increases the probable errors of measurement by nearly 50 per cent, in practically the same ratio as the exposure time is decreased.

It is difficult to find an explanation for this curious and unexpected result, to tell why, although there is a marked difference in the appearance of the lines at slits 0·025 and 0·051 mm., there seems to be a slight advantage to the broader lines given by the latter width in accuracy of measurement. It may possibly be due to the well known fact, that it is easier to make accordant pointings of a micrometer wire on a line somewhat broader than itself, than on one so narrow and fine that it is covered or nearly covered by the wire. Whatever the cause, however, the fact remains, established by measures of nearly 50 plates at each slit width, that at least equal accuracy of measurement may be obtained from a width of slit requiring only half the exposure time of that long deemed necessary for accurate radial velocity determinations.

The purely accidental errors of measurement just considered are not, however, so important as the total errors represented by the probable errors of single plates. A plate may upon measurement give very good agreement among its various lines, resulting in a low probable error, and yet give a resultant velocity differing greatly from the true one, owing to some instrumental cause producing a systematic displacement of the star lines as a whole with respect to the comparison lines. This displacement gives no evidence of its existence in the measurement, and can only be obtained by comparison of a number of plates of the same star taken under such varying conditions as may render the effect accidental in character. What is required in radial velocity work is, not so much good internal agreement among the lines, although this is very desirable, as a resultant velocity as nearly accurate as possible.

A measure of this accuracy at different slit widths is given in the tabulated 'Probable Errors of Single Plates.' A comparison of the results for the separate series, as well as for the mean, shows a marked similarity to the accidental errors in the three narrower slit widths, and a similar increase, although to a much greater degree, over 100 per cent in this case, for the widest slit, 0·076 mm., employed. This shows that the widening of the slit from 0·025 to 0·051 mm. tends to increase rather than decrease the accuracy of the velocity determination, but that a further widening to 0·076 mm. gives values less than half as accurate and that such further widening would not be permissible in good work. It does not seem so difficult in this case to find an explanation of these results. The only effect that widening the slit can have in systematically displacing the lines must be due to the position of the star image within the slit jaws. As previously stated, the effective diameter of the nucleus or 'core' of the image in photographic light is very closely two seconds of arc, 0·055 mm., with our telescope. With slits up to 0·051 mm., there is little chance of the 'core' being unsymmetrically situated, but when the slit is widened to 0·076 mm. it is possible that the nucleus may be on the whole, during a short exposure, to one or other side of the centre, a displacement of 0·005 of a millimetre from the central position, resulting in a systematic shift of the star lines equivalent to a velocity of about 10 km. per second with the single-prism spectrograph. A confirmation of this hypothesis is given by examining the increase in the probable errors of single plates for slits 0·076 mm. wide. We find it decidedly the greatest for the one-prism spectrographs, and only slightly greater than the narrower widths with the three-prism instruments. This may be ascribed to two causes: first, the smaller kilometre value for given linear displacements with three prisms, and, second, the longer time of exposure required with the greater dispersion, so that probably the vagaries of seeing and guiding during the five minutes exposure required in Series IIb would result in an integrated position of the image more nearly central than would be likely in series IIa, IIIa and IV, where the exposures were generally less than one minute.

The main results of the whole investigation may be briefly summarized as follows:—

(*a*) A previous investigation had shown that, for slit widths up to about 0·13 mm., the exposure time required to produce spectra of equal intensity is very nearly inversely proportional to the slit width.

(*b*) In order to determine the relative errors at different slit widths, nearly 50 spectra were made at each of four slit widths, 0·025, ·038, ·051, ·076 mm., with several different dispersions and under different conditions.

(*c*) The results of the measures of these plates showed that at least equal accuracy is attainable at a slit 0·051 mm. wide as at narrower widths, but that the accidental errors are increased 50 per cent and the total errors 100 per cent by a further widening to 0·076 mm.

(*d*) Finally, by combining (*a*) and (*c*) there is shown the possibility by using a wider slit than normally employed, of a considerable saving in exposure time and corresponding increase in output, without loss of accuracy.

PROBABLE ERRORS OF RADIAL VELOCITY DETERMINATION.

The magnitude of the probable errors attending the spectrographic determination of stellar radial velocities has always been with me a question of much interest, and considerable work described above along the line of the dependence of probable error upon the width of the slit employed has already been accomplished. It is proposed here to give a general discussion of the probable errors of radial velocities as affected by changes in the dispersion of the instrument, and in the type of stellar spectrum observed.

It may not be amiss to point out that in measuring stellar spectra, as in practically all scientific measurements, we have two classes of errors to deal with or guard against: first, the accidental errors of setting upon the lines of the spectra due partly to imperfect definition, and partly to the unavoidable differences in successive settings which are always present even with the most careful observers; second, the systematic errors, due in this case generally to instrumental conditions which give rise to spurious relative displacements of star and comparison lines. Among such conditions may be cited flexure or changes of temperature of the spectrograph, non-uniform illumination of the collimator, prisms, and camera, by the star or spark light, faulty focal adjustments of collimator or camera objectives, and so on. The former can be readily evaluated from the measures of the plates themselves, but no evidence of the latter appears in such measurements, and its magnitude can only be determined from the comparison of a number of plates of the same star. In the latter case, however, the errors so obtained will not be entirely systematic, but will be affected by the accidental errors present in the measured velocities. In the discussion to follow, relative measures of the accidental errors are given by the probable errors of single lines or regions on a plate, while for the systematic effect the probable error of a single plate, obtained by the discussion of several plates of the same star, is probably the best that can be done although, as stated above, such result has also included in it the effect of the accidental errors.

In considering the effect of change of dispersion, one would naturally expect to find the actual linear errors of the same magnitude for all dispersions and, as errors are always expressed in velocity values, the probable errors in kilometres per second would hence be inversely proportional to the linear dispersion. That is to say, as we have three different dispersions, 10·1, 20·2, and 33·4 tenth-metres per millimetre at $H\gamma$, practically as 3, 1½, and 1, we should expect to find the probable errors in kilometres per second inversely proportional to these latter numbers, or as 1, 2, and 3.

Most of the radial velocities at the Dominion Observatory have been obtained from spectra made with the lowest dispersion, a single-prism spectrograph, on spectroscopic binary stars of early type in which the spectral lines have generally been broad and diffuse. The probable errors of the velocity determinations of single plates have been consequently high, so high as to lead to the belief that the relation above expressed was not the true one but that the probable errors increased more rapidly than the dispersion diminished.

It seemed, therefore, worth while to make a definite test of the matter, especially as, although considerable data as to the probable errors of high dispersion star spectrographs is available, there is so far as I know not much published information in regard to the probable errors of one-prism instruments. In order to avoid, so far as possible, any effect due to diffuseness of the spectral lines, it was decided to use spectra of the solar type for the comparison. Further, to eliminate difficulties of identification of wave-lengths in the blends of lines always present in low dispersion second-type spectra, it was essential to measure the plates by the spectro-comparator, an instrument in which the actual displacement of the star lines due to velocity is compared with those in a standard plate of the sun whose velocity is known. By this method no knowledge of wave-length is necessary, and errors due to the loss of purity inherent with small dispersion cannot affect the measurements.

The brightest solar type star, Arcturus, was selected as a test object for the obvious reason that only short exposures would be necessary. To produce spectra of good quality for measurement on Arcturus, exposures are necessary of about ten minutes with the three-prism long focus spectrograph, designated as III L, 10·1 tenth-metres per mm., four to five minutes with the three-prism short focus designated as III R, 20·2 tenth-metres per mm., and one and a half minutes with the single-prism spectrograph designated as I, 33·4 tenth-metres per mm. at $H\gamma$, and, consequently, the plates required may be quickly made. Fortunately, when this investigation was begun we had already obtained nearly thirty plates with III L for another purpose, and only plates with III R and I were required. Eleven were made with III R and about fifty with I.

Of these plates, 24 of III L, 11 of III R and 38 of I were measured by myself on the spectro-comparator, and from these measures the results to be discussed were derived. In order to clearly explain how the probable errors were obtained, it is necessary to briefly describe the comparator and the method of measurement. In the first place, a standard spectrum of the sun is obtained by the same spectrograph, and this plate has impressed upon it, one on each side of the sun spectrum, a strip of the same comparison as in the star spectrum. This standard sun spectrum and the star spectrum are viewed by a special double objective, single ocular microscope, with a Lummer Brodhum cube in the ocular, which serves to superpose the two spectra so that a narrow strip of star spectrum is seen between and touching two strips of sun spectrum, while on each side a narrow strip of the star comparison lies between and touching strips of sun comparison. The standard sun spectrum is moved by a micrometer screw until the corresponding lines of the star and sun spectra are in exact coincidence, and then again moved until the comparison lines of the two spectra are coincident. The difference in the micrometer readings evidently gives us the displacement, due to radial velocity, of the star lines with respect to the sun lines, which on multiplication by a constant gives, after adding with the proper sign the known velocity of the sun, the velocity of the star with reference to the observer.

The coincidences are made at a number of chosen regions, marked by dots on the sun spectrum, which correspond, in a sense, to the lines in an early type spectrum, on which the cross wire is set. The accidental errors can thus evidently be determined from the probable error of the determination of the points of coincidence in these regions. After the spectra have been measured with the red end to the right, for example, they are reversed on the comparator and the same regions remeasured. The differences of displacement, corrected for a systematic effect due to reversal, are evidently wholly due to accidental errors of setting, and from these the probable error of a region is readily obtained in the well known way, giving a measure of the purely accidental error.

In addition to the purely accidental errors of setting are others, also of an accidental character, due to irregular arrangement of the silver grains or distortion of the film, to the forming of the coincidences to one side or other of the dot or centre of the region and consequent incorrect value of the velocity constant by which the displacement is multiplied, and to numerous other causes. A measure of the total accidental error is evidently obtained by computing the velocities separately for the mean of the two measures red right and red left of each region, by obtaining the residuals from the mean velocity of the plate, and the probable error in the usual way. This probable error should be and is, as is seen below, somewhat greater than the purely accidental error of setting.

The systematic errors due to instrumental peculiarities can only be obtained from the discussion of plates of the same star, in sufficiently large numbers to ensure that the systematic displacements for this particular spectrograph become accidental in character. It is possible, however, that there may be slight constant systematic differences in the values given by different spectrographs. We have, in the three dispersions, plates to the number of 24, 11, and 38, and, by treating the residuals from the mean velocities, we can obtain the probable error of a single plate in which, although as before stated we have the accidental errors of measurement included, we get a good relative idea of the systematic errors, and which certainly gives us an accurate idea as to the total error involved, which in the ultimate analysis is what we wish to know.

The measures of the plates used are given in Appendix F, where all the measures are collected, but for convenience a summary of the velocity values, probable errors and residuals is given below.

SPECTROGRAPH III L., 10·1 T.M. PER MM.

Plate No.	No. of Regions.	Velocity.	Probable Errors of Single Region.			Residual.
			Errors of Setting.		Total Accid'tal Errors Kms.	
			Revns.	Kms.		
1426	11	− 5·74	± 0·0015	± 0·59	± 0·82	0·23
1455	11	4·97	·0008	·32	·59	·54
1456	16	5·64	·0009	·35	·52	·13
1514	12	5·91	·0017	·66	·93	·40
1515	13	5·78	·0008	·31	·57	·27
1529	10	6·14	·0010	·41	·65	·63
1585	13	5·59	·0020	·78	·71	·08
1586	10	5·94	·0012	·49	·61	·43
1588	11	6·93	·0013	·53	·62	1·42
1595	12	4·14	·0009	·37	·53	1·37
1596	13	5·43	·0010	·39	·69	0·08
1597	13	6·12	·0011	·43	·68	·71
1606	12	5·42	·0009	·37	·61	·09
1615	12	6·24	·0011	·42	·74	·73
1618	12	6·86	·0009	·37	·76	1·35
1619	16	5·14	·0011	·40	·32	0·37
1620	14	5·30	·0011	43	·64	·29
1622	15	4·58	·0015	·57	·61	·93
1635	14	3·97	·0014	·53	·48	1·54
1645	16	5·00	·0015	·54	·64	0·51
1662	12	4·98	·0011	·45	·72	·53
1671	16	6·10	·0009	·32	·61	·59
1672	14	5·18	·0013	·51	·45	·33
1709	15	4·62	·0009	·35	·74	·89
Means..	13	− 5·51	± 0·00117	± 0·453	± 0 628	

Average probable error of setting single region = ± 0·45 km.
" " total accidental error single region = ± 0·63 km.
" " " " " " plate = ± 0·17 km.
Total probable error (accidental + system'c) single plate = ± 0·50 km.

SPECTROGRAPH III R., 20·2 T.M. PER MM.

Plate No.	No. of Regions.	Velocity.	Probable Errors of Single Regions.			Residual.
			Errors of Setting.		Total Accid'tal Errors Kms.	
			Revns.	Kms.		
3288	10	− 6·64	± 0·0011	± 0·80	± 1·22	2 09
3289	9	4·94	·0009	·67	1·04	0·39
3290	9	5·58	·0009	·67	0·83	1·03
3291	10	4·83	·0013	·95	1·18	0·28
3311	11	3·27	·0011	·78	1·02	1·28
3312	10	4·16	·0013	·95	0·64	0·39
3313	10	3·47	·0013	·95	1·25	1·08
3314	10	5·78	·0010	·73	0·87	1·23
3315	10	3·33	·0006	·44	1·11	1·22
3316	10	4·52	·0008	·58	0·88	0·03
3317	10	3·54	·0012	·88	0·99	1·01
Means .	10	− 4·55	± 0·00105	±0·75	± 1·00	

Average probable error of setting single region = ± 0·75 km.
" " total accidental error single region = ± 1·00 km.
" " " " " " plate = ± 0·32 km.
Total probable error (accidental + system'c) single plate = ± 0·75 km.

SPECTROGRAPH I, 33·5 T.M. PER MM.

Plate No.	No. of Regions.	Velocity.	Probable Errors of Single Regions.			Residual.
			Errors of Setting.		Total Acc'd'l Errors.	
			Revns.	Kms.	Kms.	
3126	6	−6·14	±0·0019	±2·25	±2·49	0·13
3127	8	7·87	·0009	1·02	1·25	1·86
3128	9	5·49	·0007	0·78	1·37	0·52
3129	7	6·58	·0016	1·86	1·02	1·57
3130	7	5·42	·0012	1·39	1·11	0·59
3146	8	8·54	·0008	0·90	1·57	2·53
3147a	9	6·42	·0014	1·57	1·89	0·41
3147b	9	5·49	·0011	1·23	1·39	0·52
3147c	9	5·43	·0008	0·90	1·30	0·58
3148a	11	7·56	·0007	0·76	1·52	1·55
3148b	11	6·84	·0010	1·08	1·21	0·83
3148c	11	6·19	·0006	0·65	1·80	0·18
3149a	9	5·49	·0008	0·90	1·83	0·52
3149b	9	4·44	·0011	1·23	1·31	1·57
3149c	9	4·87	·0012	1·34	1·79	1·14
3150a	9	4·44	·0007	0·78	1·25	1·57
3150b	9	4·44	·0011	1·23	1·87	1·57
3150c	9	5·99	·0007	0·78	1·45	0·02
3238b	9	5·51	·0008	0·90	1·16	0·50
3238c	9	6·20	·0009	1·01	1·61	0·19
3239a	9	5·58	·0009	1·01	1·00	0·43
3239b	9	5·64	·0008	0·90	1·68	0·37
3239c	9	5·64	·0005	0·56	1·15	0·37
3240a	9	4·34	·0012	1·34	1·35	1·67
3240b	9	5·08	·0010	1·12	0·93	0·93
3240c	9	5·51	·0012	1·34	1·79	0·50
3272a	9	6·21	·0011	1·23	0·91	0·20
3272b	9	6·98	·0008	0·90	1·64	0·97
3272c	9	5·96	·0006	0·67	1·17	0·05
3273a	9	6·83	·0011	1·23	1·63	0·82
3273b	9	7·76	·0011	1·23	1·39	1·75
3273c	9	5·22	·0010	1·12	1·80	0·79
3274a	9	5·22	·0009	1·01	1·06	0·79
3274b	9	6·83	·0008	0·90	1·45	0·82
3274c	9	6·15	·0011	1·23	0·86	0·14
3275a	9	5·90	·0013	1·46	1·36	0·21
3280c	9	8·07	·0009	1·01	1·71	2·06
3281c	9	4·23	·0005	0·56	0·69	1·78
Means.	8·84	−6·01	±0·00097	±1·09	±1·41	

Average probable error of setting single region = ± 1·09 km.
" total accidental error single region = ± 1·41 km.
" " " single plate = ± 0·47 km.
Total probable error (Accid'l + system'c) " = ± 0·70 km.

Collecting in the following table the final values, we obtain the relative errors for the three dispersions.

SUMMARY OF PROBABLE ERRORS.

Spectrograph.	Disp'n. t. m. per mm.	No. of Plates.	Mean Velocity.	Errors of Single Region.		Errors of Single Plates.		
				Errors of Setting.	Total Accidental Errors.	Total Errors Accid'l. and Syst'c.	Accid'l.	Syst'c.
III L.... ...	10·1	24	− 5·51	± 0·45	± 0·63	± 0·50	± 0·17	± 0·47
III R........	20·2	11	− 4·55	0·75	1·00	0·75	0·32	0·68
I............	33·4	38	− 6·01	1·09	1·41	0·70	0·47	0·52

We have in the first column the spectrograph employed; in the second, the dispersion in tenth-metres per millimetre at $H\gamma$; in the third, the number of plates measured; and in the fourth, the mean velocity of these plates. The fifth column contains the average probable error of the estimation of the coincidences in a single region, while the sixth contains the average total accidental error as obtained from the final kilometre values of the displacement for each region.

Under the heading of 'Errors of Single Plates,' we have in the seventh column, the total error obtained from the mean velocities of all the plates; and in the eighth, the accidental error obtained by dividing the total accidental error of a single region by the square root of the number of regions; while the ninth column is obtained from the two preceding columns by taking the square root of the difference of their squares.

It is difficult to account for the results obtained, especially in the errors of single plates, for, as before stated, one would expect the kilometre values of the probable errors to be inversely proportional to the linear dispersion. This is approximately true so far as the errors of single regions are concerned, and the discrepancy can be satisfactorily explained by the greater ease and accuracy in the determination of coincidences in the single-prism spectrograph, owing to the decidedly smaller curvature of the spectral lines. But when we come to the total errors of a single plate as determined from the measured velocities of the plates, we find the errors instead of being in the ratio of 1, 2, and 3, as we should expect, are as 1, 1½, and 1½, approximately.

So far as III L and III R are concerned, it must be remembered that, although the linear dispersions are as 1 to 2, the angular dispersions and the resolving powers are equal, and the decrease of the ratio from 1 : 2 to 1 : 1½ can thus be accounted for. In the single-prism spectrograph, however, the linear dispersion, angular dispersion, resolving power, and purity of spectrum are practically only one-third of those of III L, and the errors should be three times as great. Instead of that, the total error of a plate, which is of course the most important quantity to be determined, is only 40 per cent greater with the lower dispersion, and an examination of the last two columns shows that the systematic (due to changing instrumental factors) part of this error is nearly the same in III L and I, while the accidental part is nearly in proportion to the dispersions.

This would seem to indicate, either that the single-prism spectrograph is less likely to give systematic displacements of the spectrum lines than III L, or that the kilometre rather than the linear value of the systematic displacements remains constant. So far as the first supposition is concerned, although the single-prism instrument is undoubtedly less affected by flexure than III L and is probably better controlled and regulated as regards temperature, these two factors will not have much influence in the short exposures required on Arcturus. There is no ground for supposing on the other hand, that kilometre rather than linear values of the systematic displacement should remain constant, except in the case of displacements due to temperature changes in the prisms.

A partial explanation of the relative superiority of the low dispersion instrument is, that it may be due to the fact, that the three-prism plates were mostly made on different dates and at varying hour angles, though never far from the meridian, while the one-prism plates were made in four groups only, the plates being obtained consecutively and probably under similar conditions in each of the groups.

In any case, it seems to be evident that radial velocity determinations of second-type stars may be made with low dispersion instruments with an accuracy not much less than that obtainable with the high dispersion instruments at present in use. This fact, if considered established by the present investigation, is one of much importance, as it admits the carrying of the spectrographic survey of the heavens to stars more than a magnitude fainter than those at present available.

It may be of interest to compare the values of the probable errors of a region and plate in the solar-type star Arcturus with those obtained, in my investigations on the effect of slit width, given above, of the probable errors of an average line and of a single plate in the case of the early type star β Orionis. I will in this case take the mean of the values obtained for the three slit widths, 0·025, 0·038, and 0·051 mm., thus using 18 plates with III L, 18 plates with III S, and 30 plates with I.

PROBABLE ERRORS.

Spectrograph.	Line of Average Weight.	Single Plate.
III L. 18·1	± 2·20	± 1·17
III S. 20·2	± 2·47	± 1·53
I 33·5	± 3·18	± 2·16

These results are, relatively to one another, in substantial agreement with those obtained in the present investigation, though not quite so favourable to the low dispersion. There seems, hence, to be no reasonable doubt that the accuracy of radial velocity determinations does not by any means proportionately diminish with decrease of dispersion.

It is evident, therefore, that the high probable errors of single observations obtained in our work on spectroscopic binary orbits must be due, not to the small dispersion employed giving results relatively less accurate than those obtained with high dispersion instruments, but to the character of the lines in the spectra with the resultant high errors of measurement. In many cases, also, they are probably due to abnormal conditions in the orbit causing deviations from velocity curves due to simple elliptic motion, thus giving higher residuals.

I have tabulated below the probable error of an average observation of the velocity of the brighter stars of spectroscopic binary systems as determined here, and at the Allegheny and Lick observatories, and it will be noticed at once, that the accuracy very rapidly diminishes as the spectrum lines become broader and with orbits containing abnormal secondary or other effects. The slightly lower values obtained at Allegheny for the probable errors are likely due to the fact, that many of their spectra were made on the fine grained Seed 23 instead of the coarser grained Seed 27 plate used at Ottawa.

PROBABLE ERRORS OF SINGLE OBSERVATIONS.

Star.	Spectral type.	Probable Error Average Plate.	Dispersion.	Observatory.	Remarks.
7 Camelop..........	A 2 F	± 2·4	One Prism..	Ottawa.....	Lines good.
α Draconis.........	VII a	3·4	"	"	" "
θ Aquilæ.......	VII a	4·0	"	"	Changing elements ?
B. D. – 1°1004.....	B 3 A	5·2	"	"	Broad line.
α Coronæ........	VIII a b	5·4	"	"	Lines broad and asymm'l.
φ Persei..........	L	4·1	"	"	Abnormal secondary effect.
ε Herculis..........	VII a	6·4	"	"	Abnormal secondary effect.
ι Orionis...........	B, I b	6·8	"	"	Lines diffuse and asymmetric.
ψ Orionis........	B, I b	6·8	"	"	Lines very broad.
τ Tauri...........	B, I b	10·8	"	"	"
β Orionis...........	VI c	2·0	ThreePrism.	"	Lines good.
		3·2	One Prism..	" ...	"
η Virginis.........	VIII a	2·4	ThreePrism.	"	Lines fair.
η Boötis...........	XIV a	0·50	"	"	Numerous well defined.
π^4 Orionis..........	IV a	1·7	One Prism..	Allegheny..	Lines very good.
ζ^1 Lyræ...........	A I a 2	2·0	"	" ..	Lines well defined.
α Androm..........	VIII P.	2·5	"	" ..	Lines good.
β Aurigæ..........	VIII a	3·2	"	" ..	Lines sharp and narrow.
θ Aquilæ........	VII a	3·4	"	" ..	Lines fair.
δ Libræ...........	VII a	4·7	"	" ..	Ill defined lines.
α Coronæ..........	VIII a b	4·9	"	" ..	Broad lines.
2 Lacertæ..........	A I b	5·3	"	" ..	Fair lines.
u Herculis.........	A I b	8·0	"	" ..	Broad lines.
α Virginis..........	III b	9·9	"	" ..	Very broad and diffuse.
η Pegasi............	XIV a	0·47	ThreePrism.	Lick......	Good lines.
α Aurigæ........	XIV a	0·50	"	"	"
λ Androm..........	XV a	0·50	"	"	"
β Herculis.........	XV a	0·52	"	"	"
ι Pegasi...........	XII a	0·56	"	"	"
α_2 Geminorum.....	VIII a	0·64	"	"	"
α_1 Geminorum......	VIII a	0·79	"	"	"
ω Draconis........	F 5 G	0·75	"	"	Diffuse lines.
θ Draconis..........	XIII a	0·87	"	"	"
R. T. Aurigæ.....	G.	0·82	"	"	"
η Aquilæ........	XIV a c	0·85	"	"	"
W Sagittarii.......	F 5 G	0·90	One Prism..	"	Fair lines.
X "	F 8 G	1·80	"	"	"
Y "	G	2·10	"	"	"

None of the orbits determined, with low dispersion at Ottawa and Allegheny, are of stars with solar type spectra, so that no measure can be thus obtained of the relative accuracy of this dispersion. Three solar type binaries, observed at the Lick observatory with a single-prism spectrograph, show fairly accurate results, especially W Sagittarii with a plate error of ± 0·90 km., and which, if three or four discrepant observations are omitted, reduces to ± 0·55 km. This is of the same order as the probable error of a single-prism plate of Arcturus as determined here (± 0·70 km.).

The probable errors of single observations of binary and constant velocity solar type stars with three-prism dispersion, both at Lick and Ottawa. seem to be very close to half a kilometre, and in cases where it is greater, it is apparently due to the poorer quality of the spectra for measurement. Three cases in which the probable error of a plate is less than half a kilometre are known to me. At Ottawa a series of 11 plates of β Geminorum gave a probable error of ± 0·40 km. per second, and when observations are limited to certain hour angles and special precautions taken, as at Bonn by Kustner, in determination of solar parallax, where 16 plates of Arcturus gave a probable error of a single plate, ± 0·22 km., and at the Royal observatory, Cape of Good Hope, where 22 plates of β Geminorum gave a probable error of ± 0·34 and 55 plates of α Boötis of ± 0·42 km. There is no doubt, though no values have been published, that the work at the Lick and Yerkes observatories on solar type constant velocity stars is equally accurate.

It seems to me, therefore, that we may safely draw the following conclusions from the preceding discussion:—

I. The accuracy of determination of the radial velocity of stars of solar type by means of spectrographs of different dispersions is not, as would be expected, inversely proportional to the dispersion, but in the cases under discussion only a small increase of probable error, ·40 per cent, takes place when the dispersion is divided by three. As the relative exposures required are as about five to one, it is evident that stars more than a magnitude and a half fainter become available.

II. The probable error very rapidly increases with the increase in diffuseness of the lines in early type stars varying in low dispersion spectrographs from about ± 2 to ± 11 km. per second. Experience in work with these stars has convinced me that the whole of this error is not due to the accidental error of pointing, but that, in many cases some physical cause in the star's atmosphere is responsible for a considerable part of the discrepancy.

III. The result of this and other investigations shows, that the probable error of a single ordinary observation of a good second-type star with the usual three-prism dispersion is in the neighbourhood of 0·5 km. per second. When greater than this, it indicates a spectrum with poorer lines, and when less, that special precautions and limitations were adopted in the making and measurement of the spectra. It is also shown that the probable error of determination with a thoroughly stable one-prism instrument of one-third the dispersion is, for solar-type spectra measured on the spectra-comparator, about ± 0·70 km. per second, and for spectra of earlier type varies from about ± 2 to ± 11 km. per second.

IV. Generally speaking, the major part of the errors in solar type stars is due to systematic displacements of the lines as a whole, owing to flexure, temperature changes, imperfect adjustments of the optical parts, faulty guiding or other causes, and that the accidental errors of pointing are responsible generally for only one-third or less of the total error. In the case of early type stars, the systematic displacements due to instrumental conditions will probably be approximately the same while the errors of pointing are correspondingly increased.

RADIAL VELOCITIES.

As indicated in the introduction, the work on the radial velocities of selected stars has been actively prosecuted during the past year. A considerable part of my own time has been devoted to the work, and the whole of Messrs. Harper, Cannon and Parker. As in previous years, the securing of the spectra has been divided among the four observers, each observer securing spectra in their order on the programme, independently of the fact whether he is to measure and reduce the plates or not. Generally, each observer has one or more stars on which he does all the measurement and reduction, and, if binary, obtains the elements of the orbit. According to this scheme, as in former years, the spectroscopic binaries, whose orbits have been determined by my assistants, will appear as appendices to my report, my own work in this line, however, coming before my signature. As in last year's report, the record of observations and the detailed measures of all the stars discussed will appear in Appendix F. This has been done in order to render the descriptive matter and the discussions more continuous and readily followed.

No changes have been made in the method either of observation or reduction, and as they have been fully discussed in previous reports it is not necessary to again refer to them. About a year ago the new Toepfer measuring microscope was received and mounted on its folding table. It is practically the same as the one described in the 1905-6 Report at page 62, with the exception, of a second movable carriage on the main carriage for ease and convenience in adjusting the spectrum on the instrument and of some minor changes in the optical parts. It gives excellent satisfaction, both instruments being well adapted for the work they were designed to do, and the workmanship and finish being of the best. There is now no need, as sometimes happened previously, for any delay in the measurement of plates owing to the machine being in use.

The observing weather during the period this report covers has been considerably poorer than the average, especially in May and June and between October 1 and March 31. Although the number of spectra obtained is not much diminished from the previous year, yet many of these are test spectra of β Orionis and α Boötis where the exposures were very short and I think, if the whole number of available observing hours were computed, it would be found to be considerably smaller than in the previous year.

During the past twelve months, from April 1, 1909, to March 31, 1910, 910 star spectra have been obtained on 144 nights. The total number of spectra on record at the last mentioned date was 3,368. Numerous test spectra, in addition to those recorded, used in determinations of focus and other investigations have also been made.

If these spectra are classified according to the stars and purposes for which they have been made, I find that 729 spectra of 132 known spectroscopic binaries have been obtained. Of the remaining 181 plates obtained during the twelve months, 79 were of suspected binaries, 12 were for discovery purposes, and the remaining 90, of various constant velocity stars observed in connection with the investigations detailed above.

The greater number of these plates have been measured and reduced, and in addition, many plates made during the previous twelve months of the binaries whose orbits are discussed below have also been measured. It may consequently be said, that the measurement and reduction of the spectra are practically up to date.

There have been completed during the year, the elements of the orbits of seven spectroscopic binary stars. Of these binaries four are of stars of which preliminary elements were previously obtained, but in which further observations and new treatment made it desirable to redetermine the orbits.

SPECTROSCOPIC BINARIES COMPLETED.

Star.	No. of Plates.	R. A.	Declination.	Mag.	Type.	Discussed by	Remarks.
		h. m.	° ′				
ι Orionis........	107	5 30·5	− 5 59	3·4	B, Ib	Plaskett..	New Solution.
ε Herculis.......	139	16 56·5	+31 04	3·9	VIIa	Harper...	"
B.D. -1°.1004 ..	36	5 36	− 1 11	5 0	B 3A	" ...	New Binary.
η Boötis..	24	13 49·9	+18 54	3·8	XIVa	" ...	New Solution.
α Draconis......	59	14 01·7	+64 51	4·0	VIIa	" ...	"
φ Persei.	120	1 37·4	+50 11	4·3	L	Cannon...	New Binary.
τ Tauri	104	4 36·2	+22 46	4·2	B, Ib	Parker ...	"

In the third, sixth and seventh stars of the above list, the solution is entirely new and of such a character as not likely to call for a redetermination of the elements, as has been found desirable in the case of the other four binaries of which orbits have already appeared in previous reports.

In the case of ι Orionis the present orbit is a redetermination, from the same observations as the previous solution, including coefficients for a secondary disturbance of the same period as the primary. The elements of B.D. − 1°·1004 obtained by Mr. Harper were found to be remarkably similar to those of ι Orionis. As there was an undoubted secondary effect present in the former and a suspected one in the latter, it was thought desirable to determine the change in residuals introduced by the application of a secondary effect to ι Orionis. Below, it will be seen that considerable improvement has resulted.

In the case of ε Herculis. the new solution includes a considerable number of new plates of the star obtained and measured in the last year. In α Draconis, some new plates were also obtained and a least squares correction was applied to the elements previously obtained graphically.

The previous solution of η Boötis included plates made with both the one and three-prism spectrographs. It was felt desirable, in order to make the results more homogeneous and reliable, to obtain some additional three-prism plates and make a least squares solution using the high dispersion spectra only.

Although the residuals from the final velocity curve of φ Persei are in some cases considerably higher than is to be expected from the character of the spectrum, the orbit is on the whole very satisfactory, and has been very ably and thoroughly discussed by Mr. Cannon. His explanation of the cause of the observed change in the character of the spectrum depending upon the phase in the orbit is certainly a very ingenious one, and, since we know very little as yet of the cause of the abnormal effects found in so many binaries, every new hypothesis and discussion is of value. There can be no question in my mind, that in this case the deviations from simple elliptic motion cannot be explained by the presence of a second spectrum displacing the centre of intensity of the lines. Also, the observations are not well satisfied by the supposition of circular or even elliptic motion of a satellite around the light-giving body, and the question, like so many others, must be left in uncertainty.

Considering the quality of the lines for measurement in the spectrum of τ Tauri, indicated by the high probable error, 10·8 km. of a single plate, the orbit may be considered a very satisfactory one. It reflects credit on the perseverance of Mr. Parker in obtaining order out of the apparently hopeless confusion resulting from a large number of observations, many of very inferior quality, spread over a long interval when the binary is of very short period.

As stated above, plates have been obtained during the past year of 32 spectroscopic binaries. Subtracting 10, whose orbits are completed (in ι Orionis no plates, while additional plates of 3 completed binaries were obtained), leaves 22 binaries under investigation. On the 7 stars given below, considerable work has been done, but on the remaining 15 only 106 plates have been secured.

BINARIES UNDER INVESTIGATION.

Star.	No. of Plates.	R. A.	Declination.	Mag.	Spectral Type.	Plates Measured by
		h. m.	° ′			
Camelop..........	31	4 48	+53 35	4·8	VIIa	Harper.
ν Orionis...........	45	6 1·8	+14 47	4·6	IVa, b	Harper.
ω Urs. Mag........	33	10 48·2	+43 43	4·7	Ia, 2	Parker.
93 Leonis.	38	11 42·8	+20 46	4·8	F.	Cannon.
ε Urs. Min........	18	16 56·2	+82 12	4·9	XIVa	Plaskett.
γ Aquarii..........	42	22 16	− 1 53	4·1	VIIa	Cannon.
θ^2 Tauri	24	4 32·9	+15 39	3·8	Xa, b	Plaskett.

Of the 7 binaries whose orbits are discussed in this report, 240 plates were taken during the year; of the 7 binaries in the table immediately above, 231 plates; of 15 others, 106 plates; of β Orionis, 137; and of 2 others previously determined, 15 plates; making the number of plates of known binaries, 729.

It is doubtless the case, that, in many of the 15 binaries of which only a few plates have been obtained, the range of velocity will be insufficiently great when combined with the poor quality for measurement of the lines, to enable the period and elements to be determined under present conditions. This has been found to be the case with two binaries, o Andromedæ and δ Aquilæ, where, although many plates were obtained, it was found impossible to determine the period.

The new discussion of the observation of ι Orionis, taking account of the secondary disturbance will now be given.

ι Orionis.

After Mr. Harper had completed the orbit of the spectroscopic binary star B.D. − 1°·1004, details of which will be found in Appendix A, the very striking similarity between its velocity curve and elements and those of ι Orionis, considerable work on which has already been given,* led me to make a redetermination of the elements of the latter star. In the previous least squares corrections to the elements, the question of a secondary disturbance in its orbit was left unsettled owing to uncertainty attending the velocities, consequent upon the poor quality of the spectrum for measurement.

The undoubted presence of a secondary effect in B.D. − 1°·1004, and the marked improvement in agreement between the observations and the final

* Report Chief Astronomer, 1906-7, p. 146; 1907-8, p. 101

velocity curve produced by its introduction, were deemed sufficient reason for making a new solution of ι Orionis, adding coefficients for the secondary effect to the differential equations of Lehmann Filhés.†

As will be seen later, when the comparisons are made, the two binaries have very similar orbits, and a paper on this similarity, entitled 'Two Curiously Similar Spectroscopic Binaries,' by Mr. Harper and myself, was read by you at the Winnipeg meeting of the British Association for the Advancement of Science, and published later in the Astrophysical Journal.‡

After the details of the new solution of ι Orionis and a summary of the results obtained by Mr. Harper on B.D. – 1°·1004 (Appendix A) have been given, the two orbits will be compared and the points of similarity discussed as in the paper above cited.

The present determination is based wholly on the observations previously used, and indeed, on the same grouping into normal places as employed in the former least squares solution. As preliminary elements for the primary, those obtained from the graphical solution** are employed as more suitable for the application of corrections for a secondary effect than those where the deviations from a simple elliptic orbit have been smoothed out by the least squares solution. For the secondary, simple circular motion of half amplitude 7·0 km. and of the same period was superposed on the primary, the crossing points being taken at periastron and apastron. If T', the time of crossing, be taken where the secondary crosses, ascending (at the ascending node), in this case at periastron, the two terms to be added to the differential equations of Lehmann Filhés are

$$+\sin\theta\,\delta K' - 2\frac{\pi}{P'}K'\cos\theta\,\delta T',$$

obtained by differentiating the radial velocity in a circular orbit, thus,

$$\frac{dz}{dt} = K'\sin\theta$$

$$\delta\left(\frac{dz}{dt}\right) = \sin\theta\,dK' + K'\cos\theta\,d\theta,$$

and, since $\theta = 2\pi\frac{t-T'}{P'}$, we get the value given above.

For the complete differential equations we have

$$\delta\frac{dz}{dt} = \delta\gamma + (\cos u + e\cos\omega)\,\delta K + \left\{\cos\omega - \frac{\sin u\sin v}{1-e^2}(2+e\cos v)\right\}K\,\delta e$$
$$-(\sin u + e\sin\omega)\,K\,\delta\omega - \sin u\,(1+e\cos v)^2(t-T)\frac{K\,\delta\mu}{(1-e^2)^{\frac{3}{2}}}$$
$$+\sin u\,(1+e\cos v)^2\frac{K\,\mu\,\delta T}{(1-e^2)^{\frac{3}{2}}} + \sin\theta\,\delta K' - 2\frac{\pi}{P'}K'\cos\theta\,\delta T',$$

an equation of eight unknowns. As the period is considered as closely determined, the fifth term on the right hand side is omitted.

† A.N., No. 3242.
‡ Astrophysical Journal XXX, 373, December, 1909.
** Report Chief Astronomer, 1907-8, p. 151.

Forming an observation equation for the phase of each of the 26 normal places previously determined, we obtain the following in which for homogeneity we substitute,

$$x = \delta\gamma$$
$$y = \delta K$$
$$z = K\,\delta e = 112\ \delta e$$
$$u = K\,\delta\omega = 112\cdot\delta\omega$$
$$v = \frac{K\,\mu\,\delta T}{(1-e^2)^{\frac{3}{2}}} = 83\cdot46$$
$$w = \delta K'$$
$$t = \frac{2\pi}{P'} K'\,\delta T = 1\cdot5096\ \delta T'$$

where the preliminary elements are those determined graphically in the 1908 Report, p. 151:—

Velocity of system	γ = +20·7 km.
Half amplitude	K = 112 km.
Eccentricity	e = 0·75
Longitude of the apse	= 110°
Time of periastron passage and	T = J. D. 2,417,587·94
Half amplitude secondary	K' = 7·0 k.m.
Time of descending node	T' = J. D. 2,417,587·94

FIRST OBSERVATION EQUATIONS.

ι ORIONIS.

Weight.	x	y	z	u	v	w	t	Residual V
9	1·000	− 1·228	−1·425	− ·940	+ ·472	+ ·108	− .994	+ 0·57
6	1·000	− 1·178	+1·397	− ·317	− ·360	+ ·239	− ·971	+ 6·31
4	1·000	− 1·072	+1·955	− ·126	− ·372	+ ·318	− ·948	− 1·95
5	1·000	− ·838	+2·074	+ ·109	− ·270	+ ·510	− ·860	+ 6·55
3	1·000	− ·689	+1·832	+ ·197	− ·204	+ ·658	− ·752	− 3·88
1	1·000	− ·511	+1·401	+ ·262	− ·142	+ ·853	− ·521	−16·56
5	1·000	− ·466	+1·279	+ ·273	− ·130	+ ·899	− ·438	+ 0·16
4	1·000	− ·323	+ ·868	+ ·293	− ·098	+ ·996	− ·085	+ 1·00
2	1·000	− ·161	+ ·384	+ ·291	− ·075	+ ·893	+ ·450	− 6·06
1	1·000	− ·074	+ ·124	+ ·278	− ·066	+ ·679	+ ·735	+ 7·67
4	1·000	− ·004	− ·084	+ ·263	− ·062	+ ·416	+ ·823	− 2·59
2	1·000	+ ·084	− ·338	+ ·235	− ·059	+ ·006	+1·000	− 5·13
4	1·000	+ ·173	− ·586	+ ·198	− ·058	− ·420	+ ·907	+ 4·21
3	1·000	+ ·209	− ·685	+ ·180	− ·058	− ·577	+ ·817	− 1·72
4	1·000	+ ·268	− ·838	+ ·147	− ·060	− ·784	+ ·620	− 6·40
2	1·000	+ ·308	− ·938	+ ·121	− ·062	− ·888	+ ·459	+ 4·91
1	1·000	+ ·358	−1·056	+ ·084	− ·065	− ·970	+ ·244	− 2·96
3	1·000	+ ·496	−1·316	− ·046	− ·077	− ·950	− ·313	− 2·14
1	1·000	+ ·567	−1·386	− ·137	− ·086	− ·841	− 540	− 0.68
2	1·000	+ ·628	−1·376	− ·239	− ·092	− ·717	− ·697	+ 4·26
4	1·000	+ ·681	−1·260	− ·357	− ·092	− ·593	− ·805	+ 2·62
2	1·000	+ ·708	−1·112	− ·442	− ·085	− ·520	− ·854	− 9·32
4	1·000	+ ·730	− ·867	− ·543	− ·065	− .446	− ·895	− 2·92
7	1·000	+ ·718	+ ·634	− ·930	+ ·186	− ·262	− ·965	+ 2·25
10	1·000	+ ·089	+3·221	−1·643	+2·321	− ·071	− ·997	− 0·62
2	1·000	− ·398	+ ·930	−1·695	+2·987	− ·020	−1·000	− 4·99

From these observation equations the following normal equations were obtained in the usual way:—

$+95\cdot000x$	$-14\cdot186y$	$+39\cdot398z$	$-33\cdot870u$	$+25\cdot224v$	$-0\cdot523w$	$-41\cdot629t$	$-6\cdot440=0$
	$44\cdot964y$	$-29\cdot378z$	$3\cdot173u$	$+0\cdot579v$	$-22\cdot102w$	$+17\cdot998t$	$-55\cdot740=0$
		$+230\cdot064z$	$-42\cdot382u$	$+66\cdot059v$	$+39\cdot621w$	$-52\cdot492t$	$+63\cdot945=0$
			$+51\cdot602u$	$-53\cdot062v$	$+7\cdot297w$	$+42\cdot795t$	$-2\cdot824=0$
				$+76\cdot118v$	$-3\cdot703w$	$-29\cdot165t$	$-50\cdot950=0$
					$+29\cdot337w$	$-3\cdot986t$	$+12\cdot634=0$
						$+65\cdot036t$	$-50\cdot256=0$

The solution of these equations gives:—

x	=	$+\ \cdot8114$	$\delta\gamma$	=	$+\ \cdot8114$ km.
y	=	$+\ 1\cdot5442$	δK	=	$+\ 1\cdot5442$ "
z	=	$-\ 1\cdot0524$	δe	=	$-\ \cdot009397$
u	=	$+\ 4\cdot5252$	$\delta\omega$	=	$+\ \cdot040404 = 2^\circ\cdot315.$
v	=	$+\ 4\cdot1387$	δT	=	$+\ \cdot04959$ days.
w	=	$+\ 1\cdot4272$	$\delta K'$	=	$+\ 1\cdot4272$ km.
t	=	$-\ 1\cdot0166$	$\delta T'$	=	$-\ \cdot67344$ days.

Applying the correction we have the elements:—

	Preliminary.	Corrected.
γ =	+ 20·7 km.	+21·511 km.
K =	112·0 km.	113·544 "
e =	0·75	0·7406
ω =	110°	112°·315
T =	1·94 days.	1·9896 days.
K' =	7·0 km.	8·427 km.
T' =	1·94 days.	1·2675 days

An ephemeris was constructed from these elements, and the differences between the computed and observed value of the normal places are given in the column headed V in the observation equations for the second solution, and also in the table of residuals. When the values of x, y, z, &c., are substituted in the foregoing observation equations, we should get values nearly identical with these residuals, whereas, as is shown in the table of residuals, some differences between ephemeris and equation are greater than a kilometre, indicating the necessity for a second solution.

Consequently, taking as preliminary values the corrected values obtained above, and making similar substitutions to those in the first solution, a second set of observation equations was computed and is given here.

OBSERVATION EQUATIONS FOR 2ND SOLUTION.

ι Orionis.

Weight.	x	y	z	u	v	w	t	V
9	1·000	−1·232	−1·674	− ·994	+ ·676	+ ·250	− ·968	+ ·40
6	1·000	−1·216	+1·203	− ·331	− ·368	+ ·377	− ·926	+ 2·46
4	1·000	−1·109	+1·867	− ·124	− ·404	+ ·452	− ·892	− 5·43
5	1·000	− ·863	+2·072	+ ·128	− ·300	+ ·629	− ·778	+ 4·96
3	1·000	− ·706	+1·834	+ ·220	− ·231	+ ·760	− ·650	− 4·23
1	1·000	− ·518	+1·392	+ ·286	− ·156	+ ·920	− ·392	−15·62
5	1·000	− ·472	+1·268	+ ·296	− ·142	+ ·953	− ·304	+ 1·36
4	1·000	− ·323	+ ·846	+ ·314	− ·107	+ ·998	+ ·061	+ 2·80
2	1·000	− ·155	+ ·354	+ ·307	− ·081	+ ·818	+ ·575	− 4·21
1	1·000	− ·066	+ ·090	+ ·291	− ·071	+ ·565	+ ·825	+ 9·28
4	1·000	+ ·006	− ·117	+ ·273	− ·066	+ ·280	+ ·960	− 1·29
2	1·000	+ ·095	− ·371	+ ·241	− ·062	− ·139	+ ·990	− 4·17
4	1·000	+ ·184	− ·614	+ ·200	− .061	− ·548	+ ·837	+ 4·90
3	1·000	+ ·221	− ·710	+ ·180	− ·061	− ·689	+ ·725	− 1·06
4	1·000	+ ·279	− ·857	+ ·143	− ·063	− ·866	+ ·500	− 5·69
2	1·000	+ ·319	− ·953	+ ·114	− .064	− ·945	+ ·326	+ 5·80
1	1·000	+ ·369	−1·063	+ ·075	− ·067	− ·995	+ ·101	− 1·98
3	1·000	+ ·503	−1·292	− ·064	− ·078	− ·894	− ·447	− ·64
1	1·000	+ ·570	−1·338	− ·161	− ·084	− ·754	− ·656	+ ·94
2	1·000	+ ·627	−1·315	− ·267	− ·097	+ ·607	− ·794	+ 5·82
4	1·000	+ ·674	−1·152	− ·390	− ·083	− ·471	− ·882	+ 3·88
2	1·000	+ ·697	− ·984	− ·476	− ·071	− ·391	− ·920	− 8·38
4	1·000	+ ·713	− ·713	− ·582	− ·044	− ·312	− ·950	− 2·41
7	1·000	+ ·680	+ 778	− ·959	+ ·230	− ·120	− ·993	+ ·76
10	1·000	+ ·074	+3·216	−1·620	+2·217	+ ·074	− ·997	− ·20
2	1·000	− ·371	+1·381	−1·681	+2·904	+ ·125	− ·992	− ·60

From these observation equations the following normal equations were obtained:—

$+95·000x$	$-15·032y$	$+38·300z$	$-34·414u$	$+25·704v$	$+5·443w$	$-40·931t$	$+31·630$	=	0
	$+45·732y$	$-25·012z$	$+3·765u$	$-1·041v$	$-24·827w$	$+15·747t$	$-7·419$	=	0
		$+232·748z$	$-40·596u$	$+60·876v$	$+44·942w$	$-46·337t$	$-14·508$	=	0
			$+52·741u$	$-53·002v$	$+1·569w$	$+44·308t$	$-1·803$	=	0
				$+72·903v$	$+0·508w$	$-30·134t$	$-5·179$	=	0
					$+31·198w$	$-8·883t$	$+1·415$	=	0
						$+63·790t$	$-8·364$	=	0

The solution of these equations gives the following values of the unknowns:—

$x = +·0202$	$\delta\gamma = +·0202$	
$y = +·1373$	$\delta K = +·1373$	
$z = +·0996$	$\delta e = +·0008772$	
$u = +·1166$	$\delta\omega = +·01027$	$= +0°.0588$
$v = +·1330$	$\delta T = +·00154$	
$w = -·0461$	$\delta K' = -·0461$	
$t = +·15805$	$\delta T' = +·08697$	

resulting in the final values for the elements given below, where for comparison, those obtained also for the solution without secondary, are given.

ELEMENTS OF ι ORIONIS.

Element.	Simple Solution.		Solution with Secondary.		
	Preliminary.	Final Solution.	Preliminary.	1st Solution.	2nd Solution.
γ	+ 20·7 km.	+ 21·34	+ 20·7	21·511	21·532
K	112·0 km.	109·90	112·0	113·544	113·681
e	0·75	0·7543	0·75	0·7106	0·7415
ω	110°·0	113°·28	110°·0	112°·315	112°·374
T	J. D. 7,587·94	7·993	7·94	7·9896	7·9911
K′	......	......	7·0	8·427	8·381
T′	......	......	7·94	7 2675	7·3545+
a sin i	29,680,000	28,907,000	29,680,000	......	30,560,000

Before discussing these results, it will be convenient for the sake of comparison to collect together the residuals from the various solutions.

TABLE OF RESIDUALS.

Simple Solution.		Solution with Secondary.			Ephemeris—Equation.	
Preliminary.	Final.	Preliminary.	First.	Second.	First Solution.	Second Solution.
+ 0·18	+ 1·54	− 0·57	− 0·40	+ 0·20	− 0·57	+ 0·09
− 4·64	− 4·93	− 6·31	− 2·46	− 1·90	− ·17	+ 0·27
+ 4·20	+ 2·67	+ 1·95	+ 5·43	+ 5·69	− ·10	+ 0·10
− 2·98	+ 6·01	− 6·55	− 4 96	− 4·85	+ ·10	+ 0·03
+ 8·49	+ 5·09	+ 3·88	+ 4·23	+ 4·27	− ·06	− 0 01
+22·53	+19·03	+16·56	+15·62	+15·63	− ·05	0·00
+ 6·13	+ 2·68	− 0·16	− 1·36	− 1·36	− ·11	0·00
+ 5·97	+ 2·78	− 1·00	− 2·80	− 2·80	+ ·03	+ 0·05
+12·31	+ 9·64	+ 6·06	+ 4·21	+ 4·05	+ ·17	− 0·05
− 2·92	− 5·24	− 7·67	− 9·28	− 9·51	+ ·17	− 0·09
+ 5·50	+ 3·55	+ 2·59	+ 1·29	+ 1·00	+ ·27	− 0·12
+ 5·17	+ 3·65	+ 5·13	+ 4·17	+ 3·90	+ ·14	− 0·09
− 7·15	− 8·09	− 4·21	− 4·90	− 5·15	+ ·14	− 0·10
− 2·32	− 3·02	+ 1·72	+ 1·06	+ 0·81	+ ·11	− 0·12
+ ·91	+ ·63	+ 6·40	+ 5·69	+ 5·52	− ·08	− 0·07
−11·13	−11·18	− 4·91	− 5·80	− 5·90	− ·08	− 0·04
− 3·83	− 3·42	+ 2·96	+ 1·98	+ 1·92	− ·03	− 0·03
− 4·51	− 2·89	+ 2·14	+ 0·64	+ 0·75	− ·11	+ 0·02
− 5·20	− 2·68	+ 0·68	+ 0·90	− 0·71	− ·08	+ 0·07
− 9·28	− 6·00	− 4·26	− 5 82	− 5·59	− ·09	+ 0·15
− 6·77	− 2·72	− 2·62	− 3·88	− 3·63	− ·11	+ 0·07
+ 5·68	+10·21	+ 9·32	+ 8·38	+ 8·63	− ·09	+ 0·07
− ·21	+ 4·80	+ 2·92	+ 2·41	+ 2·70	− ·05	+ 0·13
− 4·09	+ 1·54	− 2·25	− 0·76	− 0·64	− ·09	+ 0·09
+ ·12	− 1·23	+ 0·62	+ 0·20	− 0·02	+ ·24	− 0·12
+ 4·87	+ 0·70	+ 4·99	+ 0·60	+ 0·54	+ 1·75	+ 0·07

I may just point out before discussing the residuals, that the changes in the elements introduced by making the second solution are very small, so that considering the type of spectrum this solution was scarcely necessary. However, by comparing the differences between ephemeris and equation in the last two columns of the preceding table, it will be seen that this last solution has rendered these residuals of satisfactory smallness.

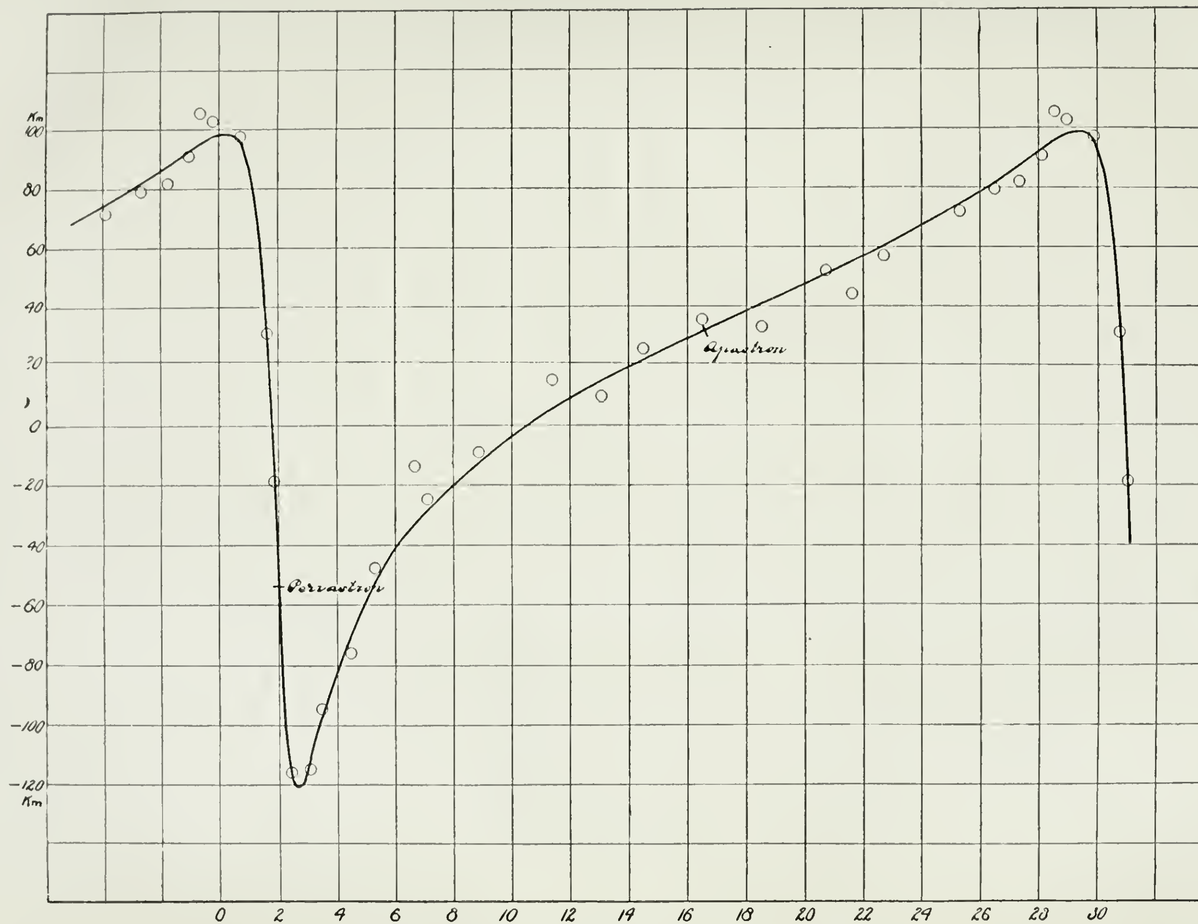

FIG. 2—Velocity Curve of ι Orionis without Secondary.

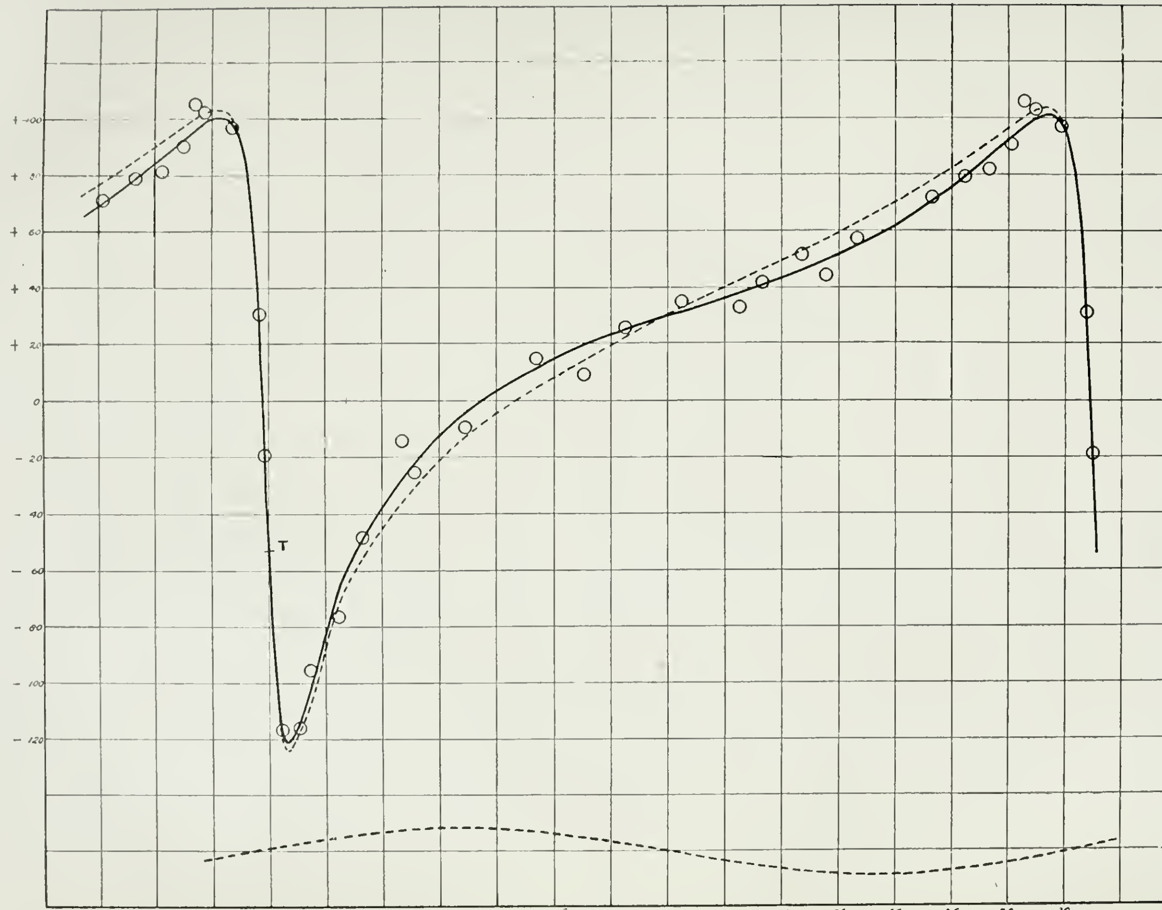

Fig. 3—Velocity Curve of ι Orionis with Secondary.

That the introduction of the secondary effect has produced very considerable improvement in the agreement between the observations and the final curves, is shown very clearly by comparing figures 2 and 3, final velocity curves of ι Orionis without and with secondary. It is perhaps still more clearly shown by comparing the residuals in the first two columns of the preceding table with those in the next three, which show a marked general decrease. The amount of this decrease is indicated by the values of Σpv^2 given in the next table, which show a decrease of 44 per cent in the preliminary and 40 per cent in the corrected values.

—	Without Secondary.		With Secondary.	
	Preliminary.	Corrected.	Preliminary.	Corrected.
Sum of Squares of Residuals	2994	2181	1683	1316
Probable Error Normal place of unit weight..	±8·0	±6·9	±6·3	±5·5
" average normal place.........	3·8	3·3	2·9	2 5
" Single Plate.....	....	7·7	....	6·8

There can hence be no question, especially when considered in connection with the orbit of B.D. – 1°·1004 (Appendix A), of the reality of this secondary effect. The observations are well satisfied by superposing circular motion of the same period and of half amplitude of 8·4 km. upon the primary.

It may be of interest to draw attention here to the remarkable similarity between the two orbits. If the elements are tabulated side by side the points of similarity may be readily observed.

Similarity of Orbits.

Element.		ι Orionis.	B. D.—1° 1004.
Primary.			
Period	U	29·136 days	27·160 days
Eccentricity	e	0·7415	0·765
Half Amplitude	K	113·681 km.	93·04 km.
Longitude of Apse.....	ω	112°·37	87°·02
Time of Periastron	T	J. D. 2,417,587.991	J. D. 2,417 [illegible]6 ·465
Velocity of System	γ	+21·532 km.	+26·12 km.
Semi Axis Major	$a \sin i$	30,560,000 km.	22,380,000 km.
Secondary.			
Half Amplitude......................	K'	8·381 km.	10·15 km.
Time of Crossing	T'	J. D. 2,417,587.3545	J. D. 2,417,960·211
Period....	U'	29·136 days	27·160 days
Semi-Diam. secondary	$a \sin i$	3,358,000 km.	3,791,000 km.

The similarity between these two binary stars in position, in spectral type, and in the elements of their orbits seemed almost too marked to be accidental, although no common cause capable of producing such similarity is known. The orbits of both stars are singular in their high eccentricity, in their high range of velocity, and especially in having a secondary effect of the same period as the primary. In only one spectroscopic binary of those so far determined, β Arietis, has the eccentricity been greater than 0·75, and although, there are several binaries with secondaries of periods submultiples of the primary, none up to the present has secondary periods equal to the primary.

The points of similarity may with advantage be separately referred to.

1. Position in the sky:
  ι Orionis R.A., $5^h 30^m$ Dec.—5° 59′.
  B.D. − 1°·1004 R.A., $5^h 36^m$ Dec.—1° 11′.

Both in the constellation of Orion and within 5° of one another.

2. Spectral type.

Both are Orion or helium stars having diffuse lines of hydrogen and helium, with occasional metallic lines and traces of the second hydrogen series. The measures depend, however, almost entirely upon the hydrogen and helium lines.

3. Periods:
  ι Orionis, 29·136 days.
  B.D. − 1°·1004, 27·160 "

Both are practically one month.

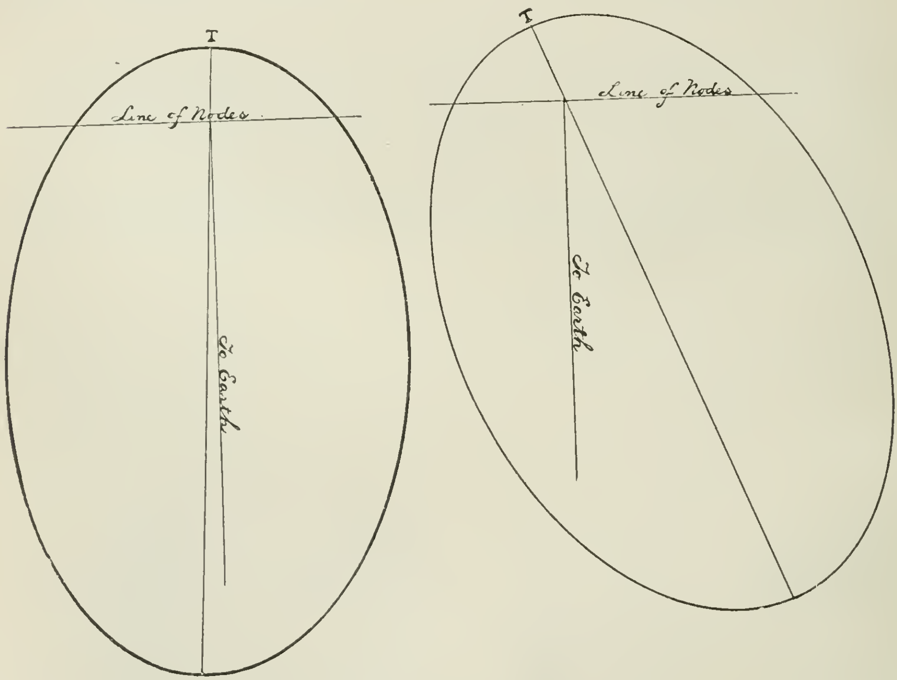

Fig. 4—Orbits of B.D.—1°. 1004 and ι Orionis.

4. Eccentricities:
  ι Orionis, 0·74.
  B.D. − 1°·1004, 0·76.

Both are exceptionally high for spectroscopic binaries.

5. Amplitude of range of velocity:
  ι Orionis, 227 km.
  B.D. − 1°·1004, 186 km.

Both are considerably higher than the average, indicating that the planes of the orbits are probably not far from the line of sight.

6. Longitude of the apses:
ι Orionis, 112°·4.
B.D. – 1°·1004, 87°·0.

In both systems the major axis is nearly parallel to the line of sight. Directions and forms of orbits are shown in Fig. 4.

7. Velocities of the systems:
ι Orionis, + 21·5 km. per second.
B.D. – 1°·1004, + 26·1 "

Both of the same order and practically the same.

The most striking similarity is undoubtedly in the secondary disturbances, which are almost identical in period, amplitude and phase.

8. Periods of the secondaries:
In both, the secondary period is the same as the primary, something hitherto unknown in spectroscopic binaries. Observations in both, apparently well satisfied by assumption of circular motion of secondary superposed on elliptical motion of primary.

9. Amplitudes or range of velocities of secondary:
ι Orionis, 16·8 km.
B.D. – 1°·1004, 20·2 km.

Practically the same, one-thirteenth and one-ninth, respectively, of the amplitudes of the primaries.

10. Times of secondary crossing primaries:
ι Orionis, 0·6 days before primary periastron.
B.D. – 1°·1004, 1·2 " "

For comparison, it may be said approximately that the time of crossing is coincident with the nearest approach of the principal pair.

11. On the assumption of the secondary being due to a revolving satellite the projection of the semi-diameter of the secondary $a \sin i$ is:
ι Orionis, 3,358,000 km.
B.D. – 1°·1004, 3,791,000 km.

It is comparatively easy to point out the similarities in the orbits, but to determine if this is due to a common cause and then to find this cause is quite another question. So far as the secondary effects are concerned, it may be safely inferred from their similarity that they are due to the same physical cause. Owing to the secondary being of the same period as the primary and to the high eccentricity of the latter, the line displacements observed are not likely due to the presence of a third body, for such a system is probably dynamically impossible. On the other hand, the equality of primary and secondary periods would be some justification for connecting the secondary effect with the orbital revolution of the system, but whether due to a resisting medium, to tidal action, or to other causes cannot at present be determined.

Quite recently in a general discussion on spectrographic binaries,* Messrs. Schlesinger and Baker presented an explanation for the observed secondary oscillations in numerous binaries as being due to a blend effect arriving from the presence of the second spectrum.

* Publications Allegheny Observatory, Vol. I, p. 150.

Although, as mentioned in the original discussion, no spectra showing duplicate lines were observed, yet in many spectra, lines were unsymmetrical in character and it is possible that fine grained plates taken at suitable phases might show the presence of a second spectrum. As soon as the star comes in range again, tests will be made to determine whether this is the case, and to what extent the velocity curve would be affected in such an event.

I have the honour to be, sir,

Your obedient servant,

J. S. PLASKETT.

APPENDIX A.

ORBITS OF ϵ HERCULIS, B.D. – 1°·1004, η BOOTIS AND α DRACONIS.

W. E. Harper, M.A.

THE SYSTEM OF ϵ HERCULIS.

In last year's report, I gave the elements of the orbit of this star based on a consideration of twenty-three plates made in 1907 and sixty made in 1908. On a few of these plates there were evidences of the second spectrum, but the data obtained regarding the second component was very meagre indeed.

The plates, that were used in the determination, were those in which the lines appeared as single. The assumption of a secondary disturbance of one-third the period of the main star greatly improved the agreement between theory and observation.

Owing to the diffuseness of the lines, the measured velocities might be in error to the extent of 10 or 15 km. per second, and it was felt desirable to continue observations that a more exact determination of the elements might be effected. Moreover, in consequence of an error afterwards to be explained, the period seemed to be a varying quantity and additional observations would, in such a case, be of great value. During the past season sixty more spectrograms of this star have been added to our number.

The following table gives the measures of all our measurable plates. On re-examination, four of the 1907 set have been rejected owing to their poor quality for measurement.

TABLE I.

Summary of Observations.

Plate No.	Julian Date.	Phase.	Vel.	Wt.	Residual.	Observer.	Remarks.
	1907.						
786	2,417,720·767	3·701	− 55·6	5	− 6	P	
816	737·741	·558	+ 12·7	5	+ 3	P	
827	738·652	1·469	+ 17·8	4	+12	H	
838	739·774	2·591	− 61·7	5	− 3	P	
851	741·738	·531	+ 7·0	6	− 1	P	
862	747·692	2·462	− 34·5	5	+14	H	
871	748·757	3·527	− 65·7	5	− 1	P	
881	752·669	3·415	− 80·4	3	− 6	H	
893	754·688	1·411	+ 4·0	3	− 8	H	
913	761·679	·355	− 21·2	2	−16	H	Poor plate.
920	765·666	·318	− 17·5	7	− 9	P	
928	766·635	1·287	+ 9·0	5	−12	T	
937	767·622	2·274	− 39·0	4	− 3	P	
952	775·673	2·278	− 57·6	4	−20	H	Poor plate.
957	777·693	·275	− 7·0	7	+ 4	P	
976	789·722	·233	− 26·8	5	−12	T	
987	794·732	1·220	+ 6·2	3	−20	T	Long exposure.
1018	810·660	1·054	+ 30·6	3	− 2	H	
1062	839·609	1·838	− 2·9	2	+20	H	Poor plate.

TABLE I.

SUMMARY OF OBSERVATIONS—*Continued.*

Plate No.	Julian Date.	Phase.	Vel.	Wt.	Residual.	Observer.	Remarks.
	1908.						
1391	2,418,010·868	·087	− 28·6	6	− 5	H	
1403	017·904	3·099	−100·9	6	−13	H	H_δ double.
1483	045·900	2·930	− 90·7	3	− 6	H	
1494	047·861	·868	+ 38·5	7	+ 8	P	
1511	054·856	3·839	− 37·0	7	+ 2	P	
1531	077·813	2·655	− 74·0	7	− 9	H	
1540	080·767	1·586	+ 6·1	6	+ 1	P[1]	
1545	082·708	3·527	− 74·0	5	− 9	P	
1547	084·770	1·565	− 28·5	2	−27	H	
1567	094·813	3·561	− 83·1	3	−20	P[1]	
1573	096·747	1·472	− 11·0	6	−18	P	
1582	098·778	3·503	− 65·6	5	+ 1	P[1]	
1603	105·774	2·452	− 46·2	4	+ 1	P[1]	
1625	115·733	·340	− 13·8	5	− 7	P	
1630	117·691	2·298	− 31·0	8	+ 6	P	
1640	119·710	·294	+ 6·1	2	+16	H	
1648	120·715	1·299	+ 24·8	6	+ 5	P	
1653	124·676	1·236	+ 20·0	6	− 5	P	
1658	126·680	3·240	− 99·5	3	−14	H	
1661	126·820	3·380	− 86·1	5	− 9	P[1]	
1666	129·730	2·266	− 27·0	7	+ 9	P[1]	
1675	131·658	·172	− 14·5	6	+ 3	C	
1676	131·688	·202	− 22·2	6	− 5	C	
1682	132·716	1·229	+ 31·2	6	+ 6	H	H_δ and K double.
1685	133·609	2·122	− 27·9	6	+ 1	C	
1686	133·649	2·162	− 36·0	5	− 4	H	
1693	134·707	3·220	−108·0	5	−23	P	Lines defined on violet.
1699	136·679	1·169	+ 26·0	4	− 3	P	
1707	137·737	2·227	− 43·6	8	−10	H	
1712	138·708	3·198	− 81·1	5	+ 5	C	
1713	138·739	3·229	− 65·8	6	+20	H	H_δ double.
1719	139·725	·192	− 13·8	6	+ 3	H	
1720	145·708	2·151	− 23·7	7	+ 8	H	
1723	147·583	·003	− 23·8	9	+ 4	H	
1728	148·722	1·141	+ 23·9	6	− 6	P	
1729	149·707	2·126	− 17·6	8	+12	H	
1734	151·716	·112	− 27·8	5	− 6	H	
1737	152·598	·994	+ 34·3	8	+ 1	P	H_δ and K double.
1738	152·631	1·027	+ 34·7	5	+ 2	P	
1743	152·753	1·149	+ 40·2	4	+10	C	
1746	153·712	2·108	− 22·3	3	+ 8	H	
1751	154·653	3·049	− 82·5	5	+ 5	P[1]	
1757	154·795	3·191	− 94·3	5	− 7	H	
1760	155·701	·074	− 22·1	3	+ 2	P	
1761	159·586	3·958	− 28·6	8	+ 3	P	
1774	161·649	1·998	− 24·0	7	+ 3	P[1]	
1782	169·701	2·003	− 35·0	7	− 8	P	
1793	173·612	1·890	− 47·8	5	−25	H	
1818	178·585	2·840	− 92·4	7	−13	H	
1838	181·660	1·891	− 24·0	7	− 2	C	
1844	182·588	2·819	− 98·9	8	−21	C	
1853	185·578	1·786	− 6·1	5	+11	H	
1866	189·604	1·788	− 20·1	4	− 3	C	
1903	216·550	·570	+ 11·2	4	+ 0	H	
1905	217·516	1·536	+ 21·0	5	+20	P[1]	
1906	217·556	1·576	− 10·0	5	− 8	P[1]	
1917	220·531	·527	+ 18·1	2	+10	P[1]	
1961	259·440	3·225	− 70·3	4	+15	H	
1983	272·422	·113	− 30·9	5	− 9	H	
1993	278·461	2·128	− 30·0	5	+ 1	C	

TABLE I.

SUMMARY OF OBSERVATIONS—*Concluded.*

Plate No.	Julian Date.	Phase.	Vel.	Wt.	Residual.	Observer.	Remarks.
	1909.						
2263	2,418,346·923	2·191	− 43·5	7	−10	H	
2264	346·958	2·226	− 39·3	8	− 5	H	
2305	360·899	·073	− 18·2	7	+ 6	C	
2306	360·942	·116	− 16·4	7	+ 6	C	
2327	369·883	1·010	+ 48·0	3	+15	C	
2328	369·935	1·062	+ 16·0	2	−17	C	
2370	379·788	2·868	− 78·0	3	+12	P	
2371	379·808	2·888	− 54·3	5	+27	P	
2384	381·814	·870	+ 36·4	3	+ 6	H	
2385	381·833	·889	+ 38·4	6	+ 6	H	
2454	397·836	·798	+ 30·0	5	+ 3	C	
2455	397·861	·823	+ 29·8	3	+ 1	C	
2513	420·807	3·652	− 38·0	5	+15	P[1]	
2514	420·833	3·678	− 54·3	6	− 3	P[1]	
2522	423·813	2·634	− 55·8	5	+ 5	H	
2523	423·849	2·670	− 56·3	6	+ 8	H	
2558	465·666	·229	− 11·9	2	− 1	P	
2568	472·771	3·310	− 69·0	4	+12	P[1]	
2573	473·756	·272	− 11·2	3	0	C	
2587	483·666	2·135	− 46·7	6	−16	C	
2597	486·650	1·095	+ 27·3	5	− 5	C	
2619	494·644	1·042	+ 34·2	6	+ 1	C	
2635	496·672	3·070	− 94·1	6	− 6	H	
2636	496·725	3·123	− 79·6	7	+ 8	H	
2638	497·612	4·010	− 41·0	5	−12	C	
2639	497·645	·020	− 29·6	6	− 2	C	
2647	501·666	·018	− 31·5	7·5	− 4	C	
2654	502·591	·943	+ 33·3	5	+ 1	P	
2662	507·619	1·947	− 17·8	7	+ 7	H	
2663	507·663	1·991	− 24·5	7	+ 2	H	
2670	514·611	·892	+ 16·2	3	−16	P[1]	
2671	514·654	·935	+ 29·6	5	− 3	P[1]	
2675	515·618	1·899	− 17·8	7	+ 4	C	
2676	515·648	1·929	− 25·0	8	− 3	C	
2682	516·581	2·862	− 68·3	5	+12	P[1]	
2683	515·612	2·893	− 80·2	5	+ 1	P[1]	
2688	518·658	·915	+ 20·7	5	−11	H	
2689	518·708	·965	+ 21·9	5	−10	H	
2702	521·658	3·915	− 19·0	5	+15	H	
2703	521·676	3·933	− 23·3	4	+ 9	H	
2710	522·706	·940	+ 42·1	5	+ 9	C	
2711	522·735	·969	+ 31·2	4	− 2	C	
2715	523·642	1·876	− 26·1	4	− 4	H	
2730	528·756	2·967	−106·1	3	−20	P[1]	
2745	530·616	·803	+ 30·3	4	+ 3	H	
2746	530·660	·847	+ 44·2	5	+14	H	
2750	537·690	3·853	− 43·8	6	− 5	C	
2751	537·716	3·879	− 33·6	6	+ 2	C	
2758	539·617	1·757	+ 3·5	4	+18	C	
2759	539·651	1·791	− 10·8	5·5	+ 7	C	
2766	545·589	3·705	− 49·0	3·5	0	H	
2767	545·639	3·755	− 35·1	3·5	+16	H	
2771	546·615	·708	+ 28·4	6·5	+ 6	C	
2772	546·644	·737	+ 23·1	6	− 1	C	
2777	553·537	3·606	− 65·6	3	− 8	H	
2778	553·589	3·658	− 63·4	5	− 9	H	
2782	558·536	·558	+ 2·8	6	− 7	P	
2783	558·576	·598	+ 9·8	6	− 4	P	
2792	567·583	1·558	− 1·2	5	0	H	
2793	567·606	1·581	+ 0·7	5	+ 4	H	

EARLY MEASURES.

Julian Date.	Phase.	Vel.	Observatory.	Remarks.
2,416,235·687	3·290	− 58	Yerkes.	
242·718	2·276	− 43	Yerkes.	
259·910	3·374	− 70	Lick.	Mg. line.
262·827	2·268	− 34	Lick.	Mg. line.
272·664	·034	− 22	Yerkes.	
616·680	2·053	− 24*	Lick.	Mg. line not very good.
658·849	3·987	− 31*	Lick.	Mg. line.

* Results of last two plates kindly communicated by Director Campbell.

The phases in the above table are reckoned from Julian Date 2,417,725·113, using the period finally decided upon, 4·0235 days. The residuals are scaled directly from the curve shown. In the column for 'Observer' the following abbreviations are used:—

P = Plaskett; P¹ = Parker; T = Tribble; C = Cannon and H = Harper.

For convenience of reference the early observations are attached.

Using the plates of 1908 and 1909, sixty in each year, the period obtained was 4·0235 days. This period suited the early observations, and in a personal communication to the writer, Dr. Baker of the Allegheny Observatory suggested, that as the difference in the periods obtained amounted in one year to the even day, that possibly there had been a day dropped in the dates of the 1907 plates. On looking the matter up, it was found that the Julian dates of those plates were in each case entered one day more than the correct value, and, consequently, the period of 4·0126 days was in error. Just how the mistake occurred is not known; the writer, however, accepts responsibility and is much indebted to Dr. Baker for his timely suggestion.

Making the necessary changes, all observations were now satisfied by the period 4·0235 days, and this was the value adopted. The plates secured in 1909 failed to show the second component spectrum, which was faintly noticeable on four or five plates of the previous years. This small proportion of plates on which the second spectrum could be at all detected seemed to justify a determination of the orbit, using the measures of the lines of the principal component only. The one hundred and thirty-nine observations were grouped according to phase into fifteen normal places, the weights assigned each group being in general one-tenth of the sum of the weights of the individual plates comprising the group. These are given in the accompanying table.

NORMAL PLACES.

	Mean Phase from final T.	Mean Vel.	Weight.	O-C.	Equation—Ephemeris.
1	·125	−24·33	8·0	− ·31	+ ·09
2	·329	−14·00	3·5	−2·35	+ ·03
3	·647	+14·10	4·0	+ ·73	− ·02
4	·930	+32·34	6·5	+1·29	+ ·03
5	1·142	+30·57	6·0	− ·71	− ·02
6	1·442	+ 8·07	3·5	−3·64	+ ·02
7	1·624	− 0·43	2·5	+3·59	− ·02
8	1·915	−20·29	6·5	+1·68	− ·03
9	2·172	−32·88	8·0	−2·10	− ·03
10	2·504	−47·75	6·0	+1·21	− ·04
11	2·900	−82·17	4·0	− ·35	− ·08
12	3·183	−88·35	6·0	+ ·46	− ·02
13	3·477	−74·83	2·5	−2·27	+ ·12
14	3·678	−55·92	3·5	− ·77	+ ·04
15	3·910	−34·60	4·0	+3·13	+ ·03

The difficulty experienced last year of obtaining a curve representing simple elliptic motion to satisfy the observations was again met, and to obtain the best agreement with the observations a sine curve of one-third the orbital period and half amplitude 8 km. was superposed on the main curve. Using the graphical method of Dr. W. F King, the preliminary values of the elements that suited best were as follows:—

P = 4·0235 days.
e = ·07.
ω = 268°.
K = 52·5 km.
T = J. D. 2417725·113.
γ = −27·27 km.
K' = 8 km.
T' = J. D. 2417725·150.
= time when secondary crosses primary from above.

A least-squares solution of the elements, exclusive of the period, was now in order, and using the differential form of Lehmann-Filhés,* fifteen observation equations were formed connecting the elements with the residuals for each normal place. For the sake of homogeneity the following substitutions were made:—

$x = \delta\gamma$
$y = \delta K$
$z = K\cdot\delta e$
$u = K\cdot\delta\omega$
$v = [1{\cdot}91693]\ \delta T$
$y' = \delta K'$
$v' = [1{\cdot}57378]\ \delta T'$

* A. N., 3242.

OBSERVATION EQUATIONS.

	Weight.	x	y	z	u	v	y'	v'	$-n$
1	8·0	1·000	+ ·119	+ ·287	+1·063	−1·134	− ·232	+ ·973	+1·45=0
2	3·5	1·000	+ ·465	+ ·877	+ ·954	− ·995	− ·928	+ ·372	+3·72
3	4·0	1·000	+ ·858	+ ·879	+ ·580	− ·545	− ·446	− ·895	+ ·08
4	6·5	1·000	+ ·995	+ ·113	+ ·143	− 074	+ ·760	− ·649	−1·30
5	6·0	1·000	+ ·966	− ·515	− ·181	+ ·242	+ ·959	+ ·283	+ ·51
6	3·5	1·000	+ ·766	− ·971	− ·570	+ ·582	− ·122	+ ·993	+3·90
7	2·5	1·000	+ ·578	− ·911	− ·744	+ ·722	− ·827	+ ·562	−3·13
8	6·5	1·000	+ ·214	− ·380	− ·906	+ ·846	− ·720	− ·694	−1·51
9	8·0	1·000	− ·133	+ ·284	− ·921	+ ·860	+ ·390	− ·921	+1·72
10	6·0	1·000	− ·558	+ ·913	− ·761	+ ·740	+ ·927	+ ·375	−1·40
11	4·0	1·000	− ·919	+ ·701	− ·329	+ ·388	− ·621	+ ·784	+1·66
12	6·0	1·000	−1·002	− ·085	+ ·095	− ·025	− ·911	− ·412	+1·18
13	2·5	1·000	− ·877	− ·886	+ ·555	− ·520	+ ·230	− ·973	+3·36
14	3·5	1·000	− ·660	−1·016	+ ·823	− ·837	+ ·922	− ·387	+1·33
15	4·0	1·000	− ·305	− ·568	+1·023	−1·086	+ ·772	+ ·636	−2·52

whence the normal equation:—

$$
\begin{array}{r}
74{\cdot}500\,x + 3{\cdot}969\,y + {\cdot}381\,z - {\cdot}069\,u - {\cdot}273\,v + 4{\cdot}254\,y' - 2{\cdot}341\,v' + 37.615 = 0 \\
34{\cdot}268\,y - 2{\cdot}428\,z + {\cdot}367\,u - {\cdot}135\,v + 5{\cdot}353\,y' - {\cdot}018\,v' - 11\;613 \\
28{\cdot}947\,z + {\cdot}229\,u - {\cdot}384\,v - 4{\cdot}133\,y' + {\cdot}395\,v' + {\cdot}3948 \\
39{\cdot}830\,u - 39{\cdot}863\,v - 1{\cdot}096\,y' + 11{\cdot}535\,v' + 20{\cdot}495 \\
40{\cdot}122\,v + 1{\cdot}252\,y' - 11{\cdot}984\,v' - 20{\cdot}225 \\
37{\cdot}029\,y' - 1{\cdot}659\,v' - 21{\cdot}085 \\
37{\cdot}463\,v' + 8{\cdot}243
\end{array}
$$

resulting in the corrections:—

$$
\begin{aligned}
\delta\gamma &= - {\cdot}57 \text{ km.} \\
\delta K &= + {\cdot}34 \text{ km.} \\
\delta e &= \pm {\cdot}000 \\
\delta\omega &= - 3^{\circ}{\cdot}97 \\
\delta T &= - {\cdot}038 \text{ days.} \\
\delta K' &= + {\cdot}59 \text{ km.} \\
\delta T' &= - {\cdot}003 \text{ days.}
\end{aligned}
$$

The value of Σpvv was reduced from 285·0 to 232·9 and satisfactory agreement was secured between equation and ephemeris residuals. The probable error of an average plate was ± 6·4 km. per second.

The final values of the elements, with their probable errors, are then as follows:—

$$
\begin{aligned}
P &= 4{\cdot}0235 \text{ days.} \\
e &= {\cdot}070 \pm {\cdot}023. \\
\omega &= 264^{\circ}{\cdot}03 \pm 15^{\circ}{\cdot}07. \\
K &= 52{\cdot}84 \text{ km.} \pm 1{\cdot}11 \text{ km.} \\
T &= \text{J. D. } 2{,}417{,}725{\cdot}075 \pm {\cdot}167 \text{ days.} \\
\gamma &= -27{\cdot}84 \text{ km.} \pm 0{\cdot}74 \text{ km.} \\
A &= 52{\cdot}45 \text{ km.} \\
B &= 53{\cdot}22 \text{ km.} \\
a \sin i &= 2{,}916{,}000 \text{ km.} \\
K' &= 8{\cdot}59 \text{ km.} \pm 1{\cdot}08 \text{ km.} \\
T' &= \text{J. D. } 2{,}417{,}725{\cdot}147 \pm {\cdot}030 \text{ days.}
\end{aligned}
$$

The curious form of the curve seems to call for some comment. It was stated last year, that if the change in the period were real it would lend strength to the satellite theory. As the period is now known to be a fixed

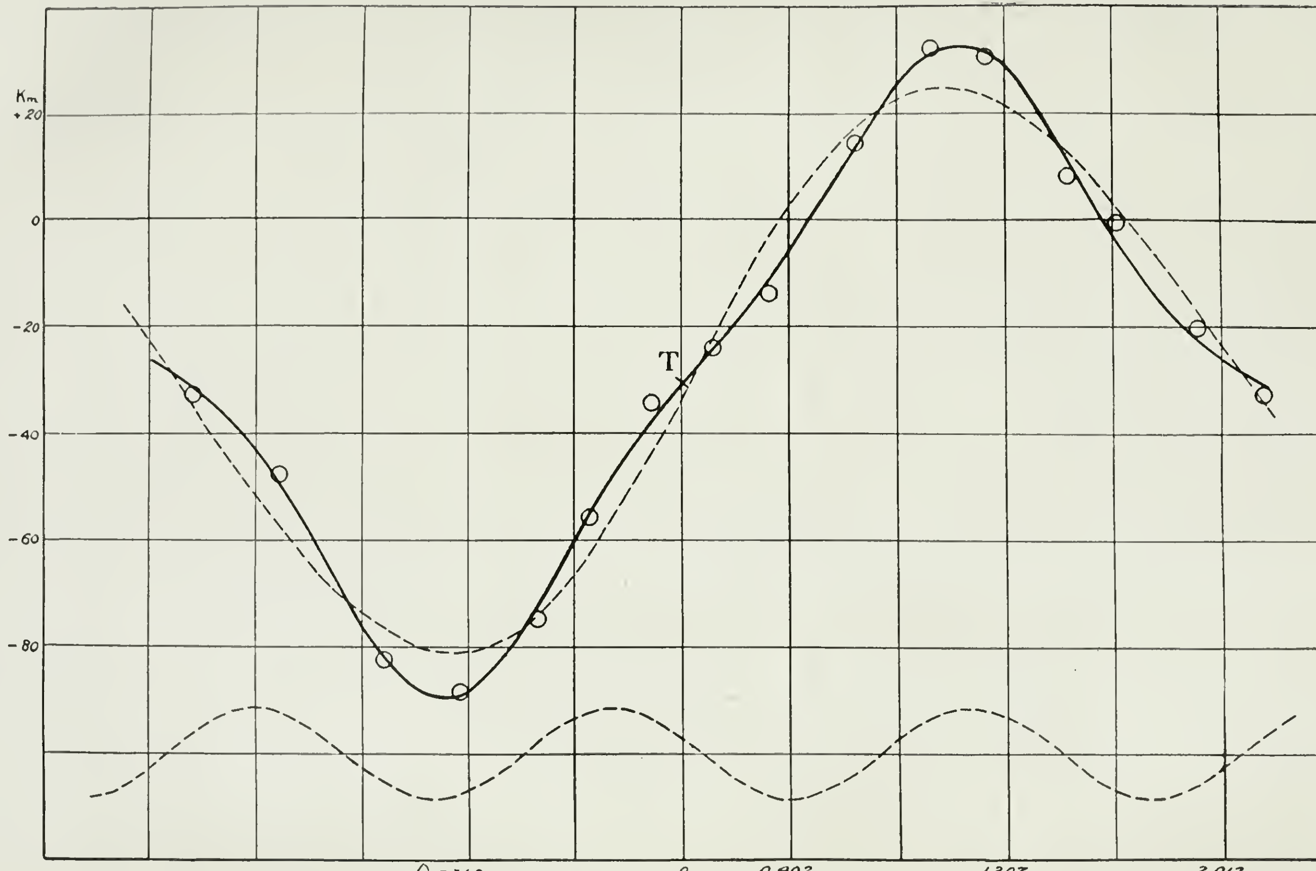

Fig. 5—Velocity Curve of ε Herculis.

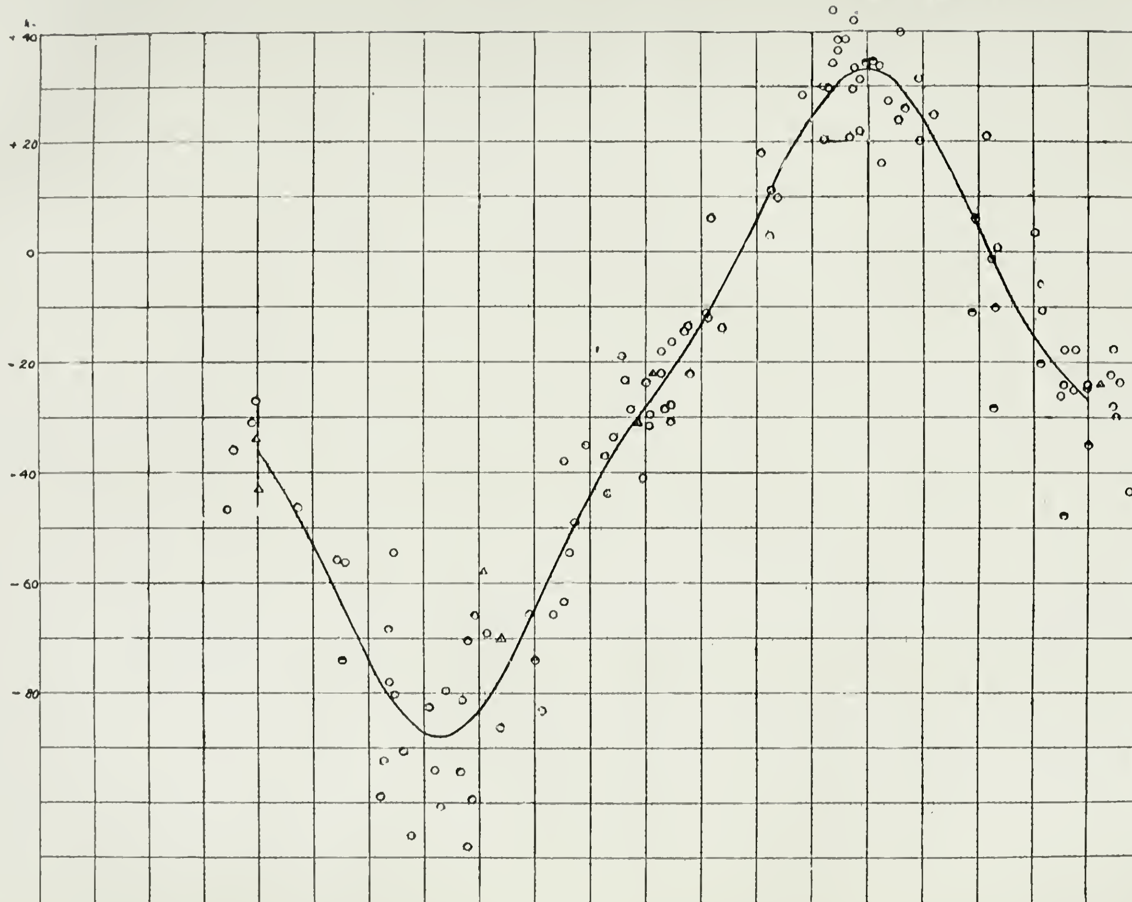

FIG. 6—Velocity Curve of ϵ Herculis showing separate observations.

quantity, the satellite theory loses some of its weight. The fact that the spectrum of the second component is seen in a few cases may have some bearing on the question. It was mentioned in last year's report, that fine grained plates would be used on this star at times of maximum separation of the lines, but this has only been possible in the case of the last ten plates made. They fail to show definitely the second spectrum, though in plate 2771, $H\gamma$ looks to have a violet component. The spectrum of the second component is so very seldom seen and when seen is so faint and uncertain, that one would conclude that its effect on the measures of the bright component would be vanishingly small. In this, of course, our judgment may be wrong, and the second spectrum being always 'mixed up' with the principal one, our measures may unconsciously be vitiated by an amount corresponding to the deviations of the observations from the elliptic curve. It is uncertain, therefore, whether the irregularities in the curve may be ascribed to the action of a satellite, the blending of the spectral lines or to some physical cause in the star itself.

The curve shown, Fig. 5, is drawn from the final elements, the circles representing the observations as grouped. A rough graph of the individual plates of 1908 and 1909 is also shown, Fig. 6, and gives an idea of the degree of dependence that may be placed in single observations of a star of this type.

THE ORBIT OF B.D. – 1°·1004.

This star, α = 5h. 36m., δ = – 1° 11′, photographic magnitude 5·1, was announced as a spectroscopic binary by Professor Frost in the Astrophysical Journal, Vol. XXIII. Four plates had been secured, one in 1905 and three in 1906, and mention was made that the helium line λ 4388 gave a distinctly different displacement to the other lines. Outside of that there was no evidence of the existence of a second component spectrum.

Work was commenced on the star here December 28, 1907, and up to March 31, 1909, thirty-six spectrograms had been secured. The instrument used was the single-prism spectrograph, which at $H\gamma$ has a dispersion of 30·2 tenth-metres per millimetre. The spectrum is of the helium type and the lines are fairly well adapted for measurement. The following table gives the more important lines used:—

LINES IN B.D.—1°.1004.

Element.	Wave-Length.	Element.	Wave-Length.
H	4861·527	H	4340·634
He	4713·308	Fe	4325·939
Fe	4549·642	C	4267 301
Fe	4528·798	He	4143·919
Mg	4481·400	He	4121·016
He	4471·676	H	4101·890
He	4437·718	He	4026·352
He	4388·100	H	3970·177

Of these the lines most commonly used were the hydrogen and helium along with the carbon line λ 4267. The iron lines were only visible when the spectrum was not too dense; a plate having the best exposure for the hydrogen and helium lines was usually too dense to show up the iron lines. The latter, when measured, however, showed no difference in displacement to the others, nor did the helium line, λ 4388, which Frost commented upon. Evidently in our plates the spectrum of one component only appeared.

Early in 1908, the period and general form of the oscillation curve were known. It was seen that there was a rapidly descending branch of the curve, where it would be well to have as many observations as possible, and it was especially watched for at these critical times. Unfavourable weather, however, during the season of 1908-9 prevented any observations being secured at the time of maximum velocity; otherwise the curve is fairly complete.

TABLE I.

Plate No.	Julian Date.	Phase.	No. of Lines.	Weight.	Velocity.	O-C.
1199	2,417,938·785	4·480	6	6	— 10·3	— 0·1
1216	944·705	10·400	6	8	+ 14·5	— 1·1
1234	957·521	23·216	7	8	+ 64·3	—13·7
1260	963·740	2·275	4	6	— 52·6	—12·6
1272	965·560	4·095	10	9	— 5·1	+10·5
1281	968·545	7·080	6	7	+ 15·0	+10·8
1299	970·556	9·091	8	10	+ 11·4	— 0·8
1300	970·591	9·126	10	8	+ 3·2	— 9·2
1313	975·585	14·120	10	7	+ 21·7	— 2·3
1318	980·655	19·190	10	9	+ 41·1	— 2·3
1346	994·654	6·029	4	7	— 0·2	+ 1·2
1351	996·589	7·964	7	8	+ 11·3	+ 3·0
1375	8,005·604	16·979	6	8	+ 28·9	— 4·0
1915	217·912	12·007	6	4	+ 7·5	—12·0
1924	224·876	18·971	5	5	+ 53·8	+11·0
1960	255·859	22·794	4	5	+ 65·2	— 8·0
1967	259·781	26·716	7	4	+119·1	+ 9·0
2017	285·788	25·563	3	5	+112·0	— 5·0
2018	285·835	25·610	4	4	+108·1	—10·0
2026	286·718	26·493	4	4	+139·5	+17·0
2033	292·776	5·391	4	4	— 17·0	—12·0
2050	294·816	7·431	5	3	— 12·0	—18·0
2060	297·806	10·421	9	8	+ 14·9	— 0·7
2091	313·667	26·282	8	8	+125·2	+ 2·0
2096	313·748	26·363	5	6	+118·5	— 4·0
2109	314·582	0·037	8	8	+ 24·4	0 0
2110	314·617	0·072	8	6	+ 31·1	+11·1
2132	320·734	6·189	7	4	— 4·1	— 3·0
2146	322·734	8·189	8	7	+ 7·7	— 1·3
2172	325·751	11·206	5	4	+ 33·7	— 4·0
2192	335·621	21·076	5	5	+ 72·8	+14·0
2210	338·694	24·149	4	5	+ 87·1	— 4·0
2224	341·581	27·036	8	8	+ 60·3	0·0
2225	341·631	27·086	7	7	+ 55·7	+ 5·0
2444	397·549	1·524	4	3	— 39·1	+12·0
2445	397·588	1·563	3	4	— 57·7	— 6·0
2859*	586·837	4·387	5	4	— 43·1	....
3200*	722·527	4·277	7	5	— 18·9	....

* These two plates not used in the determination.

The above table gives the summary of the measures. The phases are referred to the periastron finally adopted, using the period 27·160 days decided upon. The plates were weighted according to the number and quality of lines measured, the maximum weight assigned being 10. The residuals in the last column are scaled from the curve representing the final elements.

In determining the period, much assistance was given by the early observations of Frost. While our own results gave a period slightly over 27 days, the fact that an interval of some thirty or forty periods had elapsed between the Yerkes results and our own, made it possible to determine the period with greater precision. One of the early observations fell at the maximum of the curve, and the period determined by using this observation along with our own maximum was 27·160 days, which cannot be in error much more than 5 in the last place.

Using this period, the phases of the thirty-six observations from an arbitrary epoch were now computed. They were then grouped into fourteen normal places, weights being assigned to each group depending not only upon the sum of the weights of the individual plates but also upon the number of nights involved. Two plates of the same phase, but taken on different nights under different conditions, are given more weight than two equally good plates on the same night. When an attempt was made to obtain preliminary values of the elements by the graphical method of Dr. W. F. King, it was found that no curve derived from simple elliptic motion would suit the observations; there was a secondary disturbance of some nature, whose period was coincident with the period of the star itself. Secondary disturbances in other binaries—one of one-half the period, another of one-third the period—have recently been found in our work here, the assumption of their presence greatly improving the agreement between theory and observation. Hence no simple solution was attempted. A sine curve of small amplitude (6 km.) and of the same period as the star itself was superposed on the curve representing elliptic motion, and much better agreement with the observations resulted. After a great many trials a set of elements was adopted which seemed to be in best agreement with the observations. These are given below as the preliminary elements. One observation on the rapidly descending branch of the curve gave an abnormal residual, which was probably the cause of the large number of least-squares solutions required.

With these elements it was decided to make a least-square solution, using the differential equations* of Lehmann-Filhés.

The terms added for the secondary disturbance were:

$$-\sin\theta.\delta K' + \frac{2\pi}{P'}.K'\cos\theta.\delta T'$$

where K' is the half-amplitude, T' the time where the secondary curve crosses the primary from above, and θ the angle at any time from T'. The plates were, as stated above, combined according to phase into fourteen normal places, and a corresponding number of observation equations were formed connecting the elements γ, K, e, ω, T, K' and T', with the residuals for each mean place.

For the sake of homogeneity, the following transformations were made:

$$x = \delta\gamma$$
$$y = \delta K$$
$$z = K.\delta e \qquad = 110\cdot\delta e$$
$$u = K\cdot\delta\omega \qquad = 110\cdot\delta\omega$$
$$v = \frac{K}{(1-e^2)^{\frac{3}{2}}}\cdot\mu\cdot\delta T \qquad = 174{\cdot}08\ \delta T$$
$$y' = \delta K'$$
$$v' = \frac{2\pi}{P'}.K'\delta T' \qquad = 1{\cdot}3880\ \delta T'$$

*A. N. No. 3242.

OBSERVATION EQUATIONS FOR FIRST SOLUTION.

	Weight.	x	y	z	u	v	y'	v'	$-n$
1	1·5	1·000	·000	·000	−1·850	+3·423	+·453	−·892	+ 1·45 = 0
2	1·5	1·000	−·698	+2·506	− ·134	− ·110	+·779	−·627	+ 3·98
3	2·0	1·000	−·412	+1·659	+ ·061	− ·046	+·997	−·075	− 4·13
4	2·5	1·000	−·278	+1·137	+ ·110	− ·032	+·906	+·424	− 1·59
5	4·0	1·000	−·189	+ ·778	+ ·132	− ·027	+·634	+·773	+ ·45
6	3·0	1·000	−·102	+ ·917	+ ·145	− ·024	+·182	+·983	− ·82
7	1·0	1·000	+·017	− ·072	+ ·150	− ·022	−·550	+·835	+ 2·92
8	1·0	1·000	+·119	+ ·422	+ ·143	− ·024	−·947	+·322	+ 4·54
9	1·5	1·000	+·209	− ·863	+ ·128	− ·028	−·986	−·166	− 2·53
10	2·0	1·000	+·393	−1·587	+ ·069	− ·044	−·581	−·814	− 1·17
11	0·5	1·000	+·517	−2·028	+ ·056	− ·063	−·237	−·972	− 5·72
12	1·0	1·000	+·734	−2·556	− ·171	− ·121	+·093	− ·996	− 3·06
13	2·5	1·000	+·935	−2·027	− ·496	− ·173	+·283	−·959	+ 4·67
14	1·5	1·000	+·686	+4·709	−1·577	+1·904	+·421	−·907	+45·86

The following normal equations resulted:—

25·500x	+1·965y	+ 9·246z	−4·711 u	+ 6·713v	+ 6·363y'	−1·286v'	+ 71·120 = 0
	5·389y	− 9·501z	−2·910 u	+ 1·606v	− 2·588y'	−5·259v'	+ 53·510
		81·560z	−7·880 u	−14·077v	+16·387y'	+8·297v'	+314·632
			9·780 u	−13·805v	− 2·482y'	+7·046v'	−119·354
				23·137v	+ 3·116y'	−6·625v'	+136·840
					10·800y'	+1·169v'	+ 26·344

The solution of these gave the following corrections to the elements as determined graphically:—

$\delta\gamma$ = + 0·25 km.
δK = − 14·67 "
δe = − ·056
$\delta\omega$ = + 5°.92
δT = + ·027 days.
$\delta K'$ = + 4·56 km.
$\delta T'$ = − ·521 days.

The corrected values suited the observations much better than the old, lowering the sum of the squares of the residuals for the normal places from 3329 to 505. The corrections were in some cases large, and another solution was made. Using the new values of the elements, observation equations were again built up and transformed into normal equations using similar substitutions to the preceding.

OBSERVATION EQUATIONS FOR SECOND SOLUTION.

	Weight.	x	y	z	u	v	y'	v'	$-n$
1	1·5	1·000	−·096	+ ·568	−1·790	+3·206	+·556	−·831	−4·31 = 0
2	1·5	1·000	−·847	+2·142	− ·146	− ·198	+·848	−·529	+4·49
3	2·0	1·000	−·415	+1·299	+ ·153	− ·047	+·999	+·045	+6·49
4	2·5	1·000	−·325	+1·022	+ ·180	− ·062	+·848	+·529	+1·79
5	4·0	1·000	−·213	+ ·662	+ ·202	− ·051	+·537	+·844	+3·03
6	3·0	1·000	−·106	+ ·313	+ ·210	− ·045	+·064	+·998	+ ·17
7	1·0	1·000	+·041	− ·169	+ ·203	− ·042	−·647	+·763	+1·67
8	1·0	1·000	+·168	− ·577	+ ·178	− ·045	−·979	+·206	+3·03
9	1·5	1·000	+·272	− ·900	+ ·145	− ·050	−·959	−·283	−3·62
10	2·0	1·000	+ ·482	−1·487	+ ·036	− ·075	−·479	−·878	+ ·24
11	0·5	1·000	+·633	−1·908	− ·090	− ·170	−·119	−·993	−1·79
12	1·0	1·000	+·821	−1·677	− ·361	− ·148	+·211	−·977	−3·62
13	2·5	1·000	+·918	+ ·033	− ·816	+ ·023	+·395	−·919	−7·99
14	1·5	1·000	+·367	+3·373	−1·684	+2·490	+·526	−·850	+8·60

NORMAL EQUATIONS.

$25{\cdot}500\,x$	$+1{\cdot}337\,y$	$+10{\cdot}245\,z$	$-5{\cdot}012\,u$	$+7{\cdot}171\,v$	$+6{\cdot}469\,y'$	$-{\cdot}513\,v'$	$+18{\cdot}515=0$
	$5{\cdot}701\,y$	$-7{\cdot}328\,z$	$-3{\cdot}059\,u$	$+1{\cdot}084\,v$	$-2{\cdot}865\,y'$	$-5{\cdot}298\,v'$	$-32{\cdot}269$
		$43{\cdot}098\,z$	$-8{\cdot}741\,u$	$+14{\cdot}971\,v$	$+15{\cdot}289\,y'$	$+3{\cdot}186\,v'$	$+93{\cdot}146$
			$11{\cdot}419\,u$	$-14{\cdot}985\,v$	$-3{\cdot}271\,y'$	$+8{\cdot}397\,v'$	$+12{\cdot}006$
				$24{\cdot}861\,v$	$+4{\cdot}263\,y'$	$-7{\cdot}120\,v'$	$+8{\cdot}801$
					$10{\cdot}573\,y'$	$+{\cdot}675\,v'$	$+24{\cdot}588$
						$14{\cdot}925\,v'$	$+29{\cdot}330$

The corrections were:—

$\delta\gamma = -\ {\cdot}13$ km.
$\delta K = -\ 5{\cdot}01$ km.
$\delta e = -\ {\cdot}046$
$\delta\omega = -\ 11^\circ{\cdot}79$
$\delta T = -\ {\cdot}081$ days
$\delta K' = -\ {\cdot}41$ km.
$\delta T'' = +\ 1{\cdot}824$ days

The value for Σpvv was reduced from 505 to 318. The correetions to γ and K' being small, these elements were now considered as determined and were omitted in the following solutions. Another solution was found necessary, owing to large differences between the residuals as computed directly and obtained by substitution in the observation equations.

OBSERVATION EQUATIONS FOR THIRD SOLUTION.

	Weight.	y	z	u	v	v'	$-n$
1	1·5	+ ·049	− ·705	−1·774	+3·032	− ·986	+4·95=0
2	1·5	− ·859	+1·199	− ·420	− ·157	− ·830	+4·26
3	2·0	− ·571	+1·457	− ·012	− ·112	− ·368	−6·79
4	2·5	− ·402	+1·110	+ ·104	− ·084	+ ·135	−2·63
5	4·0	− ·283	+ ·812	+ ·159	− ·072	+ ·550	+ ·41
6	3·0	− ·166	+ ·495	+ ·196	− ·065	+ ·884	− ·88
7	1·0	+ ·001	+ ·025	+ ·223	− ·063	+ ·961	+1·74
8	1·0	+ ·149	− ·397	+ ·223	− ·069	+ ·588	+2·49
9	1·5	+ ·275	− ·751	+ ·206	− ·080	+ ·135	−4·70
10	2·0	+ ·539	−1·424	+ ·112	− ·125	− ·604	− ·16
11	0·5	+ ·734	−1·761	− ·020	− ·181	− ·857	+ ·07
12	1·0	+ ·987	−1·463	− ·361	− ·240	− ·978	+2·78
13	2 5	+1·067	+ ·749	− ·909	+ ·186	−1·000	−3·54
1	1·5	+ ·410	+1·475	−1·717	+2·812	− ·991	+6·31

NORMAL EQUATIONS.

$7{\cdot}627\,y$	$-6{\cdot}630\,z$	$-3{\cdot}562\,u$	$+2{\cdot}494\,v$	$-4{\cdot}843\,v'$	$+{\cdot}715 = 0$
	$27{\cdot}013\,z$	$-3{\cdot}407\,u$	$+3{\cdot}175\,v$	$+1{\cdot}432\,v'$	$-16{\cdot}624$
		$12{\cdot}036\,u$	$-15{\cdot}732\,v$	$+9{\cdot}499\,v'$	$-26{\cdot}390$
			$25{\cdot}973\,v$	$-8{\cdot}863\,v'$	$+48{\cdot}255$
				$13{\cdot}684\,v'$	$-10{\cdot}848$

whence the corrections:

$\delta K = +\ 3{\cdot}49$ km
$\delta e = +\ {\cdot}027$
$\delta\omega = +\ 5^\circ{\cdot}00$
$\delta T = +\ {\cdot}018$ days
$\delta T' = -\ 1{\cdot}217$ "

A reduction in Σpvv from 318 to 186 again resulted from the corrected elements. It was felt that this solution would suffice, but a few differences between equation and ephemeris residuals were larger than should be—two of them were approximately 1 km.—and this necessitated a fourth and final solution.

Making similar substitutions as before for the sake of homogeneity, the new observation equations were:—

OBSERVATION EQUATIONS FOR FOURTH SOLUTION

	Weight.	y	z	u	v	v′	−n
1	1·5	− ·077	− ·703	− 1·771	+ 3·123	− ·908	−3·98 = 0
2	1·5	− ·848	+ 1·751	− ·264	− ·180	− ·643	+4·37
3	2·0	− ·528	+ 1·506	+ ·067	− ·098	− ·095	−4·11
4	2·5	− ·360	+ 1·077	+ ·153	− ·071	+ ·405	− ·86
5	4·0	− ·246	+ 1·750	+ ·191	− ·060	+ ·760	+1·02
6	3·0	− ·135	+ ·416	+ ·214	− ·053	+ ·979	−1·30
7	1·0	+ ·021	− ·732	+ ·225	− ·051	+ ·846	+ ·98
8	1·0	+ ·157	− ·477	+ ·214	− ·055	+ ·341	+2·46
9	1·5	+ ·272	− ·817	+ ·191	− ·063	− ·145	−4·08
10	2·0	+ ·508	− 1·461	+ ·093	− ·096	− ·802	+ ·83
11	0·5	+ ·682	− 1·799	− ·032	− ·139	− ·966	+ ·37
12	1·0	+ ·904	− 1·671	− ·324	− ·197	− ·997	+1·29
13	2·5	+ 1·009	+ ·362	− ·842	+ ·076	− ·965	−2·42
14	1·5	+ ·353	+ 2·115	− 1·715	+ 2·821	− ·916	+5·13

NORMAL EQUATIONS.

$6·701y$	$-\ 8·592z$	$-\ 3·071u$	$+\ 1·443v$	$-\ 5·438v'$	$-\ 2·975$	$= 0$
	$43·026z$	$-\ 3·013u$	$+\ 5·155v$	$+\ 7·109v'$	$+18·781$	
		$11·618u$	$-15·755v$	$+\ 8·816v'$	$-\ ·889$	
			$26·762v$	$-\ 8·158v'$	$+\ 2·106$	
				$14·666v'$	$-\ 1·053$	

The solution gave:—

δK = − 0· 77 km.
δe = − ·010
$\delta\omega$ = − 2°·09
δT = − ·016 days.
$\delta T'$ = + ·635 days.

Satisfactory agreement between equation and ephemeris was now reached, and no further solutions were made.

For completeness, the grouping of the plates is given. The phases are based on the periastron finally accepted.

NORMAL PLACES.

Number.	Mean Phase.	Mean Velocity.	Weight.	O—C
1	·052	+ 27·27	1·5	+2·78
2	1·882	− 50·05	1·5	−3·65
3	4·489	− 9·25	2·0	+5·39
4	6·705	+ 2·44	2·5	+1·52
5	8·635	+ 8·60	4·0	− ·98
6	10·809	+ 16·67	3·0	+ ·68
7	14·120	+ 21·70	1·0	−1·59
8	16·979	+ 28·90	1·0	−2·72
9	19·112	+ 45·64	1·5	+4·25
10	22·504	+ 66·91	2·0	− ·37
11	24·149	+ 87·10	0·5	− ·40
12	25·584	+110·40	1·0	−2·02
13	26·421	+125·90	2·5	+2·32
14	27·059	+ 58·15	1·5	−3·62

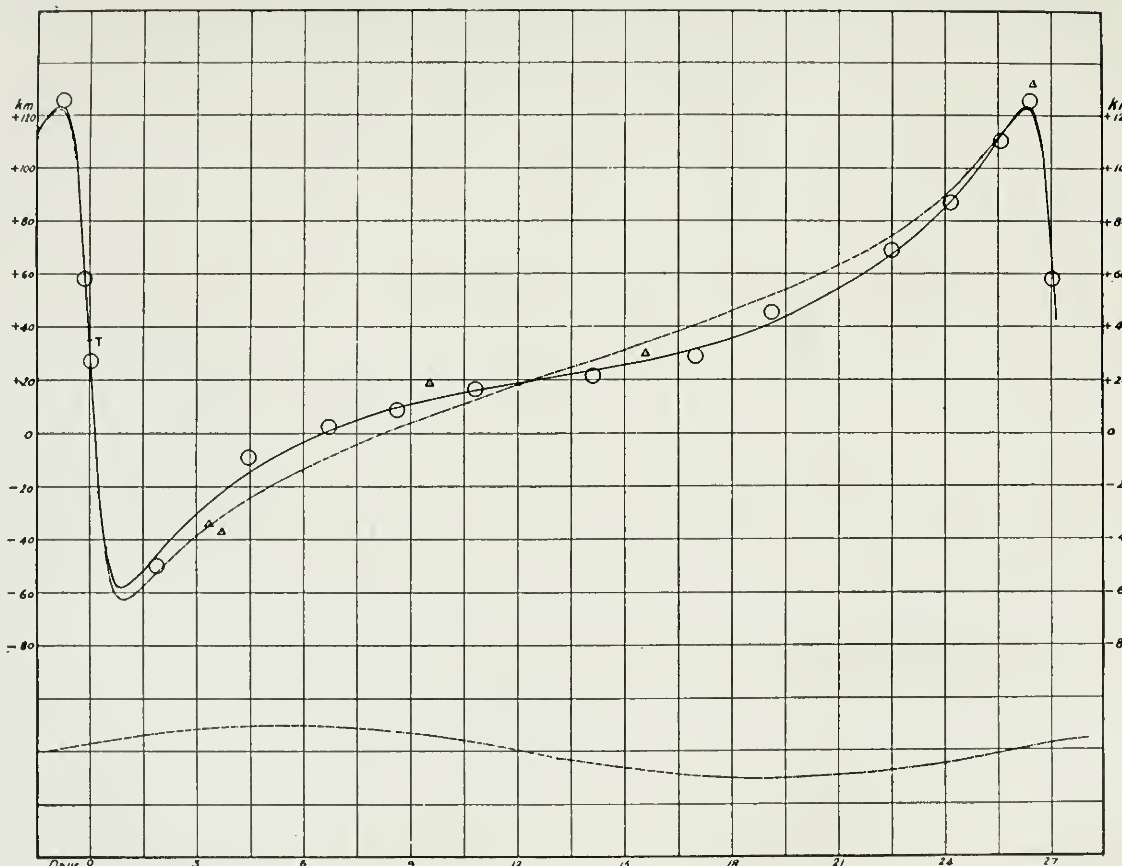

FIG. 7—Velocity Curve of B. D.—1° 1004.

The following table gives the successive approximations to the values of the elements. It will be seen that Σpvv has been reduced from 3329 to 175, the greater precision arrived at justifying the extra labour involved in the least-square solutions.

SUCCESSIVE APPROXIMATIONS TO ELEMENTS.

Elements.	Preliminary.	1st Solution.	2nd Solution.	3rd Solution.	4th Solution.
P	27·160	....	....	....	27·160days.
γ	+26·0km.	+26·25 km.	+26·12 km.	....	+26·12 km.
K	110·0km.	95·33 km.	90·32 km.	93·81 km.	93·04km.
e	·85	·794	·748	·775	·765
ω	90°	95°·92	84°·13	89°·13	87°·02
T	2417961·517	·544	.463	·481	·465
$a \sin i$	....	....	....	....	22,380,000 km.
K'	6 km.	10·56 km.	10·15 km.	....	10·15 km.
T'	2417973·070	972·549	974·373	973·156	973·791
Σpvv	3329	505	318	186	175

The probable error of an average plate as obtained from columns 5 and 7 of Table I is $\pm 5{\cdot}2$ km. per second. With two abnormal residuals around periastron omitted—in one, No. 2026, the exposure was prolonged and temperature in prisms changed—this reduces to $\pm 4{\cdot}6$ km. per second. The diameter of the circles in the curve shown, Fig. 7, represents the probable error, $\pm 5{\cdot}2$.

The curve shown, Fig. 7, is drawn to represent the final elements, though the preliminary elements gave a curve which, to the eye, appeared to suit almost as well. The circles represent our own observations grouped, the triangles individual observations of Yerkes—one of them, unpublished as yet, being communicated through the kindness of Professor Frost.

A graph of the orbit is shown in Fig. 4. More plates of this star will be made during the coming season to determine definitely the maximum velocity of approach. It was hoped that these would have been secured the past season, but unfavourable weather at every such phase seemed to be the rule, and they have not yet been secured. It is expected that they will not change materially the curve as shown.

THE ORBIT OF η BOÖTIS.

A discussion of the orbit of this binary was given in last year's report. The determination of the elements was based on sixty-four plates, thirteen from the Lick Observatory, six from the Bonn Observatory and forty-five of our own. It was suggested therein, that this procedure might be open to question on account of systematic differences in the measures, but as observations, sufficient to complete the orbit, could not be secured for some time owing to the long period of the star, it was decided to use previous measures in connection with our own to obtain what might be considered as approximate values of the elements, until such time as the necessary observations had been secured. These have now been obtained, and the treatment here given is based on twenty-four plates made with the three-prism spectrograph.

The table of measures gives all the data necessary. The phases are based on the period and periastron finally accepted. The weights assigned depend upon the quality of the plate and the various lines measured, the maximum being 10. The residuals are scaled directly from the curve shown, which represents the final elements.

MEASURES OF η BOÖTIS.

Plate Number.	Julian Date.	Phase.	Vel.	Weight.	Residual.
760	2,417,710·75	464·43	− 0·1	4	− 2·4
764	716·68	470·36	+ 2·9	10	− 0·3
990	795·58	52·12	+ 9·0	9	+ 0·2
1294	968·84	225·38	− 3·8	10	0·0
1307	970·88	227·42	− 3·5	10	+ 0·3
1332	989·94	246·48	− 5·2	10	− 0·3
1357	996·80	253·34	− 6·8	5	− 1·5
1446	8,031·91	288·45	− 7·2	7	− 0·6
1513	066·76	323·30	− 6·7	7	+ 0·7
1557	085·67	342·21	− 7·7	7	− 0·2
1553	087·67	344·21	− 7·1	9	+ 0·4
1621	115·59	372·13	− 6·0	10	+ 1·0
1663	129·61	386·15	− 7·5	9	− 1·0
1710	138·61	395·15	− 5·5	7	+ 0·5
1867	192·54	449·08	− 0·3	5	− 0·3
2115	314·97	74·37	+ 8·6	8	+ 0·2
2209	337·78	97·18	+ 5·2	7	− 1·3
2283	335·85	115·26	+ 6·0	9	+ 0·3
2396	386·71	146·12	+ 2·8	8	+ 0·7
2734	529·56	288·95	− 6·5	8	+ 0·1
2776	549·56	308·95	− 7·2	4	0·0
3184	713·78	473·18	+ 5·3	5	+ 1·6
3225	727·70	487·10	+ 6·7	7	+ 0·5
3325	742·82	5·08	+ 8·0	7	− 0·1

The period of 495·3 days previously determined was increased to 497·14 days, as this value gave better agreement between our three-prism plates and the early definite measures. This cannot be much in error.

The observations were grouped into sixteen normal places as shown in the table. The weights assigned each group were in general one-tenth of the sum of the weights of the plates comprising the group.

NORMAL PLACES.

Number.	Phase.	Vel.	Plates in Group.	Weight.	O − C	Equation—Ephemeris.
1	487·10	+ 6·70	1	·7	+ ·76	− ·04
2	5·08	+ 7·90	1	·7	− ·11	− ·03
3	52·12	+ 9·00	1	·9	− ·65	+ ·04
4	74·37	+ 8·60	1	·8	+ ·22	+ ·14
5	107·35	+ 5·65	2	1·6	+ ·13	+ ·06
6	146·12	+ 2·80	1	·8	+ ·74	− ·01
7	226·40	− 3·65	2	2·0	+ ·11	·00
8	248·77	− 5·73	2	1·5	− ·77	− ·17
9	288·72	− 6·88	2	1·5	− ·29	− ·10
10	318·08	− 6·88	2	1·1	+ ·41	+ ·11
11	343·33	− 7·36	2	1·6	+ ·11	+ ·02
12	378·77	− 6·71	2	2·0	+ ·08	+ ·03
13	394·15	− 5·50	1	·7	+ ·47	+ ·03
14	455·90	− 0·21	2	1·0	− 1·07	− ·02
15	470·36	+ 2·90	1	1·0	− ·36	− ·04
16	473·18	+ 5·30	1	·5	+ 1·62	+ ·01

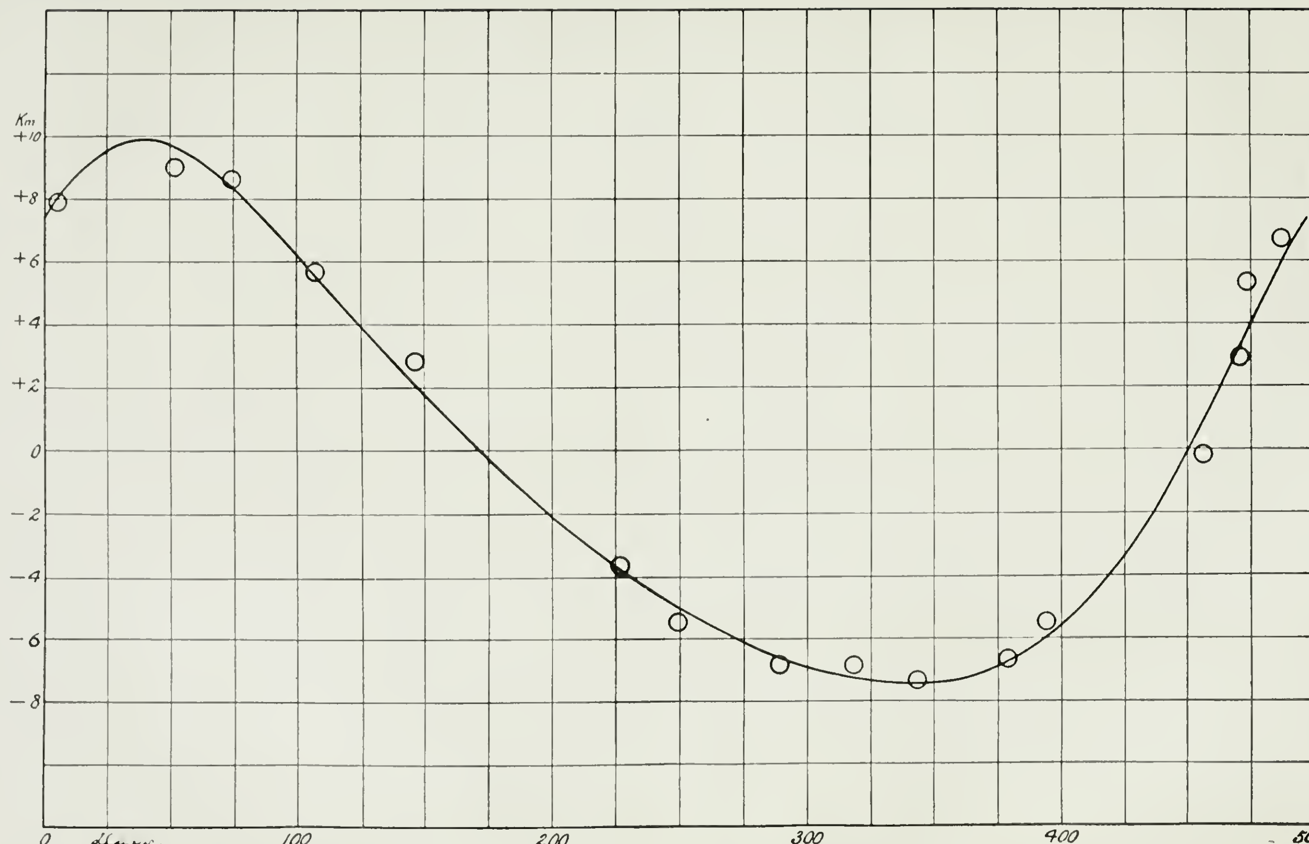

FIG. 8—Velocity Curve of η Boötis. Ottawa Three-prism Observations.

Preliminary values of the elements were determined in the usual way adopted here, and from these were built up sixteen observation equations of the form of Lehmann-Filhés connecting the five unknowns, γ, K, e, ω and T, with the residuals.

For the sake of homogeneity, the following transformations were made:—

$$\begin{aligned} x &= \delta\gamma \\ y &= \delta K \\ z &= K.\delta e \\ u &= K.\delta\omega \\ v &= \frac{K}{(1-e^2)^{\frac{3}{2}}}\cdot\mu\cdot\delta T \end{aligned}$$

OBSERVATION EQUATIONS.

	Weight.	x	y	z	u	v	$-n$
1	·7	1·000	− ·680	+ ·073	+ ·986	−1·226	−1·39=0
2	·7	1·000	− ·909	+ ·675	+ ·797	− ·979	− ·65
3	·9	1·000	+1·151	+ ·503	− ·046	+ ·227	+ 29
4	·8	1·000	+1·035	− ·243	− ·384	+ ·594	− ·29
5	1·6	1·000	+ ·699	− ·953	− ·718	+ ·813	− ·18
6	·8	1·000	+ ·272	− ·883	− ·866	+ ·788	− ·95
7	2·0	1·000	− ·439	+ ·402	− ·668	+ ·506	− ·51
8	1·5	1·000	− ·579	− ·116	− ·539	+ ·417	+ ·39
9	1·5	1·000	− ·758	+ ·980	− ·253	+ ·243	− ·02
10	1·1	1·000	− ·825	+ ·918	− ·004	+ ·089	− ·54
11	1·6	1·000	− ·828	+ 654	+ ·232	− ·074	− ·09
12	2·0	1·000	− ·724	− ·031	+ ·583	− ·377	+ ·14
13	·7	1·000	− ·622	− ·424	+ ·744	− ·553	− ·21
14	1·0	1·000	+ ·138	−1·004	+1·128	−1·261	+ ·93
15	1·0	1·000	+ ·392	− ·604	+1·103	−1·316	− ·03
16	·5	1·000	+ ·445	− ·494	+1·089	−1·314	−1·98

whence the normal equations:

$$\begin{array}{rrrrrr} 18{\cdot}400\,x & -1{\cdot}934\,y & +\ {\cdot}493\,z & +1{\cdot}363\,u & -1{\cdot}327\,v & -3{\cdot}537=0 \\ & 8{\cdot}973\,y & -3{\cdot}795\,z & +\ {\cdot}319\,u & -\ {\cdot}660\,v & -1{\cdot}163 \\ & & 7{\cdot}692\,z & -\ {\cdot}712\,u & +\ {\cdot}944\,v & -\ {\cdot}708 \\ & & & 8{\cdot}329\,u & -8{\cdot}512\,v & -\ {\cdot}061 \\ & & & & 9{\cdot}168\,v & +\ {\cdot}560 \end{array}$$

The solution of these gave the corrections:—

$$\begin{aligned} \delta\gamma &= + \ {\cdot}216 \text{ km.} \\ \delta K &= + \ {\cdot}232 \text{ "} \\ \delta e &= + \ {\cdot}026 \\ \delta\omega &= - \ 7^{\circ}{\cdot}131 \\ \delta T &= - \ 8{\cdot}853 \text{ days.} \end{aligned}$$

The sum of the squares of the residuals for the normal places was lowered from 6·9 to 5·2, and the agreement between equation and ephemeris residuals, as may be noted in the last column of Normal Places, was satisfactory. The probable error of an average plate obtained from the last two columns of the measures is ± 0·50 km. per second. The curve shown, Fig. 8, is drawn to represent the elements in the last column of the accompanying table. For convenience of reference, the elements as determined last year are given also.

ELEMENTS OF ORBIT OF η BOÖTIS.

Elements.	1909.	1910.	
		Graphical.	Final.
P	495·3 days	497·14 days	497·14 days
e	·300	·21	·236 ± ·022
ω	298°·98	322°·33	315°.20 ±4°·84
K	8·23 km.	8·46 km.	8·692 km. ± ·177 km.
γ	− ·60 "	− ·45 "	− ·234 km. ± ·035 "
T	J. D. 2417729·48	J. D. 2418249·45	J. D. 2418240 60 ± 6 0
$a \sin i$	53,474,000 km.		57,735,000 km.

THE ORBIT OF α DRACONIS.

In a previous report* were given the elements of the orbit of this spectroscopic binary, as determined by the methods of Russell, Lehmann-Filhés and others, and based upon observations made in 1906 and 1907. At that time no attempt was made to correct the elements by the method of least-squares, as the observations were not considered of sufficient accuracy to justify such a procedure. Since that time, however, least-squares has been applied to correct the graphically determined elements of stars, the observations of which were not nearly so trustworthy as those of α Draconis, and the much better agreement between theory and observation has amply justified the procedure. Such being the case, it was considered worth while applying the method to the orbit of this star. Moreover, it has developed in recent work that there are spectroscopic binaries whose elements undergo changes. In order to test whether this was the case in α Draconis, plates of this star have recently been secured, and they go to show that in the interval no appreciable changes have taken place either in the period or other elements of the star's orbit.

TABLE I.

MEASURES OF α DRACONIS 1909-10.

Plate No.	Date.	G.M.T.	Phase.	Vel.	No. of lines.	Weight.	O C.
	1909.						
2596	June 28	·616	4·36	+ 8·7	4	9	+ 5·
2605	" 30	·647	6·39	− 3·1	2	5	+10·
2731	Aug. 9	·795	46·53	+29·9	3	7	+ 2·
2740	" 10	·779	47·52	+34·7	5	10	− 1·
2741	" 10	·802	47·54	+36·4	4	9	− 1·
2747	" 12	·648	49·39	+41·3	4	9	− 3·
2748	" 12	·689	49·43	+45·8	4	9	+ 1·
2760	" 20	·681	6·04	+ 1·2	3	8	+11·
2761	" 20	·703	6·06	− 7·1	2	5	+ 3·
2847	Oct. 4	·927	51·29	+47·3	3	6	+ 3·
2851	" 5	·932	1·91	+33·1	3	6	+ 3·
2879	" 8	·938	3·92	+10·1	3	6	− 2·
	1910.						
3115	Jan. 14	·931	50·53	+55·3	4	9	+10·

* Report of the Chief Astronomer, 1907.

The thirteen plates given in Table I were secured on the ascending and descending branches of the curve, as they would in those phases be most valuable in showing any changes in the form of the curve as well as any change in the period itself. As the latter was determined from the coincidence of the early observations of the Yerkes, Lick and Potsdam Observatories with our own of 1906-7, no change was found necessary to satisfy this year's observations. The residuals shown in the last column of Table I, which are scaled directly from the curve, would seem to indicate a slight change in the velocity of the system or else a systematic difference in the two sets of observations. The forty-six observations of 1906-7 were made with the Universal spectroscope of Brashear, as adopted for radial velocity determinations; the recent ones, with the new single-prism spectrograph. In the former case the lines used in the determination of the velocity were λλ 4549, 4481 and 4340. In this year's plates, the lines measured were λλ 4481, 4340, 4131, 4128, 4102 and 3933. Whether the difference in the results is due to the different instruments employed, or is a real quantity, cannot be stated with any degree of certainty. It may be due to a combination of all three causes, but in any case the velocity of the system alone will be affected. The difference in question is a matter of three or four kilometres per second, the recent observations indicating a less velocity of approach of the system than the former.

The period was considered fixed. All the plates were gone over and weighted according to the number and quality of the various lines measured. They were then grouped according to phase into fourteen normal places, weights being assigned each group according to the sum of the weights of the individual plates and the number of nights involved. Preliminary values for the elements were obtained by the graphical method of Dr. King, though these differed slightly from the earlier determinations. These graphical values are given in column 3, Table III. In Table II is given the grouping of the plates.

TABLE II.

Normal Places.

No.	Phase.	Velocity.	Weight.	O–C.	Equation-Ephemeris.
1	4·18	+ 9·26	1·5	+3·42	+0·12
2	5·92	− 8·61	5·	+0·94	+ ·07
3	10·52	−37·60	4·	3·68	− ·06
4	15·65	−43·00	4·	+1·33	− ·05
5	17·76	−44·48	4·	+1·47	+ ·02
6	26·29	−44·30	4·	−0·89	− ·06
7	29·89	−39·25	2·	−0·40	− ·05
8	36·17	−24·33	2·	+0·70	− ·04
9	41·87	− 0·21	1·5	+1·88	+ ·07
10	44·56	+10·62	1·5	−3·63	+ ·04
11	47·21	+33·21	4·	+0·36	+ ·10
12	49·53	+46·20	3·	+1·19	− ·01
13	50·86	+45·30	3·	+0·05	+ ·06
14	1·02	+33·60	1·5	−3·70	−0·05

Using the elements determined graphically, fourteen observation equations of the differential form of Lehmann-Filhés were now built up. For sake of homogeneity, the following substitutions were made:—

$$
\begin{aligned}
x &= \delta\gamma \\
y &= \delta K \\
z &= K.\delta e = 47.\ \delta e \\
u &= K.\delta\omega = 47.\ \delta\omega \\
v &= \frac{K}{(1-e^2)^{\frac{3}{2}}}.\mu.\delta T = 7{\cdot}575\ \delta T
\end{aligned}
$$

Observation Equations.

	Weight.	x	y	z	u	v	$-n$
1	1·5	1·000	+ ·478	−1·446	−1·103	+1·291	−4·40=0
2	5·	1·000	+ ·158	−1·380	−1·077	+ ·989	−1·56
3	4·	1·000	− ·336	− ·271	− ·787	+ ·417	+4·19
4	4·	1·000	− ·551	+ ·609	− ·428	+ ·140	− ·49
5	4·	1·000	− ·587	+ ·808	− ·292	+ ·074	− ·70
6	4·	1·000	− ·556	+ ·937	+ ·200	− ·107	+ ·56
7	2·	1·000	− ·473	+ ·725	+ ·388	− ·180	− ·60
8	2·	1·000	− ·207	− ·021	+ ·691	− ·365	−3·02
9	1·5	1·000	+ ·265	−1·063	+ ·885	− ·705	−4·92
10	1·5	1·000	+ ·623	−1·359	+ ·868	− ·948	+1·04
11	4·	1·000	+1·063	− ·781	+ ·639	−1·047	− ·88
12	3·	1·000	+1·370	+ ·661	+ ·121	− ·422	+ ·57
13	3·	1·000	+1·379	+1·007	− ·290	+ ·365	+1·90
14	1·5	1·000	+1·179	+ ·257	− ·729	+1·178	−4·18

whence the normal equations:—

$$
\begin{array}{rrrrrrl}
41{\cdot}000x & +\ 7{\cdot}625y & -\ {\cdot}696z & -\ 6{\cdot}524u & +\ 2{\cdot}818v & -\ 3{\cdot}060 & = 0 \\
 & 23{\cdot}909y & -\ 5{\cdot}438z & +\ 1{\cdot}834u & -\ 2{\cdot}535v & +\ 6{\cdot}148 & \\
 & & 32{\cdot}967z & +\ 3{\cdot}880u & -\ 3{\cdot}096v & +\ 30{\cdot}621 & \\
 & & & 17{\cdot}623u & +\ 16{\cdot}435v & +\ 13{\cdot}487 & \\
 & & & & 18{\cdot}056v & +\ 8{\cdot}607 &
\end{array}
$$

The solution of these gave the following corrections to the elements:—

$$
\begin{aligned}
\delta\gamma &= +\ 0{\cdot}58\ \text{km.} \\
\delta K &= -\ 0{\cdot}75\ \text{"} \\
\delta e &= -\ {\cdot}026 \\
\delta\omega &= +\ 4^\circ\ 04' \\
\delta T &= +\ 0{\cdot}284\ \text{days.}
\end{aligned}
$$

The fact that the residuals, as computed directly and those obtained by substitution in the observation equations, differed so slightly—the mean difference being ± 0·06 km.—showed that one solution was sufficient. The value of *pvv* was reduced from 213·5 to 146·6, a considerable improvement. The final values with their probable errors are given in the last column of Table III, the probable error of an average plate obtained by scaling from the curve being ± 3·40 km.

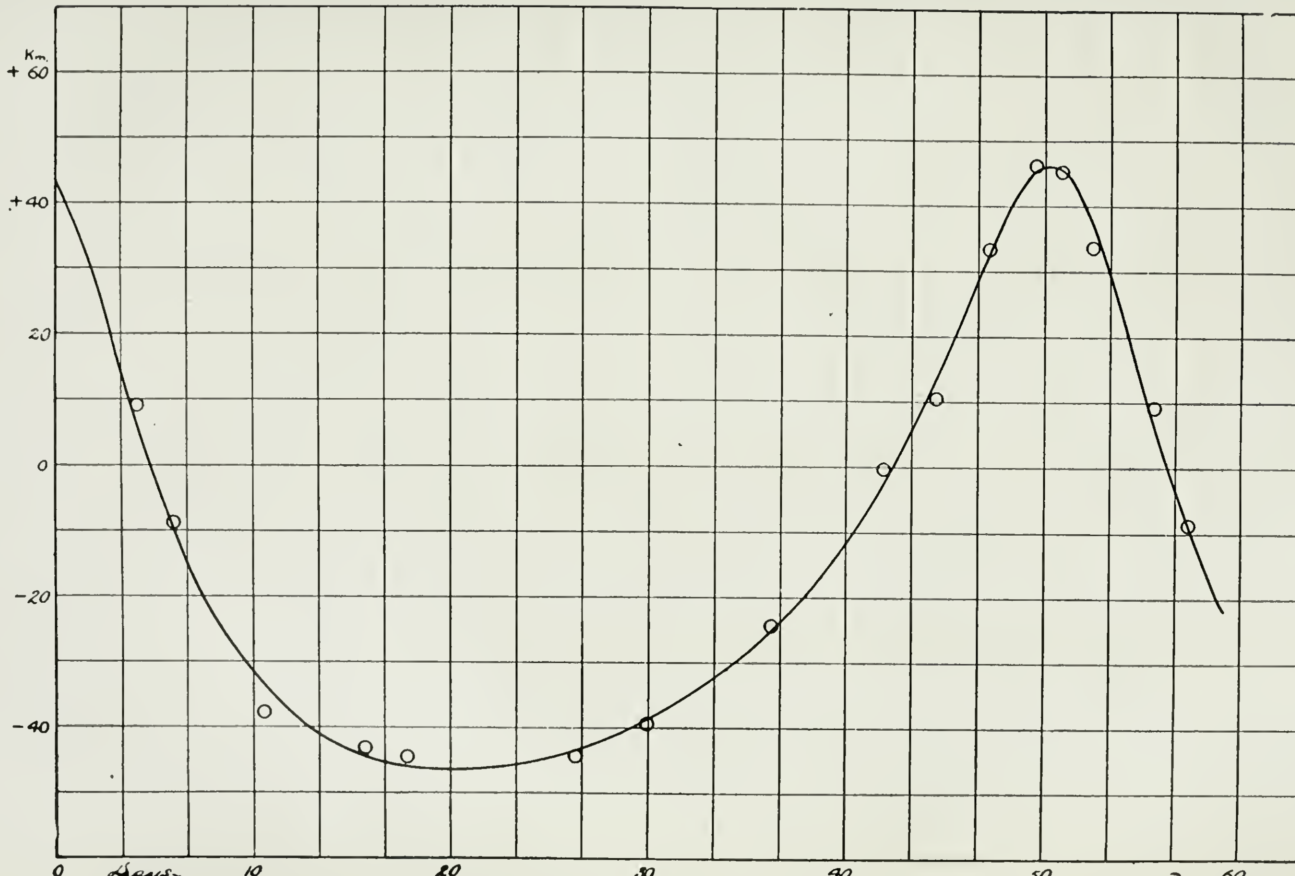

Fig. 9—Final Velocity Curve of α Draconis.

TABLE III.

ELEMENTS OF ORBIT.

Elements.	1906-7.	1909-10.	
		Graphical.	Final.
P	51·38 days.	....	51·38 days.
e	·43	·41	·384 ± ·003
ω	19° 07′	15°	19° 04′ ± 2° 13′
K	47·5 km.	47 km.	46·25 km. ± ·24 km.
T	J. D. 2,417,403	2,417,403	2417403·284 ± ·230
γ	− 16·8 km.	− 17·61 km.	− 17·03 km. ± ·15 km.
A	66·80 km.	65·61 km.	63·03 km.
B	28·20 km.	28·39 km.	29·47 km.
$a \sin i$	29,870,400 km.	....	30,173,000 km.

The curve shown in Fig. 9 is plotted from the final elements. The increased accuracy of the elements and the evidence that no appreciable change has taken place in them in the interval, seem to justify the extra labour expended on this star.

APPENDIX B.

THE ORBIT OF ϕ PERSEI.

J. B. Cannon, M.A.

ϕ Persei ($\alpha = 1^h 37^m$; $\delta = +50° 11'$) was announced a binary by Campbell in 1902,[1] as a result of measures of four plates showing a range of 36 km. per second. The spectrum is in some respects very remarkable, and was grouped by Espin[2] with a large number of others having 'remarkable' spectra, and described by him as having '*F* very bright.' For a description of the spectrum as it appeared on the plates obtained here, nothing better can be done than to refer to an article[3] by Campbell, in which he describes spectra of several stars of this type. Speaking of ϕ Persei he says: '$H\alpha$ is very bright, $H\beta$ fairly bright, $H\gamma$ and $H\delta$ each of two narrow bright lines, faint, about 4 tenth-metres apart, $H\gamma$ brighter than $H\delta$.' On our plates we find $H\beta$ also, consists of two narrow bright lines with a dark, fairly well defined centre, and although $H\alpha$ does not appear on the region photographed, it might be expected from the rapid decrease in intensity of the bright lines and the increase in intensity of the dark lines as we approach the violet end of the spectrum, that $H\alpha$ will consist of only one bright band. H_β gives only a very faint narrow absorption band, whereas $H\delta$ gives, when any, faint emission lines and $H\epsilon$ none at all. The fact of the presence of both bright and dark hydrogen lines in the spectrum places the star in Vogel's class 1*c*, 'although D_3 is not present.'[4] Besides the hydrogen lines, two other lines were found, $He\ \lambda$ 4472 and *K*, the latter of these seeming to appear when the star was on the ascending slope of the velocity curve. Both lines, however, are very faint, and although it is, therefore, impossible to make any positive assertion, the imperfect measurements obtained give velocities corresponding with those of the hydrogen lines.

One hundred and twenty plates of this star were secured altogether between December, 1908, and January, 1910, taken with the single-prism spectrographs, old and new.

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[1] L. O. B. 20.
[2] A. N., No. 2963.
[3] Astrophysical Journal II, 177.
[4] Astrophysical Journal II, 177.

SUMMARY OF MEASURES OF ϕ PERSEI.

Plate Number.	Julian Day.	Velocity.	Weight.	Phase.	Residual. O – C
1996	2,418,278·60	+ 11·7	6	114·68	– 10·0
2012	285·55	+ 36·4	5	121·63	– 0·6
2028	292·55	+ 38·9	8	2·13	– 4·0
2042	294·58	+ 40·4	8	4·16	± 0·0
2053	297·62	+ 36·9	6	7·20	+ 3·6
2088	313·48	+ 2·6	7	23·06	+ 2·6
2136	322·50	– 5·2	7	32·08	– 1·8
2167	325·57	+ 5·7	8	35·15	+ 8·7
2168	325·57	+ 7·4	6	35·15	+ 10·4
2221	341·45	+ 3·8	8	51·03	+ 6·6
2246	346·45	+ 2·1	7	56·03	+ 7·1
2377	381·55	+ 5·3	5	91·13	+ 20·3
2406	388·54	– 17·4	4	98·12	– 10·6
2426	389·56	– 12·6	6	99·14	– 7·0
2505	416·50	+ 32·6	3	126·08	– 3·0
2515	420·88	+ 40·4	4	3·96	± 0·0
2516	420·88	+ 38·1	5	3·96	– 2·3
2531	425·76	+ 41·9	3	8·84	+ 9·5
2534	425·86	+ 42·8	3	8·94	+ 10·4
2556	458·84	– 6·9	6	41·92	– 5·3
2561	465·83	– 3·7	2	48·91	– 1·7
2570	472·83	– 11·8	9	55·91	– 6·8
2603	486·83	– 12·5	4	69·91	– 1·3
2616	492·81	– 38·7	5	75·89	– 21·7
2622	494·77	18·9	4	77·85	– 1·3
2632	495·85	– 22·7	4	78·93	– 4·7
2643	497·81	– 16·9	5	80·89	+ 2·0
2650	501·77	– 16·7	5	84·85	+ 1·9
2651	501·77	– 23·5	5	84·85	– 4·6
2661	502·85	– 13·0	5	85·93	+ 5·6
2664	507·74	– 29·7	7	90·82	– 14·3
2668	508·69	– 12·8	7	91·77	– 1·8
2673	514·78	– 7·8	9	97·86	– 0·6
2678	515·72	– 12·3	8	98·80	– 6·5
2692	518·80	– 14·9	8	101·88	– 13·9
2707	521·80	+ 5·6	7	104·88	+ 1·2
2713	522·80	+ 4·3	8	105·88	– 1·7
2714	522·80	– 1·7	9	105·88	– 4·3
2727	525·82	+ 14·6	7	108·90	– 2·6
2728	525·82	+ 15·6	6	108·90	+ 3·6
2732	528·83	+ 13·5	6	111·91	– 4·0
2733	528·83	+ 17·6	7	111·91	– 0·1
2742	529·83	+ 22·2	7	112·91	+ 3·2
2749	531·73	+ 22·6	8	114·81	± 0·0
2753	537·79	+ 39·8	6	120·87	+ 3·8
2762	539·73	+ 36·4	8	122·81	– 3·0
2764	542·75	+ 50·3	4	125·83	+ 7·3
2769	545·72	+ 45·3	5	2·30	+ 2·3
2785	564·62	– 0·2	3	21·20	– 2·4
2786	564·62	+ 1·1	6	21·20	– 1·1
2787	564·62	– 2·3	5	21·20	– 4·5
2797	567·82	– 12·6	5	24·40	– 11·2
2803	570·73	– 13·2	6	27·31	– 10·2
2804	570·73	– 8·5	8	27·31	– 5·5
2812	571·63	– 2·8	5	28·21	+ 0·2
2813	571·63	– 4·9	7	28·21	– 1·9
2820	574·74	+ 0·2	7	31·32	+ 3·6
2823	577·67	± 0·0	8	34·25	+ 3·4
2824	577·67	+ 5·6	7	34·25	+ 9·0
2827	578·78	– 1·4	6	35·36	+ 1·6
2828	578·78	+ 1·1	5	35·36	+ 4·1
2833	580·62	+ 0·6	7	37·20	+ 3·4
2834	580·62	– 0·2	6	37·20	+ 2·4
2840	584·69	– 0·2	6	41·27	+ 1·2
2841	584·69	+ 7·9	6	41·27	+ 9·3
2853	586·56	– 7·5	5	43·14	– 6·1

SUMMARY OF MEASURES OF ϕ PERSEI. *Con.*

Plate Number.	Julian Day.	Velocity.	Weight.	Phase.	Residual. O − C
2854	2,418,586·56	− 0·5	6	43·14	+ 0·8
2870	588·66	− 4·8	6	45·24	− 3·6
2871	588·66	+ 4·4	6	45·24	+ 5·6
2880	592·78	− 0·6	9	49·36	+ 1·4
2881	592·78	− 3·5	7	49·36	− 1·5
2885	595·79	− 5·3	9	52·37	− 1·9
2886	595·79	− 10·7	8	52·37	− 7·3
2893	599·77	− 6·0	9	56·35	− 1·0
2894	599·77	− 7·8	6	56·35	− 2·8
2903	600·73	− 4·0	7	57·31	+ 1·6
2904	600·73	− 6·1	7	57·31	− 0·5
2911	607·57	− 9·9	5	64·15	+ 0·5
2912	607·57	− 8·5	5	64·15	+ 1·9
2914	608·70	− 13·7	7	65·28	− 2·7
2915	608·70	− 11·1	7	65·28	− 0·1
2925	609·81	− 11·0	7	66·39	+ 0·6
2926	609·81	− 8·3	3	66·39	+ 3·3
2930	615·57	− 7·8	4	72·15	+ 7·2
2931	615·57	− 11·3	5	72·15	+ 3·7
2935	619·66	− 7·6	3	76·24	+ 9·4
2936	619·66	− 18·5	4	76·24	− 1·5
2944	623·66	− 11·8	2	80·24	+ 6·0
2945	623.66	− 18·0	4	80·24	+ 0·4
2952	626·70	− 8·6	5	83·28	+ 10·6
2953	626·70	− 15·4	7	83·28	+ 3·2
2954	626·70	− 17·4	6	83·28	+ 1·2
2962	629·52	− 6·3	7	86·10	+ 11·9
2963	629·52	− 5·5	3	86·10	+ 12·9
2973	637·55	− 9·4	5	94·13	+ 2·7
2974	637·55	− 9·4	7	94·13	+ 2·4
2976	637·55	− 14·0	7	94·13	− 2·2
2989	642·50	− 11·6	9	99·08	− 5·6
2990	642·50	− 12·7	9	99·08	− 6·7
3020	651·60	+ 15·6	10	108·18	+ 5·2
3032	657·61	+ 29·8	5	114·19	+ 8·2
3033	657·61	+ 21·9	5	114·19	− 0·2
3034	657·61	+ 16·2	7	114·19	− 5·4
3051	659·79	+ 24·0	4	116·37	− 1·6
3052	659·79	+ 32·8	4	116·37	+ 7·2
3054	668·50	+ 45·6	6	125·08	+ 3·0
3055	668·50	+ 44·9	6	125·08	+ 2·3
3062	670·56	+ 43·4	7	0·64	− 0·6
3078	672·52	+ 38·3	5	2·60	− 4·0
3079	672·52	+ 33·9	7	2·60	− 8·4
3082	676·50	+ 44·4	7	6·58	+ 12·0
3083	676·50	+ 41·2	6	6·58	+ 8·8
3088	682·51	+ 31·5	4	12·59	+ 11·5
3089	682·51	+ 5·9	4	12·59	− 14·1
3095	684·48	+ 5·8	3	14·56	− 8·6
3096	684·48	− 0·6	3	14·56	− 15·0
3097	684·48	+ 14·8	4	14·56	− 0·4
3109	686·72	+ 11·9	5	16·80	+ 1·9
3110	686·72	+ 10·6	5	16·80	− 0·6
3124	687·76	+ 5·4	5	17·84	− 2·0
3152	700·53	− 2·6	7	30·61	+ 0·8
3153	700·53	− 0·7	7	30·61	+ 2·7

A striking variation in the character of the spectrum was found in the plates as the star arrived at different points in its velocity curve. The absorption bands were used entirely in the work, an attempt to obtain measures on the bright lines either directly or by means of a spectro-comparator having been found useless.

Table I contains the lines used with their wave-lengths, and the elements to which they are due.

TABLE I.

—	Wave-Length.	Element.
H_β	4861·527	Hydrogen.
	4471·676	Helium.
H_γ	4340·634	Hydrogen.
H_δ	4101·890	"
H_ϵ	3970·177	"
K	3933·825	Calcium.

The velocities obtained from the one hundred and twenty plates were plotted, together with the velocities given by Campbell from his plates of the years 1898, 1900 and 1901, and gave a period of 126·5 days, which was assumed to be very nearly correct. The curve so obtained was found to be such as could not be satisfied by simple elliptic motion. On the down slope the curve first dropped below zero, then rose almost to zero, and again dropped to nearly 20 km. before rising again to its maximum. So far the only means employed of arriving at such a curve has been the assumption of a secondary disturbance. This is what was done in this case.

The observations were grouped into sixteen normal places, given below, together with the mean phase from final periastron, the mean weight, and residual from finally accepted elements of primary and secondary.

TABLE II.

NORMAL PLACES.

No.	Mean Vel.	Mean phase.	O − C	Weight.
1	+ 21·8	114·84	+ 0·01	4
2	+ 40·9	123·64	− 0·18	4
3	+ 39·7	2·72	− 2·57	5
4	+ 39·7	8·12	+ 8·53	3
5	+ 8·2	15·63	− 4·89	3
6	− 4·7	25·02	− 4·61	5
7	+ 0·9	33·96	+ 3·67	8
8	− 0·9	43·04	+ 1·12	4
9	− 4·6	53·74	1·30	9
10	− 10·8	65·27	− 0·43	3·5
11	− 17·1	75·68	− 0·89	2·5
12	− 15·0	83·08	+ 3·49	6
13	− 12·6	92·69	+ 0·68	4
14	− 12·3	99·19	− 6·53	5
15	+ 3·7	105·59	− 0·24	2·5
16	+ 16·5	110·29	+ 4·14	4

By means of the graphic method of Dr. King,* the elements of the orbit best suited to the curve were found. At certain regions of the curve the residuals were very large. A secondary circular orbit of one-half the period superposed on the primary decidedly improved matters.

The elements of primary and secondary thus found are:—

Primary.

$e = \cdot 4$
$K = 25$ km.
$\gamma = +2\cdot 603$ km.
$\omega = 340°$
$T = 2{,}418{,}287\cdot 48$.

Secondary.

$K = 6$ km.
$T' = 2{,}418{,}330\cdot 62$.

(*Note.*—T' is the point where the up curve crosses the zero line.)

Still the residuals were far from satisfactory, and it was thought that the application of least-squares might do something towards lowering them. In the first solution all the elements with the exception of the period of the primary were used, and K and T' of the secondary.

OBSERVATION EQUATIONS FOR FIRST SOLUTION.

x	y	z	u	w	x'	y'	$-n$	Wt.
1	+ ·596	− 1·225	+ 1·112	− 1·443	+ 996	− ·090	+ 1·68	4
"	+ 1·319	+ ·949	+ ·469	− ·652	+ ·006	+ ·421	+ 0·12	4
"	+ 1·320	+ ·368	− ·192	+ ·564	+ ·549	+ ·835	− 0·79	5
"	+ 1·028	− ·860	− ·621	+ ·998	+ ·045	+ ·999	− 11·13	3
"	+ ·566	− 1·296	− ·845	+ ·862	·645	+ ·764	+ 4·71	3
"	+ ·132	− ·757	− ·833	+ ·583	− 1·000	− ·010	+ 4·60	5
"	− ·133	− ·121	− ·715	+ ·401	− ·581	− ·814	− 5·13	8
"	− ·345	+ ·395	− ·556	+ ·278	+ ·278	− ·960	− 3·46	4
"	− ·501	+ ·799	− ·345	+ 176	+ ·975	− ·224	+ 0·54	9
"	− ·597	+ ·990	− ·096	+ ·084	+ ·606	+ ·795	+ 2·13	3·5
"	− ·624	+ ·959	+ ·105	+ ·012	− ·183	+ ·983	+ 3·01	2·5
"	− ·601	+ ·713	+ ·351	− ·094	− ·899	+ ·437	− 2·82	6
"	− ·493	+ ·157	+ ·632	− ·272	− ·877	− ·481	− 2·38	4
"	− ·339	− ·432	+ ·836	− ·478	− ·411	− ·912	+ 3·97	5
"	− ·079	− 1·113	+ 1·027	− ·806	+ ·211	− ·977	− 1·79	2·5
"	+ ·211	− 1·454	+ 1·124	− 1·139	+ ·628	− ·778	− 4·78	4

where

$$x = \delta\gamma$$
$$y = \delta K$$
$$z = K\delta e = +25\,\delta e.$$
$$u = K\delta\omega = +25\,\delta\omega.$$
$$w = \frac{K\mu\delta T}{(1-e^2)^{\frac{3}{2}}} = 1\cdot 6129\,\delta T.$$
$$x' = \delta K'$$
$$y' = \frac{2\pi K'\delta T'}{P'} = \cdot 5960\,\delta T'$$

* Astrophysical Journal XXVII, 125, 1908

NORMAL EQUATIONS RESULTING THEREFROM.

+72·500x	+ 2.486 y	− 1·704 z	+ 1·555 u	− 1·480w	+ 2·538 x′	− 5·805 y′	−58·235=0
	+30·318 y	−11·595 z	− ·091 u	+ ·809w	+10·181 x′	+12·339 y′	−20·824
		+48·254 z	− 8·031 u	+ 8·489w	+ 7·672 x′	+11·617 y′	+12·384
			+32·755 u	−28·193w	+ 8·282 x′	− 6·804 y′	+12 080
				+28·678w	−11·695 x′	+10·885 y′	−18·296
					+38·405 x′	+ 2·887 y′	+ 1·671
						+34·077 y′	+30·770

This resulted in the following corrections to the elements:—

$\delta\gamma$ = + ·59 km.
δK = +1 ·47 km.
δe = + ·013.
$\delta\omega$ = +6°·749.
δT = +2 ·757 days.
$\delta K'$ = + ·354 km.
$\delta T'$ = −3 ·875 days.

and a reduction in *pvv* from 1107 to 943. Lack of agreement between ephemeris and observation equation residuals showed the necessity for another solution.

OBSERVATION EQUATIONS FOR SECOND SOLUTION.

x	y	z	u	v	x′	y′	−n	Wt.
1	+ ·466	−1·467	+1·093	−1·252	+ ·957	− ·054	−0·19	4
1	+1·239	+ ·437	+ ·645	−1·054	+ ·682	+ ·731	0·56	4
1	+1·392	+ ·821	− ·049	+ ·276	+ ·195	+ ·981	+1·58	5
1	+1·129	− ·567	− ·592	+1·035	− ·333	+ ·943	−8·73	3
1	+ ·610	−1·374	− ·883	+ ·961	− ·885	+ ·466	+5·52	3
1	+ ·129	− ·850	− ·867	+ ·614	− ·923	− ·385	+5·44	5
1	− ·164	− ·161	− ·730	+ ·398	− ·233	− ·973	−3·51	8
1	− ·357	+ ·385	− ·556	+ ·261	+ ·619	− ·786	−1·43	4
1	− ·501	+ ·798	− ·326	+ ·153	− ·987	+ ·159	+0·81	9
1	− ·582	+ ·991	− ·085	+ ·062	− ·263	− 965	+0·27	3·5
1	− ·598	+ ·968	+ ·107	·005	− ·539	+ ·842	+1·05	2·5
1	− ·568	+ ·754	+ ·338	− ·098	− ·998	+ 068	−3·18	6
1	− ·464	+ ·272	+ ·595	− ·244	− ·631	− ·775	−0·50	4
1	− ·327	− ·244	+ ·779	− ·407	+ ·038	− ·999	+6·59	5
1	− ·106	− ·887	+ ·956	− ·662	+ ·563	− ·827	+0·25	2·5
1	+ ·139	−1·334	+1·059	− ·937	+ ·875	− ·485	−4·08	4

$x = \delta\gamma.$
$y = \delta K.$
$z = K\delta e = 26{\cdot}475\ \delta e.$
$u = K\delta\omega = 26{\cdot}475\ \delta\omega.$

$$v = \frac{K\mu\delta T}{(1-e^2)^{\frac{3}{2}}} = 1.7407\ \delta T.$$

$x' = \delta K'.$

$$y' = \frac{2\pi\ K'\delta T'}{P'.} = {\cdot}6308\ \delta T'.$$

The normal equations from the above observation equations are:

72·500x	+ 2·253 y	+ ·073 z	+ 1·758 u	− 1·798 v	+ 4·915 x′	− 5·794 y′	− 4·295=0
	30·221 y	−10·422 z	+ 0·799 u	− 0·573 v	− 3·267 x′	+15·394 y′	− 8·559
		48·382 z	− 6·065 u	+ 5·755 v	+ 1·298 x′	+15·408 y′	−14·541
			32·079 u	−26·609 v	+11·283 x′	− 2·572 y′	− 2·591
				26·460 v	15·578 x′	+ 4·066 y′	+ 3·318
					35·790 x′	+ 1·873 y′	−15·097
						36·395 y′	−10·465

These gave the corrections:—

$$\begin{aligned}
\delta\gamma &= + .01 \text{ km.} \\
\delta K &= + .43 \text{ km.} \\
\delta e &= + .015 \\
\delta\omega &= + 0^\circ.538 \\
\delta T &= + 0.181 \text{ days.} \\
\delta K' &= + \ .43 \text{ km.} \\
\delta T' &= - \ .168 \text{ days.}
\end{aligned}$$

and a second reduction of *pvv* from 943 to 918. The probable error of a single plate determined from residuals scaled from the curve was computed and found to be ± 4·14 km. per second. The character of the spectrum of this star hardly justifies so large a probable error. However, the agreement between different plates in the same normal place indicates that the fault cannot all be laid to errors in measurement. What the reason may be it is impossible to say, but no doubt the physical condition of so early a class of stars is more or less responsible for what appear to us as irregularities.

The probable errors of the elements of the primary were also determined:—

$$\begin{aligned}
\gamma &\pm \ \cdot 50 \text{ km.} \\
K &\pm 1\cdot 03 \text{ km.} \\
e &\pm \ \cdot 0287 \\
\omega &\pm 4^\circ\cdot 18 \\
T &\pm 1\cdot 32
\end{aligned}$$

TABLE III.

SUMMARY OF CORRECTIONS.

Element.		Graphic.	1st Corrected.	2nd Corrected.
Primary	γ	+ 2·603 km.	+ 3·194 km.	+ 3·204 km.
	K	25·000 km.	26·475 km.	26·905 km.
	e	·400	·413	·428
	ω	340°	346°·75	347·29
	T	2,418,287·48 J. D.	2,418,290·24	2,418,290·42
	P	126·5 days.	126·5 days.	126·5 days.
Secondary				
	K'	6·00 km.	6·35 days.	6·78 km.
	T'	2,418,330·62 J. D.	2,418,326·745	2,418,326·577
	P'	63·25 days.	63·25 days.	63·25 days.
	pvv	1107·	943·	918·
	$a \sin i$			42,298,000·

The velocity curve corresponding to these elements is shown in Fig. 10.

The residuals of the normal places were now scaled from the corrected primary curve, and plotted with a view to obtaining a secondary of elliptic orbit, which might give better results than those from the circular orbit. The curve was treated similarly to the primary, the primary being in the mean time considered correct. Graphically, elements were secured as before and two least-squares corrections made, with the following results:—

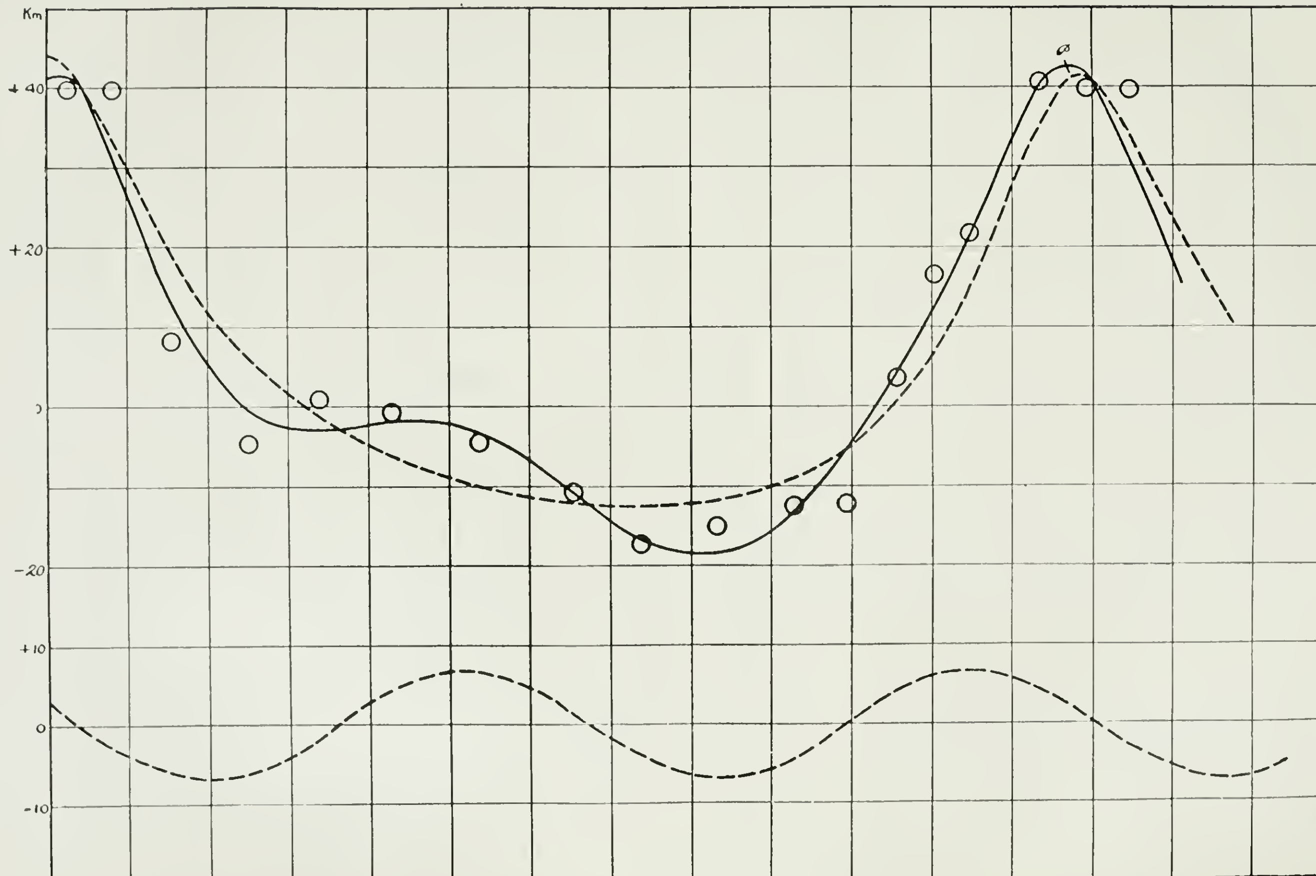


FIG. 10—Velocity Curve of ϕ Persei. Secondary Circular.

Observation Equations for First Solution of Secondary.

x	y	z	u	$-n$	P.
− ·997	− ·155	− ·028	+ ·077	+ 0·99	4
− ·610	− ·950	− ·742	+ 731	+ 0·40	4
− ·148	− ·287	− ·939	+ ·894	+ 2 ·51	5
− ·255	+ ·483	− ·917	+ ·876	− 8·15	3
− ·857	− ·873	− ·464	+ ·488	+ 4·25	3
925	− ·710	− ·429	− ·394	+ 3·78	5
− ·222	− ·445	+ 1·025	· 1·072	− 3·75	8
+ ·694	− 1·020	+ ·770	− ·773	± 0·00	4
+ ·959	− ·543	− ·234	+ ·276	+ 2·10	9
− ·212	− ·402	− ·928	+ ·884	+ 0·41	3·5
− 521	+ ·872	− ·804	+ ·782	− 0·58	2·5
− ·991	− ·266	− ·084	+ ·133	4·45	6
− ·656	− 1·011	+ ·805	− ·813	− 1·61	4
− ·007	− ·014	+ 1·050	− 1·102	+ 6·63	5
− ·638	+ 1·004	+ ·820	− ·830	+ 1·31	2·5
+ ·928	− ·701	+ ·423	− ·387	− 2·89	4

Where $x = \delta K$

$y = K\delta e \quad = 7{\cdot}8\ \delta e$

$z = K\delta\omega \quad = 7{\cdot}8\ \delta\omega$

$$u = \frac{K\mu\ \delta T}{(1-e^2)^{\frac{3}{2}}} = {\cdot}7778\ \delta T$$

From the above the following normal equations follow:—

$$\begin{array}{lllll} 35{\cdot}759\,x & +\ 0{\cdot}299\,y & -\ 2{\cdot}882\,z & +\ 3{\cdot}048\,u & +\ 31{\cdot}110 = 0 \\ & \ 29{\cdot}491\,y & +\ 0{\cdot}089\,z & +\ 0{\cdot}020\,u & -\ 21{\cdot}218 \\ & & \ 37{\cdot}146\,z & -\ 37{\cdot}331\,u & +\ 1{\cdot}881 \\ & & & \ 37{\cdot}625\,u & -\ 1{\cdot}544 \end{array}$$

The solution of these equations gave the following corrections to the elements:—

$\delta K = -\ {\cdot}87$ km.

$\delta e = +\ {\cdot}737$

$\delta\omega = -\ 17^\circ{\cdot}745$

$\delta T = -\ 2{\cdot}938$ days.

Poor agreement between observation equations and computed residuals showed the necessity of a second solution. Observation equations were formed and normal equations from them as before.

Observation Equations for Second Solution of Secondary.

x	y	z	u	$-n$	P.
− ·931	− ·680	− ·084	+ ·190	− 0·34	4
− ·548	·793	− ·668	+ ·599	− 0·57	4
+ ·168	− ·127	− ·839	+ ·716	+ 2·52	5
− ·174	− ·501	− ·853	+ ·748	− 7·37	3
− ·779	− ·912	− ·540	+ ·597	+ 5·54	3
− 1·019	− ·714	− ·363	− ·259	+ 3·94	5
− ·232	− ·045	+ 1·120	− 1·285	− 3·83	8
− ·768	− ·855	− ·722	− ·637	− 0·09	4
− ·874	− ·886	− ·259	+ ·325	+ 0·67	9
− ·219	− ·225	− ·827	− ·706	+ 0·26	3·5
− ·417	+ ·837	− ·790	·732	+ 1 75	2·5
− ·986	− ·380	− ·198	− ·333	− 3·56	6
− ·757	− 1·014	− ·839	− 893	− 1·74	4
− ·031	− ·511	− 1·135	1·283	+ 6·89	5
− ·719	− ·948	− ·784	− ·720	+ 1·31	2·5
− ·936	− ·098	− ·338	− ·193	− 3·65	4

Where
$$x = \delta K$$
$$y = K\delta e = 6 \cdot 93\, \delta e$$
$$z = K\delta\omega = 6 \cdot 93\, \delta\omega$$
$$u = \frac{K\mu\delta T}{(1-e^2)^{\frac{3}{2}}} = \cdot 7107\, T$$

Normal equations from above:—

$$\begin{array}{rrrrrl} 35 \cdot 107\, x & 5 \cdot 462\, y & -\ 2 \cdot 851\, z & +\ 3 \cdot 437\, u & -\ 3 \cdot 008 & = 0 \\ & 30 \cdot 746\, y & +\ 2 \cdot 990\, z & -\ 3 \cdot 202\, u & +\ 8 \cdot 549 & \\ & & 37 \cdot 214\, z & -\ 37 \cdot 968\, u & +\ 2 \cdot 878 & \\ & & & 39 \cdot 624\, u & -\ 3 \cdot 552 & \end{array}$$

The resulting corrections were:—

$$\delta K = + \cdot 03 \text{ km.}$$
$$\delta e = - \cdot 038$$
$$\delta\omega = + 4^\circ \cdot 890$$
$$\delta T = + \cdot 890 \text{ days.}$$

and the final values for elliptic secondary are given in the following table:—

TABLE IV.

Element.		Graphic.	1st Correction.	2nd Correction.
Secondary	K'	7·8 km.	6·93	6·96 m.
	e'	·05	0·145	0·107
	ω'	270°·00	252·255	257·145
	T'	2,418,326·42	2,418,323·48	2,418,324·37
	pvv	913	878	875

The velocity curve corresponding to these elements is shown in Fig. 11, and as will be observed is not greatly different from Fig. 10.

The total reduction of *pvv* by considering secondary elliptic is 43. Although this reduction is small and the elements only slightly varied from the circular, yet it seems to indicate a slight advantage over the circular.

There are many difficulties which present themselves in connection with this star, and their explanation seems as yet to be far distant. The first question is, what physical state will produce a spectrum such as this? Although Campbell, in his article already referred to, has spoken of the hydrogen lines γ and δ as being two slightly separated bright lines, the evidence of only some of our spectra can agree with this description. The strong contrast between the central band and the continuous spectrum at certain regions of the curve leaves no doubt whatever of the fact, that that separating band is due to absorption. As stated before, the absorption increases while the emission decreases as we go towards the violet. Perhaps the best suggestion offered as an explanation of this, is given by Professor Frost—quoted by Campbell.* He says: 'Measurements with the spectral photometer have shown that the *general* absorption of the sun's atmosphere is about 1·7 times as great for the violet as for the red rays; the case is doubtless similar for many of the stars, particularly for those having extensive atmospheres; if the same conditions applied to the *selective* as to the *general* absorption, at least a part of the contrast between bright $H\alpha$ and dark $H\gamma$ would be accounted for.'

* Astrophysical Journal, II, 177.

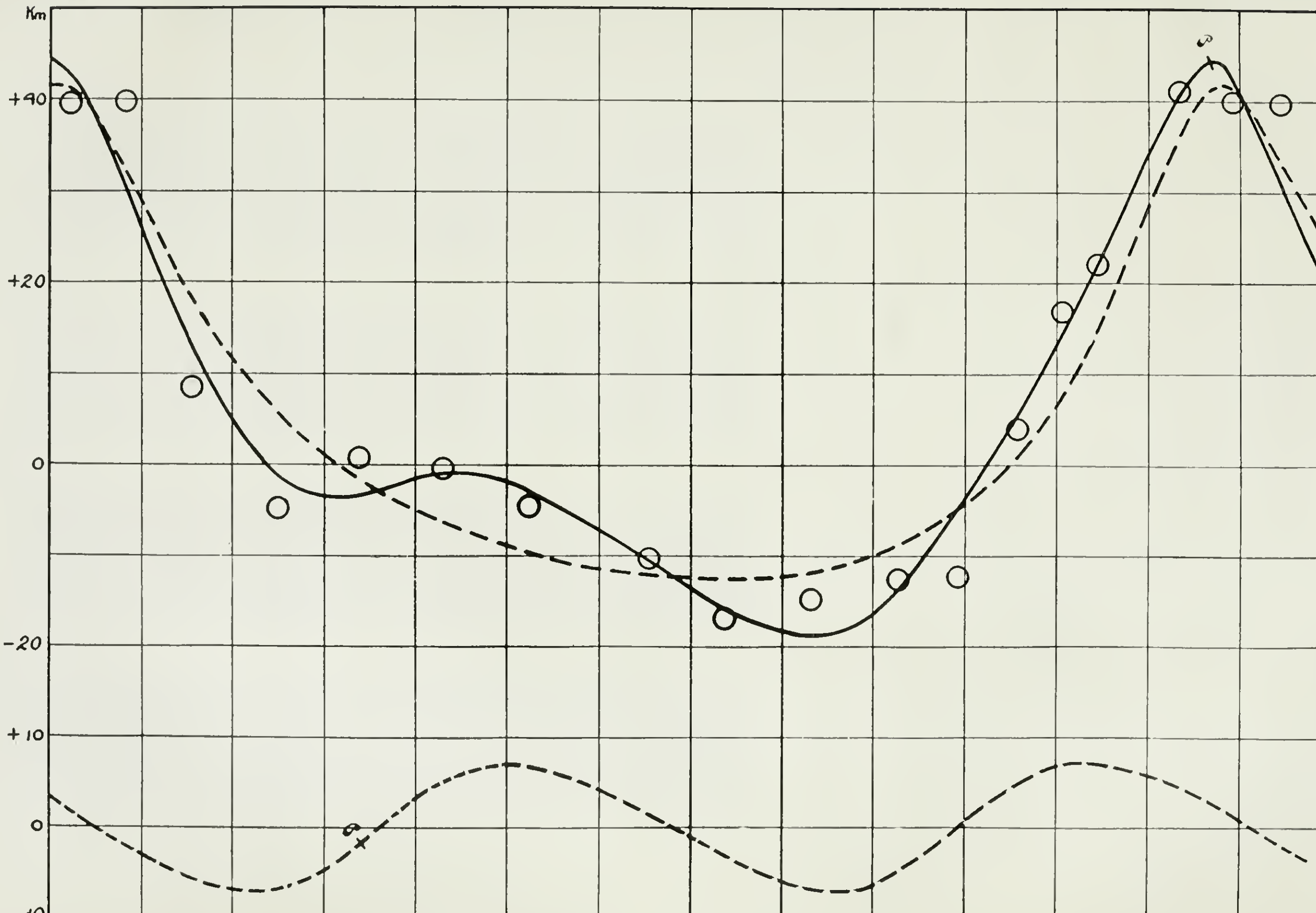
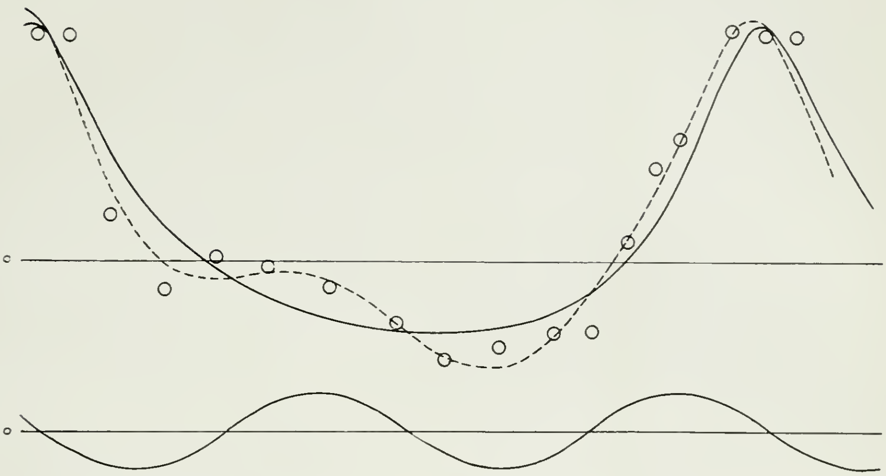


Fig. 11.—Velocity Curve of ϕ Persei—Secondary Elliptical.



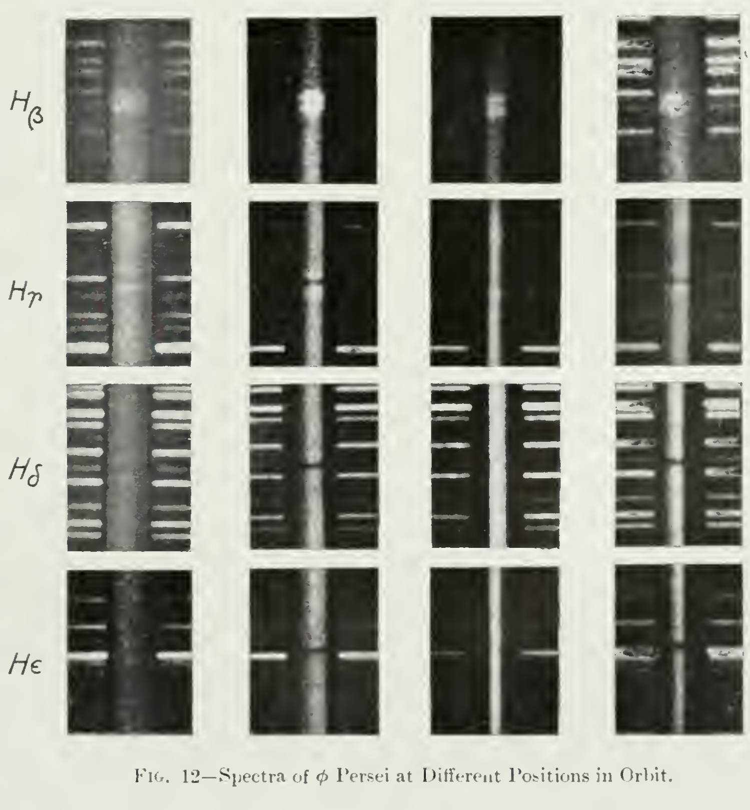


Fig. 12—Spectra of ϕ Persei at Different Positions in Orbit.

The variation of the character of the spectrum with the star's position in the orbit was referred to early in this report, but not gone into in any detail. There seems to be a strange coincidence in the fact, that at the crest of the secondary curve, Fig. 12, the spectrum shows strong absorption, while at the trough it shows very weak absorption and, if anything, slightly increased emission. Now, if a satellite about the light-giving star be responsible for this secondary disturbance—this is a mere possibility—the secondary as shown in the curve represents the effect on the primary, and the real course of the satellite's curve will be exactly opposite to that represented by the curve as shown in Figs. 10 and 11. That is to say, when the satellite is hastening from us at its greatest speed—the trough of the curve—we have very weak absorption, and when coming towards us—the crest—we have strong absorption.

Now it will be seen in Figs. 10 and 11 of the curve, that the crest of the secondary, indicating greatest velocity towards us, precedes the crest of the primary, indicating greatest velocity away from us, by about 14 days. Repre-

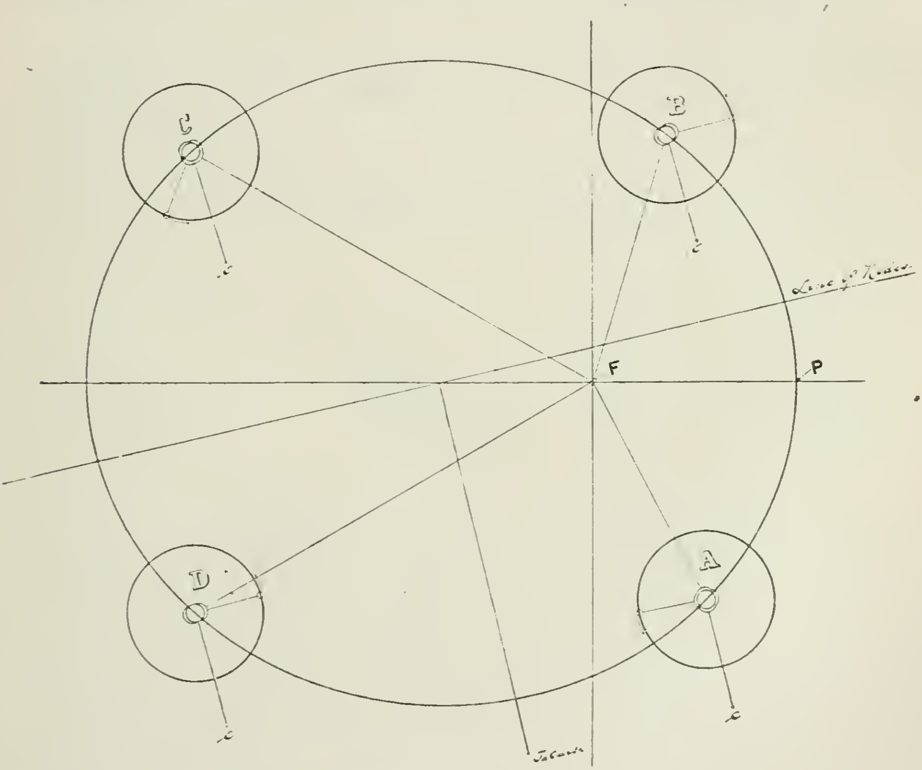


FIG. 13—Diagram showing Tidal action on ϕ Persei.

senting this fact in a figure of an ellipse with a satellite revolving about the light-giving body, as shown in Fig. 13, position A, we shall have the central dark body F and the satellite almost at right angles to the light-giving body. The spectrum of the star indicates a layer of hot, dense hydrogen, producing broad bright emission bands, and outside this a comparatively rare, cool envelope of the same element, giving the narrow bands of hydrogen absorption. Judging by the width of the bands of emission and absorption, the envelope producing the former must be many times as dense as that producing the latter. Now if the tidal action be very prominent in these early stars, and it seems very probable, we may conclude that the effect will be evident almost entirely, comparatively speaking, on the outer absorbing envelope. Returning to position *A*, Fig. 13, applying terrestrial tidal phenomena, we shall have in this position a tide on all sides of the star and a fairly heavy layer of absorbing atmosphere interposed between the emission stratum and the earth. Hence at this position we should have strong absorption.

Let us pass over positions *B* and *C* which, although they will serve our purpose, are not quite so good as *D*. At *D* we have the satellite receding at its highest speed—the trough of the curve—and the satellite and central body *F* acting almost in line. The tide in this case will result in the absorption stratum being much rarified between the star and the earth; hence very weak absorption.

The above is only a suggestion of a possible condition, which might give some such variation as we find in the character of the spectrum of the star. Some other theory may some time be put forth which will be more satisfactory.

It is proposed at some later date—perhaps four or five years hence—to resume the observation of this star and make another determination of its orbit, and especially to note what changes, if any, have occurred in the secondary disturbance. It will be of interest to see if the spectrum then shows the same variation in its character as has been noted in this discussion.

APPENDIX C.

THE ORBIT OF τ TAURI.

T. H. PARKER, M.A.

The star τ Tauri ($\alpha = 4^h\ 36^m.2$, $\delta = +\ 22°\ 36'$), was discovered to be of variable velocity by Frost and Adams in 1903.* The measures of the three plates taken at Yerkes in February and March of that year gave a range in velocity of 75 km. per second. The star has been under observation at Ottawa since November, 1907, and in all one hundred and four spectrograms have been obtained and measured. Of these, three were made in 1907, thirty-two in 1908 and sixty-nine in 1909. τ Tauri is an Orion star of type I*b* according to Vogel's classification, or IV*b* according to Miss Maury's.† In all twelve lines have been measured on the plates. These are given in the table below, and are arranged in order of frequency of measurement.

TABLE I.

LINES IN SPECTRUM OF τ TAURI.

Element.	Wave-Length.	Element.	Wave-Length.
Hγ	4340·634	Mg	4481·400
He	4471·676	He	4143·928
Hδ	4101·890	Hϵ	3970·177
He	4026·352	Ca	3933·825
Hβ	4861·527	C	4267·301
He	4388·100	He	4713·308

The lines, especially those of hydrogen, are broad and diffuse and are difficult of exact measurement. In two plates taken on the same night, the resulting radial velocities very often differ by fifteen or twenty kilometres per second. Also in the measurement of a single plate, different lines give widely different velocities, thirty kilometres per second being a common range. These differences are not systematic, and do not occur always in the measures of the same lines. They are probably due, therefore, to error in setting on account of diffuseness in the lines themselves. In many instances plates were remeasured or 'checked' by different observers, and the mean of the measurements, which were usually in good agreement, used. The chief difficulty, therefore, in the discussion of this orbit was that of determining the radial velocities given by the single plates. This made it necessary to obtain in the first place a large number of plates, and in the second place, two or more plates on the same night.

Sixty of the plates, used in the determination of the orbit, were made with the original single-prism spectrograph (I L), linear dispersion 30·2 tenth-metres

* Astrophysical Journal, Vol. XVII, p. 246.
† Annals Harvard College Observatory, Vol. 28.

per mm. at $H\gamma$, and the remainder from March to December, 1909, with the new single-prism instrument, linear dispersion at $H\gamma$, 33·4 tenth-metres per mm. The principal lines used were $H\gamma$ and the helium line λ 4471, which were measured in one hundred, and one hundred and one plates respectively. The helium line λ 4026, H_δ and H_β were also strong lines. The magnesium line λ 4481 was present in many plates, but was very broad and faint. K (λ 3933) and λ 4267 (carbon) were measured in eleven and in three plates respectively. All the lines were weighted according to quality, and also the plate itself with respect to the quality of its spectrum and agreement among the lines.

The period of the bright star about the centre of gravity of the system was finally determined, by plotting the observations, to be 1·5047 days. Although the plates, as has been already referred to, were difficult of accurate measurement, the time during which τ Tauri was under observation extended over five hundred cycles, and the above period was taken to be nearly exact. The following table gives a summary of the single observations, made on sixty-eight nights:—

TABLE II.

SUMMARY OF OBSERVATIONS.

Plate.	Julian Day.	T-T_0.	Periods from T_0.	Phase P=1·5047 days.	Vel.	Wt. Max. 10.	Residuals.
	1907.						
1153	2,417,898·677	7·677	5	·154	+46	2	+16
1180	914·758	23·759	16	1·189	−28	3	+ 1
1181	914·790	33·790	16	1·221	−21	4	− 9
	1908.						
1225	2,417,955·497	64·497	42	1·299	−13	4	+17
1226	955·524	64·524	42	1·326	0	4	+29
1232	957·466	66·466	44	·260	+63	7	+16
1256	963·618	72·618	48	·393	+48	5	− 9
1270	965·510	74·510	49	·780	−12	5	−37
1297	970·501	79·501	52	1·257	−19	6	+ 11
1298	970·524	79·524	52	1·280	−54	4	−24
1310	975·509	84·509	56	·246	+49	4	+ 4
1311	975·531	84·531	56	·268	+63	5	+15
1323	989·598	98·598	65	·793	+36	6	+12
1324	989·624	98·624	65	·819	+26	3	+ 5
1345	994·521	103·521	68	1·201	−36	3	− 6
1350	996·559	105·559	70	·230	+35	4	− 7
1374	2,418,005·568	114·568	76	·212	+11	6	−29
1383	010·535	119·535	79	·665	+36	4	− 5
1394	012·546	121·546	80	1·170	−48	2	−20
1889	199·825	308·825	205	·362	+58	3	+ 2
1913	217·834	326·834	217	·313	+53	3	0
1923	224·823	333·823	221	1·284	−28	6	− 2
1929	227·771	336·771	223	1·223	−18	2	+12
1940	234·750	343·750	228	·678	+30	3	−10
1945	245·739	354·739	235	1·111	−31	5	+ 8
1973	266·783	375·783	249	1·113	−21	4	+ 2
2000	280·751	389·751	258	·023	+14	4	+12
2008	283·813	392·813	260	·086	− 5	4	−20
2031	292·672	401·672	266	1·421	+ 5	2	+22
2032	292·715	401·715	266	1·464	+ 3	7	+15
2046	294·692	403·692	268	·433	+56	7	− 2
2049	294·755	403·755	268	·496	+64	6	+ 7
2056	297·673	406·673	270	·404	+51	5	− 6
2059	297·746	406·746	270	·477	+45	4	−12
2081	307·664	416·604	276	1·307	−16	5	+14

SUMMARY OF OBSERVATIONS.—*Con.*

Plate.	Julian Day.	$T-T_0$	Periods from T_0	Phase $P=1\cdot5047$ days.	Vel.	Wt. Max. 10.	Residuals.
	1909.						
2086	2,418,309·532	418·532	278	·266	+56	7	+ 8
2090	313·553	422·553	280	1·237	−23	5	+ 7
2097	313·800	422·860	280	1·484	−34	3	−26
2104	314·508	423·508	281	·688	+26	4	−12
2119	318·503	427·503	283	·168	+36	1	− 4
2131	320·683	429·683	285	·842	+30	5	−13
2138	322·589	431·589	286	1·245	−64	4	−34
2145	322·673	431·673	287	1·329	−46	5	−17
2159	325·456	434·456	288	1·105	−21	2	− 8
2160	325·497	434·497	288	1·146	39	4	13
2169	325·619	434·619	288	1·265	−37	3	− 6
2170	325·656	434·656	289	1·302	−30	2	0
2173	327·463	436·463	289	·101	+42	2	+23
2190	335·521	444·521	295	·632	+47	3	+ 1
2191	335·563	444·563	295	·674	+46	4	+ 5
2193	335·686	444·686	295	·797	+54	4	−33
2194	335·716	444·716	295	·827	+56	3	−37
2223	341·526	450·526	299	·621	+49	7	− 1
2247	346·495	455·495	302	1·076	−31	3	−12
2255	346·617	455·617	302	1·198	−22	4	− 7
2256	346·666	455·666	302	1·247	−21	3	−10
2271	348·614	457·614	303	·185	0	3	−35
2296	360·587	469·587	311	·120	−11	3	−33
2297	360·629	469·629	311	·162	+ 8	2	−23
2307	363·642	472·642	313	·166	+ 7	4	−25
2308	363·682	472·682	313	·206	+ 8	1	−30
2336 (I)	374·577	483·577	321	·568	+61	6	− 8
2337	374·614	483·614	321	·605	+34	4	−15
2353	377·537	486·537	323	·519	+43	6	−12
2378	381·691	490·691	326	·159	−31	3	−61
2407	388·571	497·571	330	1·020	−11	4	+22
2408	388·604	497·604	330	1·053	−38	3	53
2427	389·619	498·619	331	·563	+49	4	− 4
2775	546·767	655·767	435	1·223	−36	4	− 5
2779	557·833	666·833	443	·251	+65	3	−19
2780	557·860	666·860	443	·278	+73	5	+24
2798	567·854	676·854	449	1·244	−47	2	−16
2799	567·903	676·903	449	1·293	−43	2	−13
2806	570·816	679·816	451	1·196	−12	3	−19
2807	570·844	679·844	451	1·223	−34	4	3
2821	574·776	683·776	454	·697	+19	5	−18
2829	578·820	687·820	456	·172	+47	3	−14
2830	578·854	687·854	456	·206	+56	1	−17
2846	584·892	692·892	461	·225	+30	4	−11
2848	585·786	694·786	462	1·119	−35	6	−12
2857	586·753	695·753	462	·582	+41	3	−10
2873	588·750	697·750	463	1·074	−36	5	−17
2882	592·828	701·828	466	·638	+36	4	− 8
2887	595·882	704·882	468	·682	+63	2	−23
2895	599·838	708·838	471	·125	+27	4	− 3
2896	599·867	708·867	471	·154	+23	2	6
2905	600·781	709·781	471	1·067	25	4	− 7
2906	600·809	709·809	471	1·095	15	3	− 6
2923	609·750	718·750	477	1·008	29	6	19
2924	609·781	718·781	477	1·039	22	5	7
2938	619·917	728·917	485	·642	+58	5	−13
2940	620·806	729·806	486	·026	− 1	4	− 3
2941	620·835	729·835	486	·056	−12	4	−20
2946	623·705	732·705	487	1·421	+12	2	−30
2947	623·734	732·734	487	1·450	− 2	6	11
2955	626·751	735·751	488	1·457	13	3	1
2956	626·795	735·795	489	1·501	19	6	15
2965	629·577	738·577	490	1·274	−16	2	−14
2984	641·817	750·817	499	1·476	13	4	− 4
2985	641·845	750·845	499	1·504	−27	5	−23
3001	642·772	751·772	500	·927	+22	4	−20
3002	642·797	751·797	500	·952	+ 8	3	− 9
3018	645·767	754·767	502	·912	+25	5	−20
3019	645·783	754·783	502	·958	−24	4	−21

The one hundred and four plates were then combined into sixteen groups. The weighted mean of each group was computed from the weights of the separate plates, and the mean phase from the time of periastron calculated. The table of normal places below gives the mean phase, the mean velocity, the weight, and the residual of each of the sixteen groups. The column of residuals gives the differences obtained from the normal values, and those computed from the final elements.

TABLE III.

Normal Places.

No.	Mean Phase.	Mean Velocity.	Weight.	Residual.
1	·124	+ 1·78	2·5	− 8·50
2	·260	+41·96	5·5	+ 4·49
3	·375	+55·50	0·5	+ 3·47
4	·450	+52·15	1·5	− 3·91
5	·538	+51 40	1·5	− 4·17
6	·607	+52·75	1·5	+ ·96
7	·665	+45·82	2 0	− ·87
8	·720	+33·70	2·0	− 6·83
9	·842	+32·15	2·0	+ 8·59
10	·965	+20·80	1·0	+16·70
11	1·059	−15·98	1·0	− 5·58
12	1·134	−28·38	3·0	− 7·90
13	1·220	−29·90	2·0	− ·98
14	1·273	−32·39	3·0	− ·66
15	1·334	−25·98	3·5	+ 6·14
16	·008	−13·61	2·0	− ·18

The preliminary elements of the orbit were obtained, by the graphical method of Dr. King,* from the radial velocity curve drawn through the normal places. These are given in the table below. The value of Σpvv from the residuals between observed and computed velocities was 1318, and it was thought that this might be reduced by applying a least-squares solution. In this the period was considered fixed at 1·5047 days. The following sixteen observation equations were formed by the method of Lehmann-Filhés,† and from these corresponding normal equations were derived:—

Observation Equations for First Solution.

No.	x	y	z	u	v	$-n$	Wt.
1	+ 1·000	+ ·017	+ ·702	+ 1·083	− 1·165	+12·330	2·5
2	1·000	+ ·602	+ ·950	+ ·841	− ·801	− 2·800	5·5
3	1·000	+ .881	+ ·170	+ ·442	− ·343	− 4·330	·5
4	1·000	+ ·945	− ·412	+ ·153	− ·061	+ 1 750	1·5
5	1·000	+ ·913	− ·873	− ·173	+ ·222	+ 1·140	1·5
6	1·000	+ ·820	− ·984	− ·402	+ ·406	− 4·190	1·5
7	1·000	+ ·704	− ·902	− ·568	+ ·534	− 2·250	2·0
8	1·000	+ ·568	− ·697	− ·699	+ ·636	+ 3·990	2·0
9	1·000	+ ·194	+ ·036	− ·884	+ ·793	−10·536	2·0
10	1·000	− ·238	+ ·765	− ·898	+ ·844	−17·750	1·0
11	1·000	− ·565	+ ·978	− ·774	+ ·782	+ 4·950	1·0
12	1·000	− ·806	+ ·766	− ·573	+ ·634	+ 6·980	3·0
13	1·000	− ·985	+ ·194	− ·277	+ ·375	+ 0·810	2·0
14	1 000	− 1·044	− ·284	− ·046	+ ·142	+ 0·760	3·0
15	1·000	− 1·041	− ·774	+ ·240	− ·176	− 5·500	3·5
16	1·000	− ·617	− ·602	+ ·911	− ·998	+ 0·350	2·0

* Astrophysical Journal, Vol. XXVII, p. 125.
† Astronomische Nachrichten, 136, 17, 1894.

For the sake of homogeneity, the following substitutions were made:—

$$
\begin{aligned}
\text{Let, } x &= \delta\gamma \\
y &= \delta K \\
z &= K\delta e = 43\ \delta e \\
u &= -K\delta\omega = -\ 43\ \delta\omega \\
v &= \frac{K}{(1-e^2)^{\frac{3}{2}}}\mu\delta T \\
&= 182\cdot 48\ \delta T.
\end{aligned}
$$

NORMAL EQUATIONS FOR FIRST SOLUTION.

$$
\begin{array}{rrrrrrl}
34\cdot500x & -\ 2\cdot459y & +\ \cdot200z & +\ 1\cdot197u & -\ \cdot619v & -\ 12\cdot780 & = 0 \\
 & 19\cdot781y & -\ \cdot304z & +\ 1\cdot299u & -\ 1\cdot839v & -\ 12\cdot315 & = 0 \\
 & & 18\cdot101z & +\ 4\cdot416u & -\ 4\cdot331v & +\ 29\cdot439 & = 0 \\
 & & & 14\cdot835u & 14\cdot795v & +\ 33\cdot370 & = 0 \\
 & & & & 14\cdot911v & -\ 33\cdot405 & = 0
\end{array}
$$

From the solution of these:

$$
\begin{array}{rlcrl}
x = & +\ \cdot4540 & \text{and :—} & \delta\gamma = & -\ \cdot454 \text{ km.} \\
y = & +\ \cdot8866 & & \delta K = & +\ \cdot887 \text{ km.} \\
z = & -\ 1\cdot1374 & & \delta e = & -\ \cdot026 \\
u = & +\ 1\ 3411 & & \delta\omega = & +\ 1^\circ\cdot788 \\
v = & +\ 3\cdot3684 & & \delta T = & +\ \cdot0184
\end{array}
$$

we get the first corrected values of the elements as follows:—

Elements.	Preliminary Values.	Corrections.	New Values.
P	1·5047 dys.		
γ	+ 13·28 km.	— ·45 km.	+ 13·73 km.
K	+ 43·0 km.	+ ·89 km.	+ 43·89 km.
e	·10	— ·026	·074
ω	238°	+1°·79	239°·79
T	2,417,892·467 J. D.	+ ·018	892·485 J. D.

The value of Σpvv was not greatly reduced, from 1318 to 1233. A second solution was considered necessary from the fact that the differences between the residuals obtained from the ephemeris and those from substitution in the observation equations were seen to be too large, the difference in one case being over two kilometres. Using the corrected values for the elements and the same substitutions as before, a new set of observation equations was built up as follows:—

No.	x	y	z	u	v	$-n$	Weight.
1	+ 1·000	— ·053	+ ·513	—1·064	—1·133	+ 9·640	2·5
2	1·000	+ ·539	+1·014	— ·881	— ·868	+ 4·550	5·5
3	1·000	+ ·859	+ ·384	— ·507	— ·439	— 4·070	·5
4	1·000	+ ·951	— ·221	— ·217	— ·145	+ 3·320	1·5
5	1·000	+ ·945	— ·781	+ ·124	+ ·170	+ 3·810	1·5
6	1·000	+ ·864	— ·977	+ ·369	+ ·382	— 1·090	1·5
7	1·000	+ ·752	— ·948	+ ·551	+ ·533	+ 0·900	2·0
8	1·000	+ ·614	— ·769	— ·695	+ ·653	+ 6·980	2·0
9	1·000	+ ·228	— ·024	+ ·900	+ ·831	— 8·420	2·0
10	1·000	— ·221	+ ·752	+ ·919	+ ·876	—16·760	1 0
11	1·000	— ·555	+ ·980	+ ·791	+ ·796	+ 5·340	1·0
12	1·000	— ·785	+ ·796	+ ·600	+ ·645	+ 7·670	3·0
13	1·000	— ·971	+ ·210	+ ·293	+ ·366	+ 1·000	2·0
14	1 000	—1·028	— ·254	+ ·069	+ ·140	+ 1·010	3·0
15	1·000	—1 027	— ·734	— ·207	— ·157	— 5·360	3·5
16	1·000	— ·582	— ·588	— ·903	— ·967	+ 1·810	2·0

The resulting normal equations are:

$$
\begin{array}{rrrrrrl}
34\cdot500x & -\ 2\cdot327y & +\ \cdot637z & -\ 1\cdot279u & -\ \cdot904v & +\ 6\cdot500 & = 0 \\
 & 19\cdot405y & -\ \cdot854z & -\ 1\cdot293u & -\ 1\cdot710v & -\ 6\cdot922 & = 0 \\
 & & 18\cdot070z & -\ 4\cdot580u & -\ 4\cdot579v & -\ 7\cdot562 & = 0 \\
 & & & 15\cdot233u & +\ 15\cdot309v & -\ 3\cdot967 & = 0 \\
 & & & & 15\cdot477v & -\ 4\cdot003 & = 0
\end{array}
$$

whence:

$$
\begin{array}{rlcrl}
x = & -\ \cdot1838 & \text{and :—} & \delta\gamma = & -\ \cdot184 \text{ km.} \\
y = & +\ \cdot4487 & & \delta K = & +\ \cdot449 \text{ km.} \\
z = & +\ \cdot5568 & & \delta e = & +\ \cdot013 \\
u = & -\ 2\cdot3633 & & \delta\omega = & +\ 3^\circ\cdot085 \\
v = & +\ 2\cdot8000 & & \delta T = & +\ \cdot015 \text{ dys.}
\end{array}
$$

giving as second corrected values of the elements:

$$
\begin{array}{rl}
P = & 1\cdot5047 \text{ dys.} \\
\gamma = & +\ 13\cdot55 \text{ km.} \\
K = & +\ 44\cdot34 \text{ km.} \\
e = & \cdot087 \\
\omega = & 242^\circ\cdot88 \\
T = & 2{,}417{,}892\cdot500 \text{ J. D.} \\
a \sin i = & 914{,}000 \text{ km.}
\end{array}
$$

The changes from the first solution, it will be noticed, are very small, and the value of Σpvv has only been reduced to 1221. The agreement, however, between the residuals obtained from the computed values and those by substitution in the observation equations is now very close, none of the differences being greater than $\pm$ ·06 km. This resulted in the final elements being accepted as in the table below:—

TABLE IV.

Elements of the Orbit.

Elements.	Preliminary.	1st Corrected Values.	2nd Corrected Values (final).	Probable Error.
Period, P	1·5047 days.	1·5047 days.	1·5047 days.	....
Eccentricity, e	·10	·074	·087	$\pm$ ·0363
Long. of Apse ω	238°	239°·79	242°·88	$\pm$ 32°·75
Vel. of System γ	13·28 km.	+ 13·73 km.	+ 13·55 km.	$\pm$ 1·36 km.
Half Amplitude, K	43·0 km.	+ 43·89 km.	+ 44·34 km.	$\pm$ 0·94 km.
Time of Periastron, T	2,417,892·467 J. D.	892·485 J. D.	892·500 J. D.	$\pm$ ·137 dys.
$a \sin i$	....	....	914,000 km.	....
Σpvv	1317	1233	1221	....

The accompanying figure, Fig. 14, shows the velocity curve as drawn from the second corrected values.

The probable error for each element is also given in the above table. The probable error of a normal place of unit weight was determined, and found to be $\pm$ 7·08 km., while that of a single observation is $\pm$ 10·80 km. The probable error of a plate is much higher than that for any other binary yet determined at this Observatory. This is probably due to the very diffuse character of the spectrum, and the resulting uncertainty of the velocity measures. It is possible, of course, that some systematic effect may be present, which is thus far undeterminable. In a binary of such a short period as τ Tauri, it is probable that

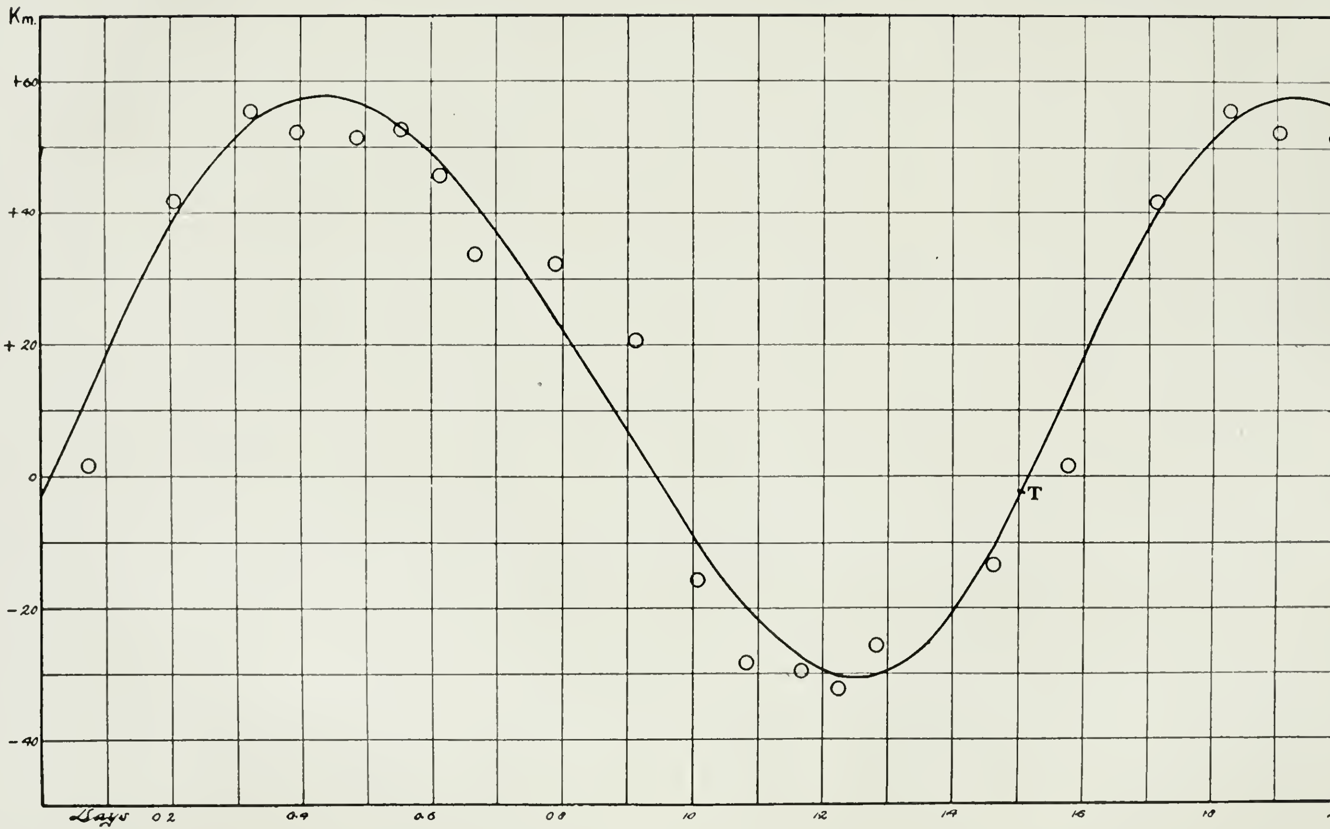


Fig. 14—Velocity Curve of τ Tauri.

the stars are comparatively close together, and the enormous tidal effects which must be thereby produced will undoubtedly have an influence on the character of the lines. Again, the spectrum may be a composite one. Although no traces of a second spectrum have been found, it is quite possible that such may be present, and is masked in the diffuseness of the lines. If such were the case, this in itself would be sufficient to explain the high residuals. Most of these occur, also, where a doubled line would have the largest disturbing effect. The elements of the orbit determined above are probably the best that can be obtained under present conditions, although it would be desirable to make a second determination after a few years.

APPENDIX D.

SOLAR WORK AND LABORATORY WORK.

Ralph E. De Lury, M.A., Ph. D.

SOLAR WORK.

During the year, work was continued with the 23-foot Littrow solar spectrograph, described in the Report of the Chief Astronomer for the year ending March 31, 1909 (pp. 251-256). Though the grating of this spectrograph had been found to produce lines of poor definition in the most favourable tests, and to be lacking in brilliancy, necessitating as it did, exposures twenty or thirty times as long as other gratings employed under similar conditions, nevertheless it was decided to get the best results possible by its use.* Over 400 exposures (120 plates) were made with it from April 1 to October 8, as follows:—

(1) *Test plates.*—About 350 test exposures were made to examine different parts of the grating, to determine the foci and times of exposure necessary, and for various adjustments.

(2) *Rotation plates.*—About 40 exposures were made, in the third order and chiefly within the range λ 4100 to λ 4500. The exposures required were about ten minutes, during which the definition of the sun's image became very poor owing to the distortion of the mirrors by heat. Several of these plates were measured, but the settings on individual lines and the measured displacements of the individual lines were so discordant, that the plates are to be regarded valueless for fine determinations of the sun's velocity of rotation.

While engaged in this work it seemed to me that it was essential to have some method of checking or eliminating any possible instrumental displacements of the lines. If the range of the spectrum studied includes lines due to the terrestrial atmosphere, any displacement due to instrumental causes can at once be detected and measured by the displacements of these lines. For other parts of the spectrum, it may be possible to introduce lines by using filters. Some solutions give fairly narrow absorption bands, *e.g.*, solutions of some of the salts of uranium, cobalt, erbium, and neodymium (see Formánek, 'Die qualitative Spektralanalyse,' 2. Aufl., and Uhler and Wood, 'Atlas of Absorption Spectra'), but these bands are on the whole too wide to be of much use in this connection where only slight shifts are to be looked for. Would it be feasible to employ long tubes of gases under pressure? The question is worth consideration, for the production of such standard lines simultaneously with the spectrum studied would be of great value in the investigation of the problem of the solar rotation, and in many other solar and stellar problems.

(3) *Sun-spot plates.*—From the *H* and *K* region to about λ 4300, in the third order, 20 exposures were made on suitable sun-spots. The exposures necessary were from 10 to 25 minutes, during which the definition of the sun's image altered so much that it became very difficult to keep the spot on the slit, thus allowing light from regions of the sun near the spot to enter the slit also.

---

* A new 4·7″ x 5″ Michelson grating was ordered in the beginning of September.

While doing the above work much time was spent in making adjustments, and I found it necessary to design and construct various pieces of apparatus, such as,—

A graduated arc and vernier-pointer mounted on the spectrograph for reading the angles of inclination of the grating; and scales for reading the foci and the positions of the photographic plate, and a vernier for reading the angle of rotation of the spectrograph.

Adjustments for the prisms in the slit-attachment, made by putting adjusting screws through the brass strips holding the prisms, to play on the prisms which rested on thin strips placed beneath them so that the prisms could be tilted slightly about vertical and horizontal axes. This was intended to serve temporarily until I could get a better working arrangement having the prisms mounted in brass blocks provided with two-way tilts worked by adjustiug screws (as employed by Adams in his work on the Rotation of the Sun, at Mount Wilson), or an arrangement having the prisms in brass blocks mounted on universal joints (ball and socket with clamp).

An arrangement by means of which the sun's image could be guided had to be constructed. Whenever it was necessary to guide the image while Mr. Gilchrist and I were engaged in the work with the spectrograph after it was installed in the fall of 1908, one of us guided while the other made the exposure. After Mr. Gilchrist's departure, I was working alone, and it became necessary to have a method of guiding and exposing which could be done by one person, and since the concave mirror is about 80 feet from the image, this presented considerable difficulty. Mr. Plaskett suggested the use of field-glasses and guiding from beside the mirror; this method worked fairly well, especially when I used the small finder of the equatorial telescope and silver-plated the slit-bars of the guide-plate. It is, of course, more satisfactory to guide from beside the image and the photographic plate. For this purpose at Mount Wilson they have set up beside the mirror, small motors which move it in the required directions and which are controlled by switches placed near the image. As this is an expensive and somewhat elaborate method. I designed and set up the simple apparatus illustrated in Fig. 15.

M is the concave mirror which produces the image *I*, and to which are clamped two arms connected with screws *S, S,* working in bearings on the cast-iron support of the mirror. By turning these screws the two arms may be moved back and forth giving *M*, rotations about a horizontal and a vertical axis, which move the image *I*, in vertical and horizontal directions respectively. The following device provides the means for producing these movements from beside the image:—

To the screws, *S, S,* are fastened the pulleys, *P, P,* in which run stout woven cord belts. These belts are carried over screw pulleys, *W, W,* and through eyes, *E, E,* and around the turning drums, *D, D,* which are placed on the wall close to where the image, *I*, falls on the face of the guide-plate (which I constructed as described in the last report, loc. cit.). By turning the handle of one drum, the image may be raised or lowered; while turning the other drum moves the image back and forth in a horizontal direction.

Climatic changes alter the lengths of the woven cords, so that they may slip on the drums; the cord belts should then be retightened, and by passing them several times around the drums and by waxing both the drums and the cords with beeswax, small changes do not matter much. All changes, however, may be compensated if springs or adjusting screws be put in the belts, or better, if pulleyed weights, *B*, *B* (as Dr. King suggested), be hung on the belts to keep them at constant tension. If the distance of the mirror from the guide-plate is to be changed much, due to change in focus of the mirror or for any other cause, it is necessary to use arms, *A*. *A*. to keep the strings playing vertically in the pulleys so that they will not slip out of them.

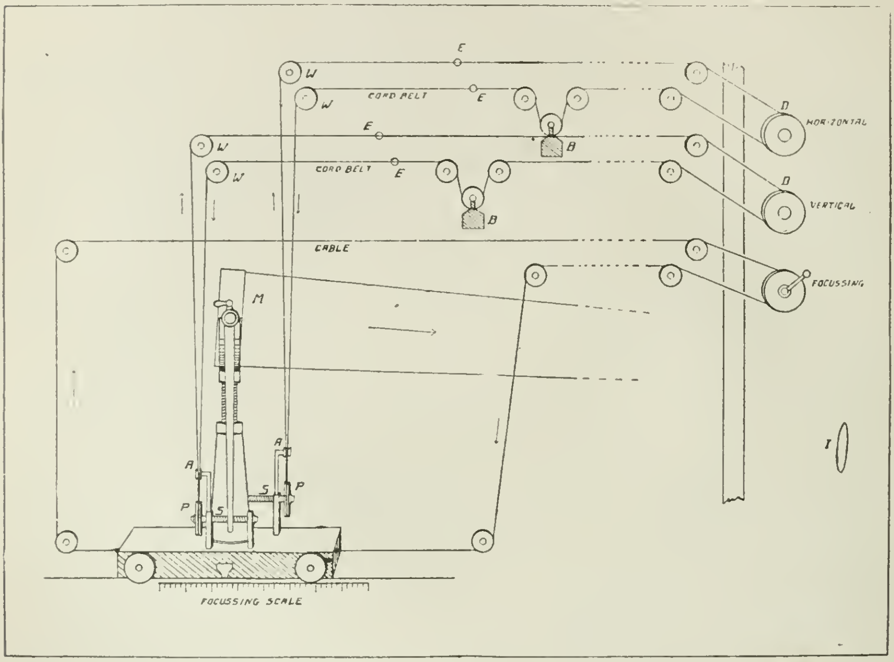


Fig. 15—Arrangement for Slow Motion of Concave Mirror.

With the above arrangement it is an easy matter to bring the image of the sun to any desired position and to correct quickly any drifts in the image during an exposure, such as caused by changes in atmosphere refraction, or due to the fact that the coelostat mirror rotates about an axis not in the plane of the mirror, or by irregularities in the driving of the clock, which I had to take apart several times, but which was finally adjusted by Mr. Lucas, so that it drives very satisfactorily, except for slight periodic effects

An arrangement similar to this guiding device may be used for focussing the image at any desired place. Such an arrangement is illustrated in the figure. It is desirable in this case to use a wire cable, and to turn the drum by means of a crank.

In addition to the above work the photography of the sun, to keep a record of the sun-spots, was continued. On each bright day a photograph of the sun is taken in the solar camera through a 'filtergelb' screen, the 15-inch refractor being masked to 3 inches. A line giving the 'east and west' direction runs across the middle of each plate. This record has been kept continuously as follows: —

1906, 94 plates, S 1, July 27, to S 94, December 27.

1907, 241 plates, S 95, January 4, to S 335, December 31; including 6 plates of the Transit of Mercury, November 14, S 309–S 314.

1908, 262 plates, S 336, January 2, to S 597, December 29; including 18 plates of the partial eclipse of June 28, S 455–S 472.

1909, 189 plates, S 598, January 6, to S 786, December 29.

1910. 44 plates, S 787, January 2, to S 830, March 29.

During the year ending March 31, 1910, 182 plates were taken. An attempt was made to measure plates S 1 to S 10 by using the large Repsold measuring instrument, but the plates were too dense to make satisfactory measures. By outlining the spot on the back of the plate with an opaque paint, it was possible to make the measurements, but the method is not very satisfactory. A better method would be to measure the areas of the spots by means of a planimeter from enlarged prints of the plates. If much of this work is to be done, however, a globe projecting machine should be used. Little attention has been paid to the measurement of the areas and positions of sun-spots on account of the fact that such elaborate measures of these are made at Greenwich, from plates taken at three British observatories located in different countries. Yet it is well worth while to keep the above record of the dark spots. We should also keep a record of the not less interesting faculæ, granulations and pores which one sees so distinctly in the image given by the reflecting telescope when the definition is good. For this reason it is recommended that a solar camera be set up for use with this instrument, when photographs could be taken on fine-grained process plates without the use of filters.

LABORATORY WORK.

The Laboratory, which adjoins the Solar Research room, has been equipped with suitable fittings and such apparatus and chemicals as were thought would be useful and necessary in dealing with photographic, spectroscopic and other problems arising in connection with and in relation to, the work of the Observatory.

In the first place, the room was equipped with two work-benches and suitable drawers and shelves; a sink with lead-covered drain and splash boards, and lead-topped shelf for holding the usual set of laboratory chemical reagents, and conveniently placed hot and cold water taps; a lead-lined fume-cupboard which was connected by a pipe to a ventilating fan which creates a suction up through the fume-cupboard and drives the air out through a window in the adjoining storage-cell room, and which serves at the same time in drawing off the disagreeable acid particles thrown out during the charging of the batteries. The window in the Laboratory was provided with a wooden screen hinged above it, so that it may be dropped when it is desired to use the Laboratory as a dark room for photographic purposes.

The apparatus includes a still for distilling water, a gasoline heater, a small gasoline blow-pipe, a gasoline blow-pipe with bellows suitable for the simpler operations of glass-blowing, a water-suction air-pump capable of producing a vacuum of a few cm. of mercury pressure, two chemical balances, a small steam-bath with electric heater suitable for evaporating solutions, drying precipitates, &c., iron tripods, stands with clamps, alcohol lamps, evaporating dishes, tongs, flasks, reagent bottles, pipettes, measuring flasks, graduated cylinders, glass and rubber tubing, glass wool, corks, filter paper, &c.

The chemicals include the common acids, salts of the ordinary metals and some of these metals, some of the rare metals and their salts which are of interest in astrophysical studies, photographic chemicals, and various useful organic and inorganic substances.

The Laboratory equipment is very complete, and it has been found very useful for cleaning and resilvering the large telescope mirrors which become tarnished periodically. In this connection I tried some experiments to see if the tarnish could be removed electrically, as can be readily done with the solid metal, but it was found that the silver film was too thin for this purpose. The tarnish could be removed, but gases formed under the silver and raised it from the glass. One of the chief objections raised against the use of metallic mirrors is that they tarnish; this tarnish can be readily removed electrically—in fact the tarnish could be prevented from forming at all by leaving the mirror covered with, say, tap water (when not in use) and having the mirror under a potential of a few volts.* Metallic mirrors conduct heat more readily than the glass mirrors, and consequently their definition would not be affected so much by surface changes of temperature. If metallic mirrors of suitable polish could be made they would be in every way preferable to those of glass.

The Laboratory has been of service also for photographic purposes, for silver-plating certain parts of apparatus (such as scales) by means of the direct current supplied from storage-cell connections which I set up at convenient places in the Laboratory, for repairing glass apparatus—barometers, levels, &c., for making special apparatus such as a glass still to distil mercury for the barometers, &c., and it has been at the service of the members of the staff for various purposes.

Recently, I have set up a thermostat consisting of a 16″ x 24″ x 16″ nickelled copper tank with stirrer, which may be driven at various speeds by cord belts running in pulleys of different sizes, mounted on a shaft which bears in a brass tube driven through one of the benches and which is operated by a ⅛ horse-power alternating current motor. There is a perforated nickelled copper plate supported above the stirring wheel, on which may be rested flasks of solutions, standard cells or resistances, or anything which is to be kept at constant temperature. A cover is provided to lessen the evaporation of the water, kerosene or whatever liquid is employed in the tank. The whole is mounted on a little truck so that it may be moved to any place desired.

I employed the thermostat for a few days, maintaining the temperature at about 0°·2 C: by stirring snow and ice in the water of the tank, while making some kinetic measurements of the induction by oxalic acid of the reaction between chromic and hydriodic acids, which together with some measurements I had previously made at the University of Chicago, will form the substance of a communication to one of the chemical journals.

If at any time it is desired to keep standard cells and resistances at any required temperature in connection with photometric studies with selenium cells, or other studies, the tank may easily be equipped with an electric heater and electric control as commonly employed.

I trust the above very complete equipment of the Laboratory will be of great service, along with the 23-foot spectrograph equipped with the new grating, in working out some of the many interesting and pressing problems in astrophysics and astrochemistry, in doing our fair share in the study of the spectra of the elements and their compounds and in determining wave-lengths in accordance with the new international system of units based on interference methods. The spectrograph could thus profitably be employed during the winter months when the conditions are not so favourable for solar work.

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* The method employed for the preservation of amalgams, Hulett and De Lury, 'The Reduction of Cadmium by Mercury and the Electromotive Force of Cadmium Amalgams,' Journal of the American Chemical Society, Vol. XXX, p. 1809.

APPENDIX E.

DOUBLE STAR MEASURES, WORK WITH STELLAR CAMERA, OCCULTATIONS, AND COMET 1910 A.

R. M. Motherwell, M.A.

MEASUREMENT OF VISUALLY DOUBLE STARS.

The programme followed in the measurement of double stars has been compiled, as in former years, from Burnham's General Catalogue, the object being to measure only such doubles as have been neglected or those where the recorded measurements would seem to justify observations at close intervals. Following are the measurements:—

Star No.*	R. A. 1880.			Dec. 1880.		Date of Measurement.	Position Angle.	Distance.	Magnitudes.	
	h.	m.	s.	°	′		°	″		
1223	2	14	35	33	42	1909·914	288·2	4·71	8·8	9·3
1655	3	12	24	46	15	1909·768	228·7	6·71	8·5	9
2040	4	0	54	14	50	1910·067	220·7	4·12	6	8·5
2043	4	1	7	17	1	1910·067	321·8	4·62	6	9·5
2536	5	1	23	8	15	1910·067	299·7	2·85	8·5	8·5
2544	5	2	13	27	53	1909·796	27·2	11·89	6·2	8·2
3334	6	15	55	37	37	1910·067	325·2	10·82	8·9	9·1
3348	6	17	4	31	53	1910·067	162·7	6·88	9·3	9·6
3398	6	21	52	8	38	1910·067	0·7	4·80	9	10
4452	8	1	54	32	34	1909·341	43·3	2·60	7	8
4491	8	6	44	27	29	1910·092	300·4	19·26	8·5	10·5
4890	8	54	39	15	45	1909·303	197·0	5·11	8·7	8·8
5014	9	11	23	37	19	1909·303	234·0	3·39	4	6·5
....	...	...	...	...	...	1909·341	235·5	3·40	4	6·5
5337	10	3	29	3	45	1909·399	294·3	31·09	8	10·5
5388	10	13	20	20	27	1909·399	116·4	3·82	2	3·5
5426	10	19	16	9	23	1909·303	68·1	3·50	8	9·7
....	...	...	...	...	...	1909·399	66·5	3·27	8	9·7
5705	11	7	2	41	44	1909·303	32·2	3·37	7	10
5809	11	25	25	36	32	1909·303	28·3	25·33	9·5	9·5
5892	11	37	32	14	11	1910·092	57·5	31·44	9	9
....	...	...	...	...	...	1910·112	57·6	30·72	9	9
....	...	...	...	...	...	1910·188	57·7	31·00	9	9
6033	12	0	45	6	29	1909·303	106·8	6·57	8·5	10
....	...	...	...	...	...	1909·437	106·4	....	8·5	10
....	...	...	...	...	...	1910·188	105·8	6·58	8·5	10
6035	12	1	7	69	45	1909·399	179·4	16·41	7·5	9
6211	12	29	0	8	7	1910·188	0·3	2·17	8	10·5
6386	13	0	28	45	55	1909·360	119·0	2·99	6	12·3
....	...	...	...	...	...	1909·494	118·1	3·11	6	12·3
6390	13	1	13	1	14	1910·188	2·6	7·32	7·3	7·5
6415	13	6	23	32	43	1909·437	345·4	1·85	7	7·4
....	...	...	...	...	...	1909·494	344·4	2·21	7	7·4
6599	13	37	3	4	9	1909·437	229·6	3·22	5·5	8
....	...	...	...	...	...	1909·494	230·7	3·45	5·5	8
....	...	...	...	...	...	1910·216	230·2	3·39	5·5	8
6614	13	39	20	−2	25	1910·188	161·8	4·31	9·5	9·5
....	...	...	...	...	...	1910·207	158·5	4·15	9·5	9·5

* The numbers refer to Burnham's General Catalogue of Double Stars.

Star No.*	R. A. 1880.	Dec. 1880.	Date of Measurement.	Position Angle.	Distance.	Magnitudes.	
	h. m. s.	° ′		°	″		
....	....	....	1910·216	161·3	....	9·5	9·5
6753	14 6 12	2 58	1910·092	213·0	61·74	6	12
....	....	....	1910·112	213·5	....	6	12
....	....	....	1910·207	212·9	64·82	6	12
6780	14 9 18	3 41	1909·494	349·8	1·52	7·9	8
7065	14 51 1	32 47	1909·437	112·1	4·13	6·3	10
....	....	....	1909·494	115·9	4·60	6·3	10
7260	15 20 0	49 57	1909·494	50·3	....	8·2	13
7318	15 29 5	10 56	1909·494	184·3	3·60	3	4
7429·5	15 48 47	52 55	1909·429	252·9	9·39	8·8	8·9
....	....	....	1909·494	252·9	9·26	8·8	8·9
....	....	....	1909·634	254·3	9·46	8·8	8·9
....	....	....	1910·216	253·2	9·08	8·8	8·9
7450	15 52 21	35 51	1909·412	14·9	8·9	8·5	9
....	....	....	1909·429	13·9	9·3	8·5	9
....	....	....	1909·437	14·1	9·5	8·5	9
7480	15 56 28	33 40	1909·634	77·2	83·97	6	9·2
7604	16 17 29	2 30	1910·207	210·6	16·50	8·5	10·5
7642	16 23 37	18 40	1909·494	87·3	....	7·5	7·5
7915	17 9 12	28 57	1909·484	17·5	5·52	7·5	9·5
....	....	....	1909·494	19·6	5·52	7·5	9·5
7927	17 10 38	3 32	1909·429	126·5	33·21	8	9·5
8003	17 19 33	37 15	1909·631	312·7	....	4	5
....	....	....	1909·686	311·4	....	4	5
....	....	....	1909·763	312·3	....	4	5
8082	17 30 52	21 4	1909·631	23·2	8·05	6	9·5
....	....	....	1909·634	24·2	7·87	6	9·5
8364	18 1 47	48 8	1909·429	78·2	3·00	7	10
8384	18 3 43	6 8	1909·631	79·8	1·60	7	7·5
9034	19 1 5	8 36	1909·631	50·2	8·11	9·5	11
....	....	....	1909·763	51·3	8·46	9·5	11
9905	20 0 55	12 20	1909·631	271·7	20·09	8	11
9970	20 5 44	36 23	1909·686	297·6	8·95	8·7	9
....	....	....	1909·763	298·5	8·86	8·7	9
9980	20 6 17	36 41	1909·763	277·1	4·41	7·5	10
9986	20 6 43	20 38	1909·782	134·1	6·39	9·5	10·5
11048	21 27 8	44 37	1909·782	183·9	4·23	9	9·3
11487	22 0 22	31 21	1909·763	47·1	17·59	9	11
11499	22 1 27	61 42	1909·763	95·2	19·95	6	12
....	....	....	1909·782	94·7	20·13	6	12
11501	22 1 38	57 44	1909·914	100·0	7·93	9·5	11
12230	23 7 24	10 25	1909·782	358·4	33·44	7	9·7
....	....	....	1909·804	5·2	33·38	7	10
....	....	....	1909·914	358·7	33·22	7	10

STELLAR CAMERAS.

Eight-inch Doublet.

The 8-inch Brashear Doublet, which had shown a negative aberration of 3·6 mm., was shipped to Brashear on June 14, 1909, for the purpose of refiguring. A month later it was returned and mounted ready for use. An application of the Hartmann test revealed a negative aberration of only 0·5 mm., about one-seventh of the original aberration. The accompanying star plates, Figs. 16 and 17, taken before and after the refiguring show what a great improvement has been made in the lenses.

Zeiss Camera.

As the 8-inch camera has a field of only ten degrees and is rigidly connected to the equatorial, it was deemed advisable to have a camera of wider field for the photographing of Halley's comet. Accordingly, a Zeiss lens of speed f 3·5 was purchased, and a camera box and mounting were made in our own workshops. Focus tests were made by means of star trails, and the camera was then mounted on the objective end of the equatorial.

This camera has a field of about forty degrees, covering an 8 x 10 plate fairly well, although, as is to be expected in such a wide-angled lens, the intensity of illumination is considerably greater at the centre of the plate than at the edge.

OCCULTATIONS OF FIXED STARS BY THE MOON.

The observation of occultations was very often interfered with by clouds. Out of 42 predicted occultations only 4 were observed. All observations were made with the 15-inch equatorial with micrometer attachment.

Date.	Star.	Magnitude.	Time (G. M. T.) Immersion.			Time (G. M. T.) Emersion.		
1909.			h.	m.	s.	h.	m.	s.
Oct. 20	6 Sagittarii.	2·3	12	13	45·1	..	..	..
Nov. 23	26 Ceti.	6·0	10	7	12·6	11	7	28·1
" 23	33 Ceti.	6·1	14	14	59·9	15	26	38·6
1910.								
Mar. 16	τ Tauri.	4·5	12	35	22·5	13	39	9·5
Mar. 16	Companion to τ Tauri.	....	12	32	55·5	..	..	..

COMET 1910 A.

This remarkable comet was first observed at Johannesburg on the morning of January 17, its great brilliancy rendering it visible after sunrise. A close watch was kept at the Dominion Observatory but, owing to cloudy weather, the comet was not seen until January 25, on which date I first observed it with a pair of field-glasses at $10^h 30^m$ (G.M.T.), and in a few minutes it was a conspicuous object in the sky. Photographs were taken on every possible occasion with the 8-inch doublet, the following table giving the record of exposures:—

Plate.	Date.	Exposure. Beginning.		Exposure. Duration.		Remarks.
	1910.	h.	m.	h.	m.	
1	Jan. 25	11	1	0	3	Clear.
2	" 25	11	7	0	7	
3*	" 25	11	15	0	10	
4	" 25	11	31	0	8	
5	" 28	11	10	0	9	Clear and very cold.
6*	" 28	11	22	0	25	
7*	" 31	11	19·5	0	25·5	Hazy.

* See accompanying cuts of Comet 1910 A, Figs. 18, 19, 20

APPENDIX F.

DETAILED MEASURES OF STAR SPECTRA.

α BOÖTIS.

RECORD OF SPECTROGRAMS.

P.—Plaskett.
C.—Cannon.
P¹.—Parker.

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure. G. M. T.	Duration.	Hour Angle at end.	Comparison Spectrum. Exposure in Seconds.	Comparison Spectrum. Kind.	Temperature Centigrade. Room. Beginning.	Room. End.	Prism Box. Beginning.	Prism Box. End.	Slit Width.	Focal Position. Star Focus.	Focal Position. Collimator.	Focal Position. Camera.	Seeing.	Observer.	Remarks.
				1908.	h. m.	m	h. m.							in.						
α Boötis	1426	1 I L..	Seed 27.	Mar. 23	16 42	25	2 15 E	12-12-12-12	Fe V spark.	+ 4·5	+ 3·5	+ 4·9	+ 4·9	·001	72·0	10·8	26·78	Fair ...	P	
"	1455	" ..	" 27.	April 3	18 47	16	0 15 W	18-18-18-18	" ..	− 9·0	− 9·5	1·7	1·7	·001	71·2	10·8	26·8	" ...	P	
"	1456	" ..	" 27.	" 3	19 00	22	0 43 W	18-18-18-18	" ..	− 9·5	− 9·5	1·7	1·7	·001	71·2	10·8	26·8	" ...	P	
"	1514	" ..	" 27.	May 4	18 54	8	2 35 W	15-30-15	" ..	+ 8·0	+ 7·6	13·4	13·4	·001	71·2	10·8	26·92	Good...	P	
"	1515	" ..	" 27.	" 4	19 14	4	2 53 W	15-30-15	" ..	7·6	7·5	13·4	13·4	·001	71·2	10·8	26·92	" ...	P	
"	1529	" ..	" 27.	" 15	15 58	14	0 25 W	15-30-15	" ..	14·6	14·5	18·9	18·9	·001	72·0	10·8	27·18	" ...	P¹	
"	1585	" ..	" 27.	June 6	16 05	20	2 00 W	15-15-15-15	" ..	20·6	20·6	25·2	25·2	·001	72·2	10·8	27·28	Fair ..	P	
"	1586	" ..	" 27.	" 6	17 21	18	3 15 W	15-15-15-15	" ..	20·5	20·6	25·2	25·2	·001	72·2	10·8	27·28	" ...	P	
"	1588	" ..	" 27.	" 8	13 25	20	0 30 E	15-15-15-15	" .	26·6	27·0	30·4	30·4	·001	72·5	10·8	27·3	" ...	P	
"	1595	" ..	" 27.	" 10	15 41	10	1 50 W	12-12-12-12	" ..	14·6	14·4	20·2	20·2	·001	72·3	10·8	27·32	" ...	P	
"	1596	" ..	" 27.	" 11	13 10	15	0 35 E	15-15-15-15	" ..	17·0	16·8	18·7	18·7	·001	72·3	10·8	27·32	" ...	P	
"	1597	" ..	" 27.	" 11	13 25	10	0 25 E	15-15-15-15	" ..	16·8	16·8	18·7	18·7	·001	72·3	10·8	27·32	" ...	P	
"	1606	" ..	" 27.	" 13	16 07	30	2 40 W	15-15-15-15	" ..	21·5	21·3	26·0	26·0	·001	72·3	10·8	27·35	Poor ...	P	
"	1615	" ..	" 27.	" 20	13 25	17	2 25 W	15-15-15-15	" .	26·0	25·6	29·8	29·8	·001	72·3	10·8	27·52	Fair ...	P	
"	1616	" ..	" 27.	" 20	15 30	25	4 00 W	15-15-15-15	" .	23·6	23·5	29·0	28·9	·001	72·3	10·8	27·52	Windy..	P	
"	1619	" ..	" 27.	" 22	13 13	20	0 10 W	15-15-15-15	" ..	21·5	20·9	24·2	24·1	·001	72·3	10·8	27·43	Fair ...	P	
"	1620	" ..	" 27.	" 22	13 35	20	0 35 W	15-15-15-15	" ..	20·8	20·3	24·1	24·0	·001	72·3	10·8	27·43	" ...	P	
"	1622	" ..	" 27.	" 22	14 38	19	2 38 W	15-15-15-15	" ..	19·5	19·0	23·8	23·7	·001	72·3	10·8	27·43	" ...	P	
"	1635	" ..	" 27.	" 26	13 44	32	3 08 W	15-15-15-15	" ..	23·5	22·0	25·9	25·8	·001	72·3	10·8	27·4	Hazy ..	P	
"	1645	" ..	" 27.	" 27	13 12	20	0 30 W	15-15-15-15	" ..	25·0	24·3	28·5	28·3	·001	72·3	10·8	27·46	Fair ...	P	
"	1662	" ..	" 27.	July 6	13 41	18	1 35 W	15-15-15-15	" ..	25·8	25·4	26·6	27·2	·001	72·3	10·8	27·45	" ...	P	Trouble with temperature control.
"	1671	" ..	" 27.	" 8	13 42	18	1 45 W	20-20-20-20	" ..	21·5	21·3	22·8	22·8	·001	72·2	10·8	27·42	" ...	P	
"	1672	" ..	" 27.	" 8	14 05	20	2 05 W	20-20-20-20	" ..	21·3	20·6	22·8	22·8	·001	72·2	10·8	27·42	" ...	C	
"	1709	" ..	" 27.	" 15	13 28	17	2 00 W	30-30-30-30	" ..	19·6	19·5	21·8	21·8	·001	72·3	10·8	27·4	Good...	P	

FIG. 16—Star Plate taken before Lens was corrected for Aberration.

Fig. 17—Star Plate taken after Lens was corrected for Aberration.

Fig. 18—Comet 1910 a.

Photographed Jan. 25^{d} 11^{h} 15^{m} G.M.T.

FIG. 19—Comet 1910 A.
Photographed Jan. 28d 11h 22m G.M.T.

FIG. 20—Comet 1910 A.
Photographed Jan. 31^{d} 11^{h} 19^{m} G.M T.

				1910.																			
"	3126	I	" 27.	Jan.	15	19	40	1	3 50 E	6	"	..	−14·0	−14·0	−9·3	−9·3	·0015	42·2	....	27·55	Fair	P	
"	3127	I	" 27.	"	15	20	01	2	3 30 E	6	"	..	−14·0	−14·0	−9·3	−9·3	·0015	42·2	....	27·55	"	P	
"	3128	I	" 27.	"	15	20	06	2	3 25 E	6	"	..	−14·0	−14·0	−9·3	−9·3	·0015	42·2	....	27·55	"	P	
"	3129	I	" 27.	"	15	20	13	2	3 20 E	6	"	..	−14·3	−14·5	−9·3	−9·3	·0015	42·2	....	27·55	"	P	
"	3130	I	" 27.	"	15	20	19	2	3 15 E	6	"	..	−14·6	−14·8	−9·3	−9·3	·0015	42·2	....	27·55	"	P	
"	3146	I	" 27.	"	25	21	36	2	1 30 E	6	"	..	−8·8	−8·8	−3·4	−3·4	·001	42·2	....	27·55	2–3	P	
"	3147	I	" 27.	"	25	21	52	7	1 10 E	6	"	..	−8·8	−8·8	−3·4	−3·4	·001	42·2	....	27·55	2–3	P	Three exposures.
"	3148	I	" 27.	"	25	22	05	8	1 00 E	6	"	..	−8·9	−8·9	−3·4	−3·4	·001	42·2	....	27·55	2–3	P	" "
"	3149	I	" 27.	"	25	22	20	8	0 45 E	6	"	..	−8·9	−8·9	−3·4	−3·4	·001	42·2	....	27·55	2–3	P	" "
"	3150	I	" 27.	"	25	22	31	8	0 34 E	6	"	..	−8·9	−9·0	−3·4	−3·4	·001	42·2	....	27·55	2–3	P	" "
"	3238	I	" 27.	Feb.	25	17	20	6	3 30 E	4	"	..	−14·0	−14·1	−6·4	−6·4	·002	42·2	....	27·55	3	P	Two "
"	3239	I	" 27.	"	25	17	40	6	3 10 E	4	"	..	−14·1	−14·2	−6·4	−6·4	·002	42·2	....	27·55	3	P	Three "
"	3240	I	" 27.	"	25	17	55	6	2 55 E	4	"	..	−14·3	−14·5	−6·4	−6·4	·002	42·2	....	27·55	3	P	" "
"	3272	I	" 27.	Mar.	3	17	05	6	2 25 E	5	"	..	+0·1	+0·1	+7·8	+7·8	·0015	42·2	....	27·55	3	P	" "
"	3273	I	" 27.	"	3	17	23	6	2 07 E	5	"	..	+0·1	+0·1	+7·8	+7·8	·0015	42·2	....	27·55	3	P	" "
"	3274	I	" 27.	"	3	17	31	6	1 59 E	5	"	..	+0·1	+0·1	+7·8	+7·8	·0015	42·2	....	27·55	3	P	" "
"	3275	I	" 27.	"	3	17	36	2	1 54 E	5	"	..	+0·1	+0·1	+7·8	+7·8	·0015	42·2	....	27·55	3	P	One "
"	3276	I	" 27.	"	3	17	47	6	1 43 E	5	"	..	+0·1	+0·1	+7·8	+7·8	·003	42·2	....	27·55	3	P	Three "
"	3277	I	" 27.	"	3	17	52	6	1 38 E	5	"	..	+0·1	+0·1	+7·8	+7·8	·003	42·2	....	27·55	3	P	" "
"	3278	I	" 27.	"	3	17	57	2	1 33 E	5	"	..	+0·1	+0·1	+7·8	+7·8	·003	42·2	....	27·55	3	P	One "
"	3279	I	" 27.	"	3	18	08	6	1 22 E	5	"	..	+0·1	+0·1	+7·8	+7·8	·003	42·2	....	27·55	3	P	Three "
"	3280	I	" 27.	"	3	18	20	2	1 10 E	5	"	..	+0·1	+0·1	+7·8	+7·8	·002	42·2	....	27·55	3	P	One "
"	3281	I	" 27.	"	3	18	40	2	0 50 E	5	"	..	+0·1	+0·1	+7·8	+7·8	·002	42·2	....	27·55	3	P	" "
"	3288	IIIR.	" 27.	"	5	18	22	5	2 00 E	30–30	"	..	1·6	1·6	10·7	10·7	·0015	70·0	10·8	1·23	3–4	P	
"	3289	"	" 27.	"	5	18	37	4	1 45 E	30–30	"	..	1·6	1·5	10·7	10·7	·0015	70·0	10·8	1·23	3	P	
"	3290	"	" 27.	"	5	18	43	4	1 39 E	30–30	"	..	1·4	1·3	10·7	10·7	·0015	70·0	10·8	1·23	3	P	Seeing thick.
"	3291	"	2	"	5	18	47	2	1 35 E	20–20	"	..	1·3	1·2	10·7	10·7	·0015	70·0	10·8	1·23	3	P	
"	3311	"	Seed 27.	"	10	17	51	3	2 10 E	30–30	"	..	−1·5	−1·5	9·4	9·4	·0015	70·0	10·8	1·23	4	P	
"	3312	"	" 27.	"	10	17	57	3	2 04 E	30–30	"	..	−1·5	−1·5	9·4	9·4	·0015	70·0	10·8	1·23	4	P	
"	3313	"	" 27.	"	10	18	03	3	1 58 E	30–30	"	..	−1·5	−1·5	9·4	9·4	·0015	70·0	10·8	1·23	4	P	
"	3314	"	" 27.	"	10	18	09	3	1 52 E	30–30	"	..	−1·6	−1·6	9·4	9·4	·0015	70·0	10·8	1·23	4	P	
"	3315	"	" 27.	"	10	18	15	3	1 46 E	30–30	"	..	−1·6	−1·6	9·4	9·4	·0015	70·0	10·8	1·23	4	P	
"	3316	"	" 27.	"	10	18	23	3	1 38 E	30–30	"	..	−1·6	−1·6	9·4	9·4	·0015	70·0	10·8	1·23	4	P	
"	3317	"	" 27.	"	10	18	30	4	1 30 E	30–30	"	..	−1·6	−1·7	9·4	9·4	·0015	70·0	10·8	1·23	4	P	

α BOÖTIS 1426.

Standard 1520.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·027	− ·036	− ·009	− ·0098	− ·032	−15·81	0·38
6	38	35	+ 3	+ 22	36	17·44	1·71
7	35	29	+ 6	+ 52	32	14·69	0·74
8	32	30	+ 2	+ 12	31	13·74	1·69
9	38	32	+ 6	+ 52	35	15·04	0·39
10	39	40	− 1	− 18	40	16·63	1·20
11	43	39	+ 4	+ 32	41	16·47	1·04
12	39	36	+ 3	+ 22	38	14·76	0·67
13	39	39	0	− 8	39	14·67	0·76
14	36	40	− 4	− 48	38	13·84	1·59
15	48	49	− 1	− 18	48	16·90	1·47
	− ·414	− ·405					
		− ·414					
		− ·819					

log ...... 9·91328
log *f* .... 1·27409

log V .... 1·18737
V ... = − 15·39

V⊙ .... + 0·39
V_a .... + 9·08
V_d .... + 0·18

+ 9·65

Radial velocity .... = − 5·74

α BOÖTIS 1455.

Standard 1520.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
7	− ·022	− ·023	− ·001	− ·0007	− ·023	−10·56	0·75
8	26	24	+ 2	+ 23	25	11·08	1·27
9	24	25	− 1	− 7	24	10·31	0·50
10	26	25	+ 1	+ 13	26	10·81	1·00
11	23	24	− 1	− 7	23	9·24	0·57
12	21	25	− 4	− 37	23	8·93	0·88
13	30	25	+ 5	+ 53	27	10·16	0·35
14	22	25	− 3	− 27	24	8·74	1·07
15	28	30	− 2	− 17	29	10·21	0·40
16	26	25	+ 1	+ 13	25	8·89	0·92
17	27	27	0	+ 3	27	8·94	0·87
	− ·275	− ·278					
		− ·275					
		− ·553					

log .... = 9·74273
log *f* ..... = 1·24533

log V ..... = 0·98806
V .... = − 9·73

V⊙ ...... + 0·39
V_a ...... + 4·38
V_d ...... − 0·01

+ 4·76

Radial velocity .... = − 4·97

α BOÖTIS 1456.
Standard 1520.

Observed by / Measured by } J. S. Plaskett.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·024	− ·024	·000	+ ·0007	− ·024	−11·86	1·50
6	21	20	− 1	+ 17	20	9·52	0·84
7	22	21	− 1	+ 17	22	10·10	0·26
8	24	23	− 1	+ 17	23	19·19	0·17
9	22	27	− 5	− 43	25	10·74	0·38
10	28	30	− 2	− 13	29	12·06	1·70
11	27	23	+ 4	+ 47	25	10·04	0·32
12	24	24	0	+ 7	24	9·32	1·04
13	27	30	− 3	− 23	28	10·53	0·17
14	27	27	0	+ 7	27	9·83	0·53
15	27	32	− 5	− 43	30	10·56	0·20
16	29	33	− 4	− 33	31	10·60	0·24
17	30	34	− 4	− 33	32	10·60	0·24
18	30	27	+ 3	+ 37	29	9·29	1·07
19	33	33	0	+ 7	33	10·24	0 12
20	35	34	+ 1	+ 17	34	10·22	0·14
	− ·430	− ·442					
		− ·430					
		− ·872					

log........= 9·94052
log f .... = 1·07349

log V. ....= 1·01401
V.. ..= −10·33

V☉........= + 0·39
V_a. ....= + 4·37
V_d. ..... .= − 0·07

+ 4·69

Radial velocity. ....= − 5·64

α BOÖTIS 1514.
Standard 1520.

Observed by / Measured by } J. S. Plaskett.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
4	− ·006	+ ·004	+ ·010	+ ·0110	− ·001	−0·51	3·30
5	+ 3	7	+ 4	+ 50	+ 5	+2·47	0·32
6	9	6	− 3	− 20	7	3·33	0·54
7	10	10	0	+ 10	10	4·59	1·80
8	12	9	− 3	− 20	10	4·43	1·64
9	5	7	+ 2	+ 30	6	2·58	0·21
10	11	8	− 3	− 20	10	4·16	1·37
11	12	3	− 9	− 80	8	3·21	0·42
12	4	6	− 2	+ 30	5	1·94	0·85
13	10	4	− 6	− 50	7	2·63	0·16
14	5	4	− 1	0	5	1·82	0·97
15	11	6	− 5	− 40	8	2·82	0·03
	+ ·086	+ ·074					
		+ ·086					
		+ ·160					

log........= 9·20412
log f ......= 1·24332

log V.. ..= 0·44744
V......= + 2·80

V☉........= + 0·39
V_a. ....= − 8·91
V_d.........= − 0·19

− 8·71

Radial velocity............= − 5·91

α BOÖTIS 1515.

Standard 1520.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	+ ·001	+ ·005	+ ·0004	+ ·0048	+ ·003	+ 1·48	1·48
6	8	9	+ 1	+ 18	8	3·81	0·85
7	7	9	+ 2	+ 28	8	3 67	0·71
8	6	7	+ 1	+ 18	7	3·10	0·14
9	10	5	− 5	− 42	8	3·44	0·48
10	6	4	− 2	− 12	5	2·08	0·88
11	9	5	− 4	− 32	7	2·81	0·15
12	8	8	0	+ 8	8	3·11	0·15
13	9	7	− 2	− 12	8	3·01	0·05
14	12	12	0	+ 8	12	4·37	1·41
15	8	6	− 2	− 12	7	2·46	0·50
16	11	10	− 1	− 2	10	3·42	0·46
17	6	4	− 2	− 12	5	1·66	1·30
	+ ·101	+ ·091					
		+ ·101					
		+ ·192					

log... .... = 9·28330
log f ...... = 1·18647
log V. ... = 0·46977
V..... = + 2·95

V☉........ = + 0·39
V_a......... = − 8·92
V_d......... = − 0·20
− 8·73
Radial velocity............ = − 5·78

α BOÖTIS 1529.

Standard 1520.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
7	+ ·015	+ ·014	− ·001	− ·0001	+ ·015	+ 6·89	0·25
8	20	15	− 5	− 41	17	7·53	0·89
9	17	20	+ 3	+ 39	19	8·16	1·52
10	14	14	0	+ 9	14	5·82	0·82
11	19	13	− 6	− 51	16	6 43	0·21
12	15	18	+ 3	+ 39	16	6·21	0·43
13	14	12	− 2	− 11	13	4·89	1·75
14	21	21	0	+ 9	21	7·65	1·01
15	18	17	− 1	− 1	18	6 34	0·30
16	19	19	0	+ 9	19	6·49	0·15
	+ ·172	+ ·163					
		+ ·172					
		+ ·335					

log......... = 9·52504
log f ...... = 1·29412
log V.. ... = 0 81916
V .... . = + 6·59

V☉...... = + 0·39
V_a......... = −13·10
V_d... ..... − 0·02
−12·73
Radial velocity. .... = − 6·14

α BOÖTIS 1585.

Standard 1520.

Observed by, Measured by } J. S. Plaskett.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	+ ·020	+ ·030	+ ·010	+ 013	+ ·025	+ 12·35	1·74
6	28	31	+ 3	+ 6	29	13·80	0·29
7	34	29	− 5	− 2	32	14·69	0·60
8	31	30	− 1	+ 2	30	13 30	0·79
9	31	28	− 3	0	30	12·89	1·20
10	35	36	+ 1	+ 4	35	14·55	0·46
11	38	36	− 2	+ 1	37	14·86	0·77
12	34	30	− 4	− 1	32	12·43	1·66
13	45	32	− 13	− 10	39	14 67	0·58
14	47	39	− 8	− 5	43	15·66	1·57
15	44	37	− 7	− 4	40	14·08	0·01
16	48	38	− 9	− 6	44	15·04	0·95
17	45	45	0	+ 3	45	14·90	0·81

+ ·480   + 442
+ ·480
+ ·922

log .... = 9·96473   V⊙ ... = + 0·39
log f .... = 1·18647 V_a .... = − 20·01
V_d .... = − 0·13
log V .... = 1·15120
V .... = + 14·16   − 19·75
Radial velocity .... = − 5·59

α BOÖTIS 1586.

Standard 1520.

Observed by, Measured by J. S. Plaskett.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
7	+ ·028	+ ·024	− ·004	+ ·0008	+ ·026	+ 11·94	1·90
8	32	27	− 5	− 2	29	12·85	0·99
9	32	32	0	+ 48	32	13·75	0·09
10	37	31	− 6	− 12	34	14 13	0·29
11	37	32	− 5	− 2	35	14·06	0·22
12	39	38	− 1	+ 38	38	14·76	0·92
13	38	35	− 3	+ 18	37	13·92	0·08
14	43	31	− 12	− 72	37	13·48	0·36
15	46	37	− 9	− 42	42	14·79	0·95
16	45	42	− 3	+ 18	43	14·70	0·8

+ ·377   + ·329
+ ·377
+ ·706

log .... = 9·84880   V⊙ ... = + 0·39
log f .... = 1·29412 V_a ... = − 20·02
V_d .... = − 0·21
log V .... = 1·14292
V .... = + 13·90   − 19·84
Radial velocity ..... = − 5·94

α BOÖTIS 1588.

Standard 1520.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
7	+ ·035	+ ·024	− ·011	− ·0055	+ 030	+13·77	0·65
8	30	25	− 5	+ 5	28	12·41	0·71
9	31	30	− 1	+ 45	30	12·89	0·23
10	38	31	− 7	− 15	35	14·55	1·43
11	38	30	− 8	− 25	34	13·66	0·54
12	32	26	− 6	− 5	29	11·26	1·86
13	38	28	− 10	− 45	33	12·41	0·71
14	35	37	+ 2	+ 75	36	13·11	0·01
15	43	35	− 8	− 25	39	13·73	0·61
16	40	35	− 5	+ 5	37	12·65	0·47
17	43	41	− 2	+ 35	42	13 91	0·79
	+ ·403	+ ·342					
		+ ·403					
		+ ·745					

log ..... = 9·87216 V⊙... = + 0·39
log f ... = 1 24533 V_a .... = −20·48
V_d..... = + 0·05
log V.... = 1·11749
V.... = +13·11 −20·04
Radial velocity......... = − 6 93

α BOÖTIS 1595.

Standard 1520.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
7	+ ·039	+ ·033	− ·006	− ·003	+ ·036	+16·53	0·09
8	40	38	− 2	+ 1	39	17·28	0·66
9	37	41	+ 4	+ 7	39	16·76	0·14
10	41	36	− 5	− 2	39	16·21	0·41
11	44	45	+ 1	+ 4	44	17·67	1·05
12	46	42	− 4	− 1	44	17·09	0·47
13	50	44	− 6	− 3	47	17·68	1·06
14	50	43	− 7	− 4	46	16 75	0·13
15	46	43	− 3	0	45	15·84	0·78
16	47	43	− 4	− 1	45	15·38	1·24
17	50	52	+ 2	+ 5	51	16·89	0·27
18	51	45	− 6	− 3	48	15·38	1·24
	+ ·541	+ ·505					
		+ ·541					
		+1·046					

log ...... = 0·01953 V⊙... = + 0·39
log f .. . = 1·20008 V_a .... = −20·98
V_d .... − 0·13
log V.... = 1·21961
V.... = +16·58 −20·72
Radial velocity......... = − 4·14

α BOÖTIS 1596.

Standard 1520.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	+ ·024	+ ·031	+ ·007	+ ·0079	+ ·028	+13·83	1·44
6	31	29	− 2	− 11	30	14·28	0·99
7	32	30	− 2	− 11	31	14·23	1·04
8	33	34	+ 1	+ 19	33	14·63	0·64
9	34	36	+ 2	+ 29	35	15·04	0·23
10	33	35	+ 2	+ 29	34	14·13	1·14
11	38	40	+ 2	+ 29	39	15·67	0·40
12	41	40	− 1	− 1	41	15·92	0·65
13	47	40	− 7	− 61	43	16·18	0·89
14	48	46	− 2	− 11	47	17·12	1·85
15	51	44	− 7	− 61	47	16·55	1·28
16	47	40	− 7	− 61	44	15·04	0·23
17	47	49	+ 2	+ 29	48	15·89	0·62

+ ·506   + ·494
+ ·506
+1·000

log .... = 0·00000
log f .... = 1·18647
log V .... = 1·18647
V .... = +15·36

V⊙ .... = + 0·39
V_a .... = − 21·19
V_d .... = + 0·05
− 20·75

Radial velocity .... = − 5·39

α BOÖTIS 1597.

Standard 1520.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	+ ·026	+ ·026	·000	+ ·0013	+ ·026	+ 12·84	1·80
6	29	28	− 1	+ 3	29	13.80	0·84
7	35	32	− 3	− 17	33	15·15	0·51
8	31	32	+ 1	+ 23	32	14 18	0·46
9	37	31	− 6	− 47	34	14·61	0·03
10	32	30	− 2	− 7	31	12·89	1·75
11	41	36	− 5	− 37	38	15·26	0·62
12	35	41	+ 6	+ 73	38	14·76	0·12
13	41	45	+ 4	+ 53	43	16·18	1·54
14	42	39	− 3	− 17	41	14·93	0·29
15	44	41	− 3	− 17	43	15 14	0·50
16	46	43	− 3	− 17	44	15·04	0·40
17	48	46	− 2	− 7	47	15·56	0·92

+ ·487   + ·470
+ ·487
+ ·957

log . .. = 0·98091
log f .... = 1·18047
log V ... = 1·16738
V ... = +14·70

V⊙ .... = + 0·39
V_a .... = − 21·20
V_d .... = + 0·03
− 20·78

Radial velocity............ = − 6·08

α BOÖTIS 1606.

Standard 1520.

Observed by, Measured by } J. S. Plaskett.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	+ ·030	+ ·027	− ·003	− ·0015	+ ·029	+14·33	1·75
6	33	32	− 1	+ 5	32	15 23	0·95
7	34	37	+ 3	+ 45	36	16·53	0·35
8	38	37	− 1	+ 5	37	16·40	0·22
9	42	41	− 1	+ 5	41	17·62	1·44
10	37	38	+ 1	+ 25	38	15·80	0·38
11	43	38	− 5	− 35	40	16·07	0·11
12	42	40	− 2	− 5	41	15·92	0·26
13	43	40	− 3	− 15	42	15·80	0·38
14	47	44	− 3	− 15	45	16·39	0·21
15	48	51	+ 3	+ 45	50	17·60	1·42
16	51	45	− 6	− 45	48	16·41	0·23

+ ·488   + ·470
+ ·488

+ ·958

log....... = 9·98137   V☉.... = + 0·39
log f ..... = 1·22877 V_a..... = − 21 82
V_d...... = − 0·17
log V. ... = 1·21014
V. ...= +16·22   − 21·62
Radial velocity.......... = − 5·40

α BOÖTIS 1615.

Standard 1520.

Observed by, Measured by } J. S. Plaskett.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
6	+ ·033	+ ·033	·000	− ·0004	+ ·033	+15 71	0·78
7	38	38	0	− ·0004	+ ·038	17·45	0·96
8	44	38	− 6	− 64	41	18·17	1·68
9	41	39	− 2	− 24	40	17·19	0·70
10	37	42	+ 5	+ 46	40	16·63	0·14
11	43	44	+ 1	+ 6	43	17·27	0·78
12	45	43	− 2	− 24	44	17·09	0·60
13	42	46	+ 4	+ 36	44	16·55	0·06
14	45	47	+ 2	+ 16	46	16·75	0·26
15	41	43	+ 2	+ 16	42	14·79	1·70
16	47	44	− 3	− 34	46	15 72	0·77
17	42	46	+ 4	+ 36	44	14·57	1·92

+ ·498   + ·503
+ ·498

+1·001

log....... = 0·00043   V☉.... = + 0·39
log f ..... = 1·21346 V_a .. ..= − 22·99
V_d...... = 0·00
og V..... = 1·21479
V..... = +16·40   − 22·60
Radial velocity... .... .= − 6·20

α BOÖTIS 1616.

Standard 1520.

Observed by / Measured by } J. S. PLASKETT.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
6	+ ·029	+ ·030	+ ·001	+ ·0023	+ ·030	+14·28	1·58
7	33	32	− 1	+ 3	32	14·69	1·17
8	38	34	− 4	− 27	36	15·96	0·10
9	37	31	− 6	− 47	34	14·61	1·25
10	35	37	+ 2	+ 33	36	14·97	0·84
11	39	35	− 4	− 27	37	14·86	1·00
12	44	44	0	+ 13	44	17·09	1·23
13	44	42	− 2	− 7	43	16·18	0·32
14	51	46	− 5	− 37	48	17·48	1·62
15	46	48	+ 2	+ 33	47	16·55	0·69
16	51	50	− 1	+ 3	50	17·09	1·23
17	48	50	+ 2	+ 33	50	16·56	0·70
	+ ·495	+ ·479					
		+ ·495					
		+ ·974					

log...... = 9·98856   V⊙... = + 0·39
log f .... = 1·21436 V_a.... = −23·00
V_d .... = − 0·17
log V.... = 1·20292
V... = + 15·96   −22·78
Radial velocity........... = − 6·82

α BOÖTIS 1619.

Standard 1520.

Observed by / Measured by } J. S. PLASKETT.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	+ ·036	+ ·033	− ·003	− ·0024	+ ·035	+17·29	0·45
6	38	36	− 2	− 14	37	17·61	0·13
7	39	36	− 3	− 24	37	16·99	0·75
8	38	41	+ 3	+ 36	39	17·28	0·46
9	37	44	+ 7	+ 76	41	17·62	0·12
10	44	42	− 2	− 14	43	17·88	0·14
11	48	45	− 3	− 24	46	18·48	0·74
12	47	48	+ 1	+ 16	48	18·64	0·90
13	47	46	− 1	− 4	47	17·68	0·06
14	50	50	0	+ 6	50	18·21	0·47
15	53	52	− 1	− 4	52	18·31	0·57
16	53	51	− 2	− 14	52	17·77	0·03
17	53	54	+ 1	+ 16	54	17·88	0·14
18	58	52	− 6	− 44	55	17·62	0·12
19	56	56	0	+ 6	56	17·38	0·36
20	56	57	+ 1	+ 16	57	17·13	0·61
	+ ·753	+ ·743					
		− ·753					
		1·496					

log.... = 0·17667   V⊙.... = + 0·39
log f .. = 1·07349 V_a...... = − 23·32
V_d.. ... = − 0·01
log V.. = 1·25016
V.. = + 17·80   − 22·94
Radial velocity ... ... = − 5·14

α BOÖTIS 1620.

Standard 1520.

Observed by }
Measured by } J. S. PLASKETT.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
6	+ ·036	+ ·028	− ·008	− ·0073	+ ·032	+15·23	1·93
7	37	38	+ 1	+ 17	37	16·99	0·17
8	35	26	+ 1	− 17	36	15·96	1·20
9	40	38	− 2	− 13	39	16·76	0·40
10	40	41	+ 1	− 17	41	17·04	0·12
11	45	46	+ 1	+ 17	45	18·08	0·92
12	50	46	− 4	− 33	48	18·64	1·48
13	48	45	− 3	− 23	47	17·68	0·52
14	49	49	0	+ 7	49	17·85	0.69
15	47	52	+ 5	+ 57	49	17·25	0·09
16	53	49	− 4	− 33	51	17·43	0·27
17	52	53	+ 1	+ 17	53	17·55	0·39
18	55	58	+ 3	− 23	56	17·94	0·78
19	52	50	− 2	− 12	51	15·83	1·33
	+ ·639	+ ·629					
		+ ·639					
		+1·268					

log ...... = 0·10312
log f .... = 1·13236
log V.... = 1 23548
V.... = +17·20

V⊙..... = + 0·39
V_a...... = −23·32
V_d...... = − 0·03
−22·96

Radial velocity............ = − 5·76

α BOÖTIS 1622.

Standard 1520.

Observed by }
Measured by } J. S. PLASKETT.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
6	+ ·043	+ ·041	− ·002	− ·0002	+ ·042	+19·99	1·38
7	41	47	+ 6	+ 78	44	20·19	1·58
8	42	41	− 1	+ 8	42	18·61	0·00
9	43	40	− 3	− 12	42	18·05	0·56
10	38	41	+ 3	+ 48	40	16·63	1·98
11	48	47	− 1	+ 8	47	18·88	0·27
12	49	48	− 1	+ 8	49	19·03	0·42
13	49	52	+ 3	+ 48	50	18·81	0·20
14	53	50	− 3	− 12	52	18·94	0·33
15	57	47	− 10	− 82	52	18·31	0·30
16	56	53	− 3	− 12	55	18·80	0·19
17	55	56	+ 1	+ 28	55	18·21	0·40
18	66	55	− 11	− 92	60	19·22	0·61
19	56	56	0	+ 18	56	17·38	1·23
20	62	57	− 5	− 32	60	18·04	0·57
	+ ·758	+ ·731					
		+ ·758					
		+1·489					

log ..... = 0·17289
log f .... = 1·09483
log V ... = 1·26772
V ... = +18·52

V⊙..... = + 0·39
V_a ..... = −23·33
V_d.... = − 0·16
−23·10

Radial velocity.......... = − 4·58

α BOÖTIS 1635.

Standard 1520.

Observed by } J. S. Plaskett.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
6	+ ·042	+ ·042	·000	+ ·0021	+ ·042	+19·99	0·43
7	49	43	− 6	− 39	46	21·12	1·56
8	47	42	− 5	− 29	44	19·50	0·06
9	43	44	+ 1	+ 31	44	18·91	0·65
10	51	44	− 7	− 49	48	19·95	0·39
11	53	48	− 5	− 29	50	20·08	0·52
12	47	52	+ 5	+ 71	50	19·41	0·15
13	54	50	− 4	− 19	52	19·56	0·00
14	55	58	+ 3	+ 51	56	20·40	0·84
15	57	54	− 3	− 9	56	19·72	0·16
16	59	54	− 5	− 29	56	19·14	0·42
17	55	58	+ 3	+ 51	57	18·87	0·69
18	62	55	− 7	− 49	58	18·58	0·98
19	59	60	+ 1	+ 31	60	18·62	0·94

+ ·733   + ·704
+ ·733
+1·437

log ...... = 0·15746   V☉.. ... = + 0·89
log*f* ...... = 1·13236 V_a........ = −23·76
V_d........ = − 0·05
log V...... = 1·28982
V..... = +19·49   −23·42
Radial velocity.... ...... = − 3·93

α BOÖTIS 1645.

Standard 1520.

Observed by } J. S. Plaskett.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
6	+ ·041	+ ·034	− ·007	− ·0054	+ ·038	+18·09	0·65
7	46	43	− 3	− 14	44	20·20	1·46
8	46	39	− 7	− 54	43	19·06	0·32
9	43	41	− 2	− 4	42	18·05	0·69
10	43	39	− 4	− 24	41	17·04	1·70
11	51	49	− 2	− 4	50	20·08	1·34
12	52	51	− 1	− 6	51	19·80	1·06
13	52	53	+ 1	+ 26	52	19·56	0·92
14	54	51	− 3	− 14	53	19·30	0·56
15	50	53	+ 3	+ 46	52	18·31	0·43
16	58	54	− 4	− 24	56	19·14	0·40
17	57	56	− 1	− 6	56	18·54	0·20
18	59	59	0	− 16	59	18·90	0·16
19	56	64	+ 8	96	60	18·62	0·12
20	61	53	− 8	− 64	57	17·13	1·61
21	60	65	+ 5	− 66	62	18·09	0·65

+ ·829   + ·804
+ ·829
+1·633

log........ = 0·21299   V☉....... = + 0·39
log*f* ...... = 1·05938 V_a.... ... = −24·02
V_d........ = − 0·03
log V ..... = 1·27237
V ..... = +18·72   −23·66
Radial velocity..... ...... = − 4·94

α BOÖTIS 1662.

Standard 1520.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
6	+ ·047	+ ·044	− ·003	− ·0007	+ ·045	+21·42	1·76
7	47	43	− 4	− 17	45	20·66	1·00
8	46	41	− 5	− 27	44	19·50	0·16
9	47	47	0	+ 23	47	20·20	0·54
10	46	45	− 1	+ 13	45	18·71	0·95
11	50	48	− 2	+ 3	49	19·68	0·02
12	59	49	− 10	− 77	54	20·97	1·31
13	56	53	− 3	− 7	54	20·31	0·65
14	52	52	0	+ 23	52	18·94	0·72
15	54	52	− 2	+ 3	53	18·66	1·00
16	57	55	− 2	+ 3	56	19·14	0·52
17	52	56	+ 4	+ 63	54	17·88	1·78
	+ ·613	+ ·585					
		+ ·613					
		+1·198					

log ...... = 0·07846 V⊙.... = + 0·39

log f .... = 1·21436 V_a...... = −24·86

V_d...... = − 0·10

log V..... = 1·29282

V..... = +19·63 −24·57

Radial velocity. ...... = − 4·94

α BOÖTIS 1671.

Standard 1520.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	+ ·031	+ ·038	+ ·007	+ ·0056	+ ·035	+17·29	1·30
6	42	44	+ 2	+ 6	43	20·47	1·88
7	45	42	− 3	− 44	43	19·74	1·15
8	42	44	+ 2	+ 6	43	19·06	0·47
9	42	44	+ 2	+ 6	43	18·48	0·11
10	45	46	+ 1	− 4	45	18·70	0·11
11	48	45	− 3	− 44	47	18·88	0·29
12	47	52	+ 5	+ 36	49	19·03	0·44
13	50	50	0	− 14	50	18·81	0·22
14	50	51	+ 1	− 4	51	18·57	0·02
15	52	53	+ 1	− 4	52	18·31	0·28
16	55	55	0	− 14	55	18·80	0·21
17	52	55	+ 3	+ 16	54	17·88	0·71
18	57	56	− 1	− 24	56	17·95	0·78
19	54	58	+ 4	+ 26	56	17·38	1·21
20	59	60	+ 1	− 4	60	18·04	0·55
	+ ·771	+ ·793					
		+ ·771					
		+1·564					

log ..... = 0·19424 V⊙ . . = + 0·39

log f . . . . = 1·07349 V_a...... = −24·98

V_d...... = − 0·11

log V..... = 1·26773

V..... = +18·52 −24·70

Radial velocity. .... = − 6·18

α BOÖTIS 1672.

Standard 1520.

Observed by } J. S. Plaskett.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
6	+ ·040	+ ·036	− ·004	− ·0031	+ ·038	+ 18·09	1·47
7	44	45	+ 1	+ 19	44	20·20	0·74
8	44	48	+ 4	+ 49	46	20·39	0·93
9	44	48	+ 4	+ 49	46	19·77	0·21
10	47	44	− 3	− 21	46	19·12	0·44
11	48	51	+ 3	+ 39	49	19·68	0·12
12	53	53	0	+ 9	53	20·58	1·02
13	49	52	+ 3	+ 39	51	19·19	0·37
14	59	51	− 8	− 71	55	20·03	0·47
15	56	54	− 2	− 11	55	19·37	0·19
16	59	53	− 6	− 51	56	19·14	0·42
17	59	61	+ 2	+ 29	60	19·87	0·31
18	62	61	− 1	− 1	61	19·54	0·02
19	63	58	− 5	− 41	61	18·93	0·63
	+ ·727	+ ·715					
		+ ·727					
		+ 1·442					

log . . . . = 0·15897 V⊙ . . . . = + 0·39
log f . . . . = 1·13236 V_a . . . . . = − 24·95
V_d . . . . = − 0·14
log V . . . . = 1·29133
V . . . . = + 19·56 − 24·70
Radial velocity . . . . = − 5·14

α BOÖTIS 1709.

Standard 1520.

Observed by } J. S. Plaskett.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
6	+ ·045	+ ·045	·000	− ·0001	+ ·045	+ 21·42	1·11
7	49	48	− 1	0	48	22·04	1·73
8	48	48	0	− 1	48	21·28	0·97
9	48	51	+ 3	+ 29	50	21·48	1·17
10	50	47	− 3	− 31	49	20·37	0·06
11	53	56	+ 3	+ 29	54	21·69	1·38
12	48	55	+ 7	+ 69	52	20·19	0·12
13	55	55	0	− 1	55	20·69	0·38
14	57	56	− 1	0	56	20·40	0·09
15	53	56	+ 3	+ 29	55	19·37	0·94
16	56	53	− 3	− 31	55	18·80	1·51
17	58	58	0	− 1	58	19·20	1·11
18	63	61	− 2	− 21	62	19·86	0·45
19	64	60	− 4	− 41	62	18·64	1·67
20	67	66	− 1	0	66	19·25	1·06
	+ ·814	+ ·815					
		+ ·814					
		+ 1·629					

log . . . . = 0·21192 V⊙ . . . . = + 0·39
log f . . . . = 1·09483 V_a . . . . . = − 25·14
V_d . . . . . = − 0·14
log V . . . . = 1·30675
V . . . = 20·27 − 24·89
Radial velocity . . . . = − 4·62

a BOÖTIS 3126.

Standard 3171.

Slit ·001

Observed by / Measured by } J. S. Plaskett.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·020	− ·032	− ·012	+ ·0077	− ·0260	− 34·12	1·41
6	25	32	− 7	− 27	285	35·87	3·16
7	26	28	− 2	− 23	270	32·66	·05
8	25	31	6	+ 17	280	32·58	·13
9	29	33	− 4	− 3	310	34·66	1·95
10	27	22	+ 5	− 93	245	26·39	6·32
	− ·152	− ·178					
	− ·178						
	− ·330						

log.... = 9·51851
log *f* . = 1·99438

log V.. = 1·51289
V.. = − 32·58

V⊙.... = + ·26
V_a..... = + 25·96
V_d..... = + ·22
+ 26·44

Radial velocity............... = − 6·14

a BOÖTIS 3127.

Standard 3171.

Slit ·001

Observed by / Measured by } J. S. Plaskett.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·026	− ·030	− ·004	+ ·0005	− ·0280	− 36·75	2·40
6	27	28	− 1	− 25	275	34·61	·26
7	25	28	− 3	− 5	265	32·05	2·30
8	31	30	+ 1	− 45	305	35·49	1·14
9	29	34	− 5	− 30	315	35·22	·87
10	28	35	− 7	+ 35	315	33·93	·42
11	27	33	− 6	+ 25	300	31·21	3·13
12	33	38	− 5	+ 15	355	35·54	1·19
	− ·226	− ·256					
	− ·256						
	− ·482						

log.... = 9·68305
log *f* .. = 1·85232

log V.. = 1·53537
V.. = − 34·31

V⊙.... = + 0·26
V_a..... = + 25·96
V_d..... = + ·22
+ 26·44

Radial velocity............... = − 7·87

α BOÖTIS 3128.

Standard 3171.

Slit ·001. Observed by / Measured by } J. S. Plaskett.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·020	− ·026	+ ·006	+ ·0012	− ·0230	−30·19	1·78
6	21	29	+ 8	+ 32	250	31·47	·50
7	28	33	+ 5	+ 2	305	36·89	4·92
8	25	30	+ 5	+ 2	275	32·00	·03
9	28	31	+ 3	− 18	295	32·99	1·02
10	27	29	+ 2	− 28	280	30·16	1·81
11	27	33	+ 6	+ 12	300	31·21	·76
12	29	35	+ 6	+ 12	320	32·03	·06
13	31	33	+ 2	− 28	320	30·81	1·16

− ·236   − ·279
− ·279
− ·515

log . = 9·71181
log f ... = 1·79244
log V ... = 1·50425
V ... = −31·93

V⊙ .... = + 0·26
V_a ...... = + 25·96
V_d ...... = + ·22
+ 26·44

Radial velocity. . ... = − 5·49

α BOÖTIS 3129.

Standard 3171.

Slit ·001. Observed by / Measured by } J. S. Plaskett.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·023	− ·031	+ ·008	+ ·0051	− ·0270	−35·44	2·29
6	28	25	− 3	− 59	265	33·35	·20
7	30	27	+ 3	+ 1	285	34·47	1·32
8	24	32	+ 8	+ 51	280	32·58	·57
9	29	26	− 3	− 59	275	30·75	2·40
10	30	30	0	− 29	300	32·31	·84
11	28	35	+ 7	+ 41	315	32·77	·38

− ·192   − ·206
− ·206
− ·398

log..... = 9·59988
log f .... = 1·91891
log V ... = 1·51879
V ... = −33·02

V⊙ ..... = + 0·26
V_a ...... = + 25·96
V_d ...... = + ·22
+ 26·44

Radial velocity.... .... = − 6·58

α BOÖTIS 3130.

Standard 3171.

Slit ·001

Observed by / Measured by } J. S. Plaskett.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·020	− ·025	+ ·005	+ ·0033	− ·0225	−29·53	2 25
6	23	28	+ 5	+ 33	255	32·09	·31
7	24	29	+ 5	+ 33	265	32·05	·27
8	24	27	+ 3	+ 13	255	29·67	2·11
9	29	28	− 1	− 27	285	31·87	·09
10	33	30	− 3	− 47	315	33·93	2·15
11	33	31	− 2	− 37	320	33·29	1·51

− ·186 − ·198
− ·198

− ·384

log....... = 9·58433
log f ..... = 1·91891

log V.... = 1·50324
V.... = − 31·86

V⊙.. = + 0·26
V_a ... = + 25·96
V_d ... = + ·22

+ 26·44

Radial velocity...... . = − 5·42

α BOÖTIS 3146.

Standard 3171.

Slit ·001

Observed by / Measured by } J. S. Plaskett.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·026	− ·026	·000	− ·0012	− ·0260	−34·12	·25
6	25	31	+ 3	+ 18	280	35·24	·87
7	28	32	+ 2	+ 8	300	36·29	1·92
8	33	32	− 1	− 22	325	37·82	3·45
9	29	31	+ 2	+ 8	300	33·55	·82
10	29	28	− 1	− 22	285	30·70	3·67
11	31	30	− 1	− 22	305	31·73	2·64
12	32	38	+ 6	+ 48	350	35·54	1·17

− ·233 − ·248
− ·248

− ·481

log....... = 9·68215
log f ..... = 1·85232

log V.... = 1·53447
V.... = − 34·24

V⊙.. = + 0·26
V_a... = + 25·37
V_d... = + 0·07

+ 25·70

Radial velocity..... . = − 8·54

α BOÖTIS 3147a.

Standard 3171.

Slit ·001.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·026	− ·028	− ·002	+ ·0018	− ·0270	−35·44	3·14
6	24	31	− 7	− 32	275	34·62	2·32
7	26	34	− 8	− 42	300	36·29	3·99
8	26	31	− 5	− 12	285	33·16	0·86
9	28	27	+ 1	+ 48	275	30·75	1·55
10	27	26	+ 1	+ 48	265	28·54	3·86
11	29	28	+ 1	+ 48	285	29·65	2·65
12	25	34	− 9	− 52	295	29·53	2·77
13	31	37	− 6	− 22	340	32·74	0·44

− ·242 − ·276
− ·276
− ·518

log.... ..= 9·71433 V⊙..... = + 0·26
log f .....= 1·79244 Vα..... = +25·37
Vd. .... = + 0·07
log V.....= 1·50677
V.. .= − 32·12 +25 70
Radial velocity............. = − 6.42

α BOÖTIS 3147b.

Standard 3171.

Slit ·001.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·024	− .025	+ ·001	+ ·0013	− ·0245	−32·16	0·93
6	26	26	0	+ 23	260	32·73	1·50
7	23	28	+ 5	− 27	255	30·84	0·39
8	24	32	+ 8	− 57	280	32·58	1·35
9	27	31	+ 4	− 17	290	32·43	1·20
10	27	26	− 1	+ 33	265	28·54	2·89
11	25	28	+ 3	− 7	265	27·57	3·66
12	29	32	+ 3	− 7	305	30·54	0·69
13	36	34	− 2	+ 43	350	33·70	2·47

− ·241 − ·262
− ·262
− ·503

log .. . = 9·70157 V⊙ ..... = + 0·26
log f .... = 1 79244 Vα....... = +25·37
Vd... . . = + 0·07
log V.... = 1·49401
V.... = − 31·19 +25·70
Radial velocity .... = − 5·49

α BOÖTIS 3147c.

Standard 3171.

Slit ·001.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·021	− ·028	+ ·007	+ ·0028	− ·0245	−32·16	·95
6	25	26	+ 1	− 32	255	32 10	·89
7	26	30	+ 4	− 2	280	33·87	2·66
8	26	29	+ 3	− 12	275	32·00	·79
9	27	29	+ 2	− 22	280	31·31	·10
10	25	30	+ 5	+ 8	275	29·62	1·59
11	23	30	+ 7	+ 28	265	27·57	3·64
12	26	33	+ 7	+ 28	295	29·53	1·68
13	33	35	+ 2	− 22	340	32·74	1·53

− ·232 − ·270
− ·270
− ·502

log.......... = 9·76070
log f........ = 1·79244
log V........ = 1 49314
V. . .... = −31·13

V⊙... .... = + 0·26
V_a......... = +25·37
V_d .. .. = + ·07
+25·70

Radial velocity ... .= − 5·43

α BOÖTIS 3148a.

Standard 3171.

Slit ·001.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·027	·033	+ ·006	+ ·0025	− ·0300	−39·37	5·99
6	26	26	0	− 35	260	32·73	65
7	28	29	+ 1	− 25	285	34·47	1·09
8	29	30	+ 1	− 25	295	34 43	·95
9	26	31	+ 5	+ 15	285	31·87	1·51
10	28	31	+ 3	− 05	295	31·77	1·61
11	28	32	+ 4	+ 05	300	31·21	2·17
12	31	33	+ 2	− 15	320	32 03	1·35
13	31	37	+ 6	+ 25	340	32·74	·64
14	32	38	+ 6	+ 25	350	32·53	·85
15	36	40	+ 4	+ 05	380	34·12	·74

− ·322 − ·360
− ·360
− ·682

log ... . =9·83378
log f........ =1·68810
logV .... =1·52188
V ..... . = −33·26

V⊙ .... = + 0·26
V_a .... = +25·37
V_d .... = + ·07
+25·70

Radial velocity .... = − 7·56 α BOÖTIS 3148*b*.

Standard 3171.

Observed by } J. S. PLASKETT.
Measured by }

Slit ·001.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	−·023	−·024	+·001	−·0009	−·0235	−30·84	1·74
6	30	26	− 4	− 59	280	35·25	2·67
7	27	28	+ 1	− 9	275	33·26	·68
8	29	30	+ 1	− 9	295	34·33	1·75
9	29	32	+ 3	+ 11	305	34·11	1·53
10	28	27	− 1	− 29	275	29·62	2·96
11	27	33	+ 6	+ 41	300	31·21	1·37
12	33	35	+ 2	+ 1	340	34·04	1·46
13	31	33	+ 2	+ 1	320	30·81	1·77
14	34	37	+ 3	+ 11	355	32·99	·41
15	32	39	+ 7	+ 51	355	31·87	·71

−·323	−·344	
−·344		
−·667		

log..... = 9·82413   V⊙.... = − 0·26
log *f* ... = 1·68810 V_a.. .. = +25·37
   V_d..... = + ·07
log V.... = 1·51223
V.... = −32·53   +25·70
Radial velocity.......... = − 6·83

α BOÖTIS 3148c

Standard 3171.

Observed by } J. S. PLASKETT.
Measured by }

Slit ·001.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	−·022	−·028	+·006	+·0022	−·0250	−32·81	·71
6	26	29	+ 3	− 8	275	34·62	2·52
7	28	31	+ 3	− 8	295	35·68	3·58
8	28	33	+ 5	+ 12	305	35·49	3·39
9	26	29	+ 3	− 8	275	30·75	1·35
10	30	32	+ 2	− 18	310	33·39	1·29
11	29	31	+ 2	− 18	300	31·21	·89
12	26	33	+ 7	+ 32	295	29·53	2·57
13	29	32	+ 3	− 8	305	29·37	2·73
14	29	35	+ 6	+ 22	320	29·74	2·36
15	33	35	+ 2	− 18	340	30·53	1·57

−·306	−·348	
−·348		
−·654		

log ..... = 9·81558   V⊙.... = + 0·26
log *f* .. = 1·68810 V_a..... = +25·37
   V_d..... = + ·07
log V.... = 1·50368
V.... = −31·89   +25·70
Radial velocity. . ..... = − 6·19

α BOÖTIS 3149a.

Standard 3171.

Observed by } J. S. Plaskett.
Measured by }

Slit ·001.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·022	− ·024	+ ·002	− ·0046	− ·0230	− 30·19	1·13
6	25	33	+ 8	+ 14	290	36·51	5·19
7	24	31	+ 7	+ 4	275	33·26	1·94
8	23	32	+ 9	+ 24	275	32·00	·68
9	25	31	+ 6	− 6	280	31·31	·01
10	24	33	+ 9	+ 24	285	30·70	·62
11	23	28	+ 5	− 16	2 5	26·53	4·79
12	28	36	+ 8	+ 14	320	32 04	·72
13	28	33	+ 5	− 16	305	29 37	1·95

− ·222   − ·281
− ·281

− ·503

log .... = 9·70157   V⊙ ... = + 0·26
log *f* ...... = 1·79244 V_a .... = +25·37
V_d .... = + ·07

log V ...... = 1·49401
V ... = − 31·19   +25·70
Radial velocity .... = − 5·49

α BOÖTIS 3149b

Standard 3171.

Observed by } J. S. Plaskett.
Measured by }

Slit ·001.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·020	− ·025	+ ·005	− ·0017	− ·0225	− 29·53	·63
6	23	28	+ 5	− 17	255	32·10	1·94
7	22	30	+ 8	+ 13	260	31·45	1·29
8	24	29	+ 5	− 17	265	30·84	·32
9	27	28	+ 1	− 57	275	30·75	·41
10	22	30	+ 8	+ 13	260	28·00	2·16
11	20	31	+ 11	+ 43	255	26·53	3·63
12	24	35	+ 11	+ 43	295	29·53	·63
13	31	37	+ 6	− 7	340	32·74	2·58

− ·213   − ·273
− ·273

− ·486

log .... = 9·68664   V⊙ ... = + 0·26
log *f* ...... = 1·79244 V_a ... = +25·37
V_d .... = + ·07

log V ...... = 1·47908
V .. = − 30·14   +25·70
Radial velocity .... = − 4·44

α BOÖTIS 3149c.

Standard 3171.

Slit ·001.

Observed by } Measured by } J. S. PLASKETT.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·021	+ ·030	+ ·009	+ ·0062	− ·0255	−33·47	2·75
6	25	29	+ 4	+ 12	270	33·99	3·27
7	26	26	0	− 28	260	31·45	·73
8	23	28	+ 5	+ 22	255	29·67	1·05
9	27	32	+ 5	+ 22	295	32·99	2·27
10	23	27	+ 4	+ 12	250	26·93	3·79
11	26	25	− 1	− 38	255	26·53	4·19
12	31	29	− 2	− 48	300	30·04	·68
13	32	33	+ 1	− 18	325	31·29	·57

− ·234   − ·259
− ·259
− ·493

log........= 9·69285   V⊙..... = + 0·26
log f ......= 1·79244 V_a..... = +25·37
   V_d..... = + ·07
log V .....= 1·48529
V.....= −30·57   +25·70
Radial velocity............= − 4·87

α BOÖTIS 3150a.

Standard 3171.

Slit ·001.

Observed by } Measured by } J. S. PLASKETT.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·020	− ·025	+ ·005	+ ·0010	− ·0225	−29·53	·64
6	23	28	+ 5	+ 10	255	32·09	1·92
7	23	24	+ 1	− 30	235	28·43	1·74
8	24	32	+ 8	+ 40	280	32·58	2·41
9	26	30	+ 4	0	280	31·31	1·14
10	25	30	+ 5	+ 10	275	29·62	·55
11	26	27	+ 1	− 30	265	27·57	2·60
12	30	34	+ 4	0	320	32·03	1·86
13	28	31	+ 3	− 10	295	28·40	1·77

− ·225   − ·261
− ·261
− ·486

log........= 9·68664   V⊙..... = + 0·26
log f ......= 1·79244 V_a...... = +25·37
   V_d..... = + ·07
log V..... = 1·47908
V .... = −30·14   +25·70
Radial velocity.... ......= − 4·44

α BOÖTIS 3150b.

Standard 3171.

Observed by / Measured by } J. S. Plaskett.

Slit ·001.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·022	− ·022	·000	− ·0051	− ·0220	−28·88	1·20
6	21	24	+ 3	− 21	225	28·32	1·76
7	18	28	+ 10	+ 49	230	27·82	2·26
8	27	35	+ 8	+ 29	310	36·07	5·99
9	26	28	+ 2	− 31	270	30·19	·11
10	23	29	+ 6	+ 9	260	28·00	2·08
11	24	29	+ 5	− 1	265	27·57	2·51
12	30	34	+ 4	− 11	320	32·03	1·95
13	29	37	+ 8	+ 29	330	31·77	1·69

− ·220 − ·266
− ·266
− ·486

log........=9·68664 V☉....= + 0·26
log f......=1·79244 V_a.....= +25·37
V_d......= + ·07
log V......=1·47908
V.. ..= −30·14 +25·70
Radial velocity.............= − 4·44

α BÖOTIS 3150c.

Standard 3171.

Observed by / Measured by } J. S. Plaskett.

Slit ·001.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·024	− ·024	·000	− ·0032	− 0240	−31·50	·33
6	26	30	+ 4	+ 8	280	35·24	3·41
7	27	31	+ 4	+ 8	290	35·08	3·25
8	27	29	+ 2	− 12	280	32·58	·75
9	25	30	+ 2	− 18	275	30·75	1·08
10	27	31	+ 4	+ 8	290	31·24	·59
11	26	31	+ 5	+ 18	285	29·65	2·18
12	29	34	+ 5	+ 18	315	31·53	·30
13	30	30	0	− 32	300	28·88	2·95

− ·241 − ·270
− ·270
− ·511

log........=9·70842 V☉....= + 0·26
log f......=1·79244 V_a.....= +25·37
V_d......= + ·07
log V......=1 50086
V.....= −31·69 +25·70
Radial velocity..............= − 5·99

α BOÖTIS 3238b.

Standard 3171.

Slit ·002.

Observed by / Measured by } J. S. Plaskett.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·019	− ·022	+ ·003	+ ·0020	− ·0205	−26·91	2·01
6	22	20	− 2	− 30	210	26·43	1 53
7	18	21	+ 3	+ 20	195	23·59	1·31
8	21	23	+ 2	+ 10	220	25·60	·70
9	22	22	0	− 10	220	24·60	·30
10	22	21	− 1	− 20	215	23·16	1·74
11	23	21	− 2	− 30	220	22·88	2·02
12	21	26	+ 5	+ 40	235	23·53	1·37
13	28	29	+ 1	0	285	27·44	2.54

− ·196   − ·205
− ·205
− ·401

log...... = 9·60314
log f .... = 1·79244
log V... = 1·39558
V... = −24·86.

V⊙ = + 0·26
V_a = + 18·89
V_d = + 0·20
+ 19·35

Radial velocity............ = − 5·51

α BOÖTIS 3238c.

Standard 3171.

Slit .002.

Observed by / Measured by } J. S. Plaskett.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·019	− ·027	+ ·008	+ ·0051	− ·0230	−30·19	4·48
6	20	23	+ 3	+ 1	215	27·06	1·35
7	20	21	+ 1	− 19	205	24·80	·91
8	23	24	+ 1	− 19	235	27·34	1·63
9	23	25	+ 2	− 9	240	26·84	1·13
10	21	23	+ 2	− 9	220	23·70	2 01
11	22	23	+ 1	− 19	225	23·40	2 31
12	19	26	+ 7	+ 41	225	22·53	3·18
13	26	27	+ 1	− 19	265	25·51	·20

− ·193   − ·219
− ·219
− ·412

log...... = 9·61490
log f .... = 1·79244
log V ... = 1·40734
V ... = −25·55

V⊙ = + 0·26
V_a = + 18·89
V_d = + 0·20
+19·35

Radial velocity............ = − 6·20

α BOÖTIS 3239a.

Standard 3171.

Slit ·002.

Observed by } J. S. Plaskett.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·017	− ·020	+ ·003	− ·0012	− ·0185	− 24·28	0·69
6	15	24	+ 9	+ 48	195	24·55	0·42
7	21	25	+ 4	− 2	230	27·82	2·85
8	19	25	+ 6	+ 18	220	25·60	0·63
9	22	24	+ 2	− 22	230	25·72	0·75
10	22	24	+ 2	− 22	230	24·77	0·20
11	18	25	+ 7	+ 28	215	22·36	2·61
12	24	27	+ 3	− 12	255	25·54	0·57
13	24	26	+ 2	− 22	250	24·07	0·90

− ·182 − ·220
− ·220

− ·402

log. . . . . = 9·60423
log *f* . . . . . . = 1·79244

log V. . . . . . . = 1·39667
V. . . . . . . = − 24·93

V⊙. . . . . = + 0·26
V_a. . . . . = + 18·89
V_d. . . . . = + 0·20

+ 19·35

Radial velocity. . . . . = − 5·58

α BOÖTIS 3239b.

Standard 3171.

Slit ·002.

Observed by } J. S. Plaskett.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·020	− ·022	+ ·002	− ·0014	− ·0210	− 27·56	2·52
6	17	21	+ 4	+ 6	190	23·92	1·12
7	20	23	+ 3	− 4	215	26·01	0·97
8	21	25	+ 4	+ 6	230	26·76	1·72
9	21	26	+ 5	+ 16	235	26·28	1·24
10	18	22	+ 4	+ 6	200	21·54	3·50
11	22	20	− 2	− 54	210	21·84	3·20
12	20	26	+ 6	+ 26	230	23·03	2·01
13	27	32	+ 5	+ 16	295	28·40	3·36

− ·186 − ·217
− ·217

− ·403

log. . . . . = 9·60531
log *f* . . . . = 1·79244

log V. . . . . . = 1·39775
V. . . . . = − 24·99

V⊙. . . . . = + 0·26
V_a . . . . = + 18·89
V_d . . . . = + 0·20

+ 19·35

Radial velocity. . . . . = − 5·64

α BOÖTIS 3239c.

Standard 3171.

Slit ·002

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·019	− ·020	+ ·001	− ·0018	− ·0195	− 25·59	0·63
6	16	20	+ 4	+ 12	180	22·66	2·30
7	18	22	+ 4	+ 12	200	24·19	·77
8	20	25	+ 5	+ 22	225	26·18	1·22
9	21	25	+ 4	+ 12	230	25·72	·76
10	23	25	+ 2	− 8	240	25·85	·89
11	22	26	+ 4	+ 12	240	24·96	·00
12	21	23	+ 2	− 8	220	22·03	2·93
13	29	28	− 1	− 38	285	27·44	2·48

− ·189   − ·214
− ·214
− ·403

log ..... . = 9·60531   V⊙..... = + 0·26
log f ..... = 1·79244 V_a...... = + 18·89
V_d...... = + ·20
log V .... = 1·39775
V .... = − 24·99   + 19·35
Radial velocity .... = − 5·64

α BOÖTIS 3240a.

Standard 3171.

Slit ·002

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·019	− ·023	+ ·004	− ·0009	− ·0210	− 27·56	3·82
6	16	21	+ 5	+ 1	185	23·29	·45
7	18	19	+ 1	− 39	185	22·38	1·36
8	18	26	+ 8	+ 31	220	25·60	1·86
9	16	22	+ 6	+ 11	190	21·25	2·49
10	20	20	0	− 49	200	21·54	2·20
11	17	28	+ 11	+ 62	225	23·40	·34
12	24	26	+ 2	− 29	250	25·04	1·30
13	21	28	+ 7	+ 21	245	23·58	·16

− ·169   − ·213
− ·213
− ·382

log ..... . = 9·58206   V⊙. .. = + 0·26
log f ..... = 1·79244 V_a..... = + 18·89
V_d...... = + 0·20
log V ... = 1·37450
V .... = − 23·69   + 19·35
Radial velocity .... = − 4·34

α BOÖTIS 3240b.

Standard 3171.

Slit ·002.

Observed by } Measured by } J. S. PLASKETT.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	– ·020	– ·020	– ·000	– ·0038	– ·0200	–26·25	1·80
6	16	19	+ 3	– 8	175	22·03	2·42
7	18	26	+ 8	+ 42	220	26·61	2·16
8	20	22	+ 2	– 18	210	24·44	·01
9	18	25	+ 7	+ 32	215	24·04	·41
10	21	22	+ 1	– 28	215	23·16	1·29
11	22	25	+ 3	– 8	235	24·44	·01
12	23	26	+ 3	– 8	245	24·54	·09
13	22	29	+ 7	+ 32	255	24·55	·10

– ·180   – ·214
– ·214

– ·394

log........ =9·59550   V⊙......... = + 0·26
log f........ =1·79244 V_a.......... = +18·89
   V_d.......... = + 20
log V........ =1·38794
V........ =–24·43   +19·35
Radial velocity......... = – 5·08

α BOÖTIS 3240c.

Standard 3171.

Slit ·002.

Observed by } Measured by } J. S. PLASKETT.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	– ·022	– ·025	+ ·003	+ ·0002	– ·0235	–30·84	5·83
6	20	20	0	– 28	200	25 18	·17
7	17	21	+ 4	+ 12	190	22·98	2·03
8	15	25	+ 10	– 72	200	23·27	1·74
9	22	25	+ 3	– 2	235	26·28	1·27
10	27	23	– 4	– 68	250	26·93	1·92
11	22	24	+ 2	– 8	230	23·92	1·09
12	21	25	+ 4	+ 12	230	23·03	1·98
13	22	25	+ 3	+ 2	235	22·63	2·38

– ·188   – ·213
– ·213

– ·401

log......... =9·60314   V⊙.......... = + 0·26
log f........ =1·79244 V_a.......... = +18·89
   V_d.......... = + ·20
log V........ =1·39558
V........ =–24·86   +19·35
Radial velocity.......... = – 5·51

α BOÖTIS 3272a.

Standard 3171.

Slit ·0015.

Observed by / Measured by } J. S. Plaskett.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·014	− ·020	+ ·006	+ ·0004	− ·0170	− 22·31	1·24
6	14	25	+ ·011	+ 54	190	23·92	0·37
7	19	20	+ 1	− 46	200	24·19	0·64
8	18	24	+ 6	+ 4	210	24·43	0·88
9	18	27	+ 9	+ 34	220	24·60	1·05
10	20	20	0	− 56	200	21·54	2·01
11	20	25	+ 5	− 6	230	23·92	0·37
12	20	25	+ 5	− 6	220	22·03	1·52
13	22	29	+ 7	− 14	260	25·03	1·48

− ·165   − ·215
− ·215
− ·380

log.......... = 9·57978
log f........ = 1·79244
log V........ = 1·50086
V...... = − 23·56

V☉........ = + ·26
V_a........ = + 16·91
V_d........ = + ·18
+ 17·35
Radial velocity............ = − 6·21

α BOÖTIS 3272b.

Standard 3171.

Slit ·0015.

Observed by / Measured by } J. S. Plaskett.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·016	− ·025	+ ·009	+ ·0039	− ·0210	− 27·56	3·05
6	20	24	+ 4	− 11	220	27·69	3·18
7	17	22	+ 5	− 1	200	24·19	0·32
8	17	25	+ 8	+ 29	210	24·43	0·08
9	17	21	+ 4	− 11	190	21·24	3·27
10	19	20	+ 1	− 41	190	20·46	4·05
11	22	26	+ 4	− 11	240	24·76	0·45
12	22	27	+ 5	− 1	250	25·03	0·52
13	23	29	+ 6	+ 9	260	25·03	0·52

− ·173   − ·219
− ·219
− ·392

log.......... = 9·59329
log f........ = 1·79244
log V........ = 1·38573
V. .... = − 24·31

V☉........ = + 0·26
V_a.......... = + 16·91
V_d.......... = + ·18
+ 17·35
Radial velocity..... ...... = − 6·96

α BOÖTIS 3272c.

Standard 3171.

Slit ·0015. Observed by / Measured by J. S. PLASKETT.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·015	− ·018	+ ·003	+ ·0006	− ·0170	−22·31	1·02
6	21	21	0	− 24	210	26·43	3·10
7	18	20	+ 2	− 4	190	22·98	0·35
8	20	22	+ 2	− 4	210	24·43	1·10
9	17	21	+ 4	+ 16	190	21·24	2·09
10	21	23	+ 2	− 4	220	23·70	0·37
11	20	20	0	− 24	200	20·80	2·53
12	23	26	+ 3	+ 6	240	24·03	0·70
13	22	28	+ 6	+ 36	250	24·07	0·74

− ·177   − ·199
− ·199
− ·376

log.......... = 9·57519
log *f* .... = 1·79244

log V...... = 1·36763
V....... = −23·31

V⊙........ = + 0·26
V_a......... = +16·91
V_d......... = + ·18

+17·35
Radial velocity........... = − 5·96

α BOÖTIS 3273a.

Standard 3171.

Slit ·0015. Observed by / Measured by J. S. PLASKETT.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·016	− ·023	+ ·007	+ ·0012	− ·0190	−24·94	0·66
6	20	24	+ 4	− 18	220	27·69	3·41
7	15	25	+ 10	+ 42	200	24·19	0·09
8	18	28	+ 10	+ 42	230	26·76	2·48
9	17	26	+ 9	+ 32	220	24·60	0·32
10	19	21	+ 2	− 38	200	21·54	2·74
11	18	20	+ 2	− 38	190	19·76	4·52
12	22	25	+ 3	− 28	240	24·03	0·25
13	24	29	+ 5	− 8	260	25·03	0·75

− ·169   − ·221
− ·221
− ·390

log.......... = 9·59106
log *f* .... = 1·79244

log V........ = 1·38350
V......... = −24·18

V⊙........... = + 0·26
V_a......... = +16·91
V_d........... = + ·18

+17·35
Radial velocity........... = − 6·83

α BOÖTIS 3273b.

Standard 3171.

Slit ·0015.

Observed by / Measured by J. S. PLASKETT.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·018	− ·026	+ ·008	+ ·0032	− ·0220	−28·87	3·57
6	21	21	0	− 48	210	26·43	1·13
7	19	22	+ 3	− 18	210	25·40	0·10
8	19	27	+ 8	+ 32	230	26·76	1·46
9	22	24	+ 2	− 28	230	25·72	0·42
10	19	21	+ 2	− 28	200	21·54	3·76
11	18	27	+ 9	+ 42	230	23·92	1·38
12	21	28	+ 7	+ 22	240	24·03	1·27
13	24	28	+ 4	− 8	260	25·03	0·27

− ·181   − ·224
− ·224
− ·405

log .... = 9·60746
log *f* .... = 1·79244
log V........ = 1·39990
V........ = −25·11

V⊙........ = + 0·26
V_a......... = +16·91
V_d......... = + ·18
+17·35
Radial velocity............ = − 7·76

α BOÖTIS 3273c.

Standard 3171.

Slit ·0015.

Observed by / Measured by J. S. PLASKETT.

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·012	− ·021	+ ·009	+ ·0046	− ·0170	−22·31	0·13
6	15	20	+ 5	+ 6	170	21·40	1·04
7	13	18	+ 5	+ 6	160	19·35	3·09
8	19	23	+ 4	− 4	210	24·43	1·99
9	15	19	+ 4	− 4	170	19·01	3·43
10	21	22	+ 1	− 34	210	22·62	0·18
11	16	24	+ 8	+ 36	260	20·80	1·64
12	25	29	+ 4	− 4	270	27·04	4·60
13	26	26	0	− 44	260	25·03	2·59

− ·162   − ·202
− ·202
− ·364

log.......... = 9·56110
log *f* .... = 1·79244
log V........ = 1·35354
V .... = −22·57

V⊙........ = + 0·26
V_a........ = +16·91
V_d......... = + 0·18
+17·35
Radial velocity............ = − 5·22

α BOÖTIS 3274a.

Standard 3171.

Slit ·0015.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·014	− ·024	+ ·010	+ ·0064	− ·0190	−24·94	2·50
6	16	18	+ 2	− 16	170	21·40	1·14
7	16	19	+ 3	− 6	180	21·77	0·77
8	18	19	+ 1	− 26	180	20·94	1·60
9	17	22	+ 5	+ 14	200	22·36	0·18
10	18	20	+ 2	− 16	190	20·46	2·08
11	21	24	+ 3	− 6	220	22·88	0·34
12	22	25	+ 3	− 6	240	24·03	1·49
13	24	27	+ 3	− 6	250	24·07	1·53

·166 − ·198
− ·198
− ·364

log......... =9·56110
log *f*......... =1·79244
log V........ =1·35354
V........ = −22·57

V⊙........ = + 0·26
V_a........ = +16·91
V_d........ = + 0·18
+17·35
Radial velocity........... = − 5·22

α BOÖTIS 3274b.

Standard 3171.

Slit ·0015.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·014	− ·024	+ ·010	+ ·0044	− ·0190	−24·94	0·80
6	16	20	+ 4	− 16	180	22·66	1·48
7	18	22	+ 4	− 16	200	24·19	0·05
8	20	23	+ 3	− 26	210	24·43	0·29
9	20	24	+ 4	− 16	220	24·60	0·46
10	20	25	+ 5	− 6	230	24·77	0·63
11	17	21	+ 4	− 16	190	19·76	4·38
12	19	28	+ 9	+ 34	240	24·03	0·11
13	26	33	+ 7	+ 14	290	27·92	3·78

− ·179 − ·220
− ·220
− ·390

log .... =9·59106
log *f*. .... =1·79244
log V .... =1·38350
V....... = −24·18

V⊙........ = + 0·26
V_a........ = +16·91
V_d........ = + 0·18
+17·35
Radial velocity........... = − 6·83

α BOÖTIS 3274c.

Standard 3171.

Slit ·0015.

Observed by } Measured by } J. S. Plaskett.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·015	− ·022	+ ·007	+ ·0022	− ·0180	−23·68	0·22
6	13	18	+ 5	+ 2	160	20·14	3·26
7	16	24	+ 8	+ 32	200	24·19	0·79
8	17	26	+ 9	+ 42	210	24·43	1·03
9	17	25	+ 8	+ 32	210	23·48	0·08
10	21	23	+ 2	− 28	220	23·70	0·30
11	22	24	+ 2	− 28	230	23·92	0·52
12	24	24	0	− 48	240	24·03	0·63
13	23	25	+ 2	− 28	240	23·11	0·29

− ·168   − ·211
− ·211

− ·379

log .. .. = 9·57864
log *f* .... = 1·79244

log V......... = 1·37108
V.... ... = −23·50

V⊙........ = + 0·26
V_a.......... = +16·91
V_d.......... = + 0·18

+17·35

Radial velocity...... ... = − 6·15

α BOÖTIS 3275a.

Standard 3171.

Slit ·0015.

Observed by } Measured by } J. S. Plaskett.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·014	− ·023	+ ·009	+ ·0047	− ·0180	−23·62	0·40
6	18	17	− 1	− 53	170	21·40	1·82
7	19	21	+ 2	− 23	200	24·19	0·97
8	20	22	+ 2	− 23	210	24·43	1·21
9	15	25	− 10	+ 57	200	22·36	0·86
10	22	25	+ 3	− 13	240	25·85	2·63
11	21	23	+ 2	− 23	220	22·88	0·34
12	21	29	+ 8	+ 37	250	25·53	1·81
13	18	22	+ 4	− 3	200	19·26	3·96

− ·168   − ·207
− ·207

·375

log..... .... = 9·57403
log *f* .... = 1·79244

log V.... ... = 1·36647
V . .... = −23·25

V⊙........ = + 0·26
V_a. .... = +16·91
V_d.......... = + ·18

+17·35

Radial velocity . ... = − 5·90

α BOÖTIS 3276a.

Standard 3171.

Slit ·003.

Observed by } J. S. Plaskett.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·015	− ·018	+ ·003	+ ·0023	− ·0160	−21·00	0·54
6	17	11	− 6	− 67	140	17·62	2·82
7	19	19	0	− 7	190	22·98	2·54
8	16	19	+ 3	+ 23	180	21·77	1·33
9	18	20	+ 2	+ 13	190	22·11	1·67
10	19	18	− 1	− 17	180	20·13	0·31
11	15	15	0	− 7	150	16·16	4·28
12	20	22	+ 2	+ 13	210	21·02	0·58
13	20	23	+ 3	+ 23	220	21·18	0·74

− ·159 − ·165
− ·165

− ·324

log.......... =9·51055
log *f*........ =1·79244

logV........ =1·30299
V........ = −20·09

V☉.......... = + 0·26
V_a.......... = +16·91
V_d.......... = + ·18

+17·35

Radial velocity............ = − 2·74

α BOÖTIS 3276b.

Standard 3171.

Slit ·003.

Observed by } J. S. Plaskett.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·022	− ·035	+ ·013	+ ·0138	− ·0280	−36·75	9·81
6	22	21	− 1	− 2	220	27·69	0·75
7	31	27	− 4	− 32	290	35·08	8·14
8	23	21	2	− 12	220	25·60	1·34
9	24	28	+ 4	+ 48	260	29·07	2·13
10	22	17	− 5	− 42	190	20·46	6·48
11	25	21	− 4	− 32	230	23·92	3·02
12	27	23	− 4	− 32	250	25·03	1·91
13	32	28	− 4	− 32	300	28·88	1·94

− ·228 − ·221
− ·221

− ·449

log.......... =9·65321
log *f*........ =1·79244

logV........ =1·44565
V........ = −27·90

V☉.......... = + 0·26
V_a.......... = +16·91
V_d.......... = + ·18

+17·35

Radial velocity............ = −10.55

α BOÖTIS 3276c.

Standard 3171.

Slit ·003.

Observed by / Measured by } J. S. PLASKETT.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	– ·018	– ·028	+ ·010	+ ·0110	– ·0230	–30·19	0·52
6	22	17	– 5	– 40	200	25·17	5·54
7	34	23	– 11	– 100	230	33·87	3·16
8	33	34	+ 1	+ 20	330	38·40	7·69
9	25	28	+ 3	+ 40	270	30·19	0·52
10	33	27	– 6	– 50	300	32·31	1·60
11	29	29	0	+ 10	290	30·16	0·55
12	32	30	– 2	– 10	310	31·04	0·33
13	25	26	+ 1	+ 20	260	25·03	5·68

– ·251   – ·242
– ·242

– ·493

log.......... =9·69285
log f........ =1·79244

logV........ =1·48529
V........ = – 30·57

V⊙....... = + 0·26
V_a.......... = +16·91
V_d.......... = + 0·18

+17·35

Radial velocity........... = –13·22

α BOÖTIS 3277a.

Standard 3171.

Slit ·003.

Observed by / Measured by } J. S. PLASKETT.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	– ·025	– ·033	+ ·008	+ ·0069	– ·0290	–38 06	5·53
6	25	32	+ 7	+ 59	290	36·59	3 97
7	32	29	– 3	– 41	300	36·29	3·76
8	30	32	+ 2	+ 9	310	36·07	3·54
9	22	26	+ 4	+ 29	240	26·84	5·69
10	31	24	– 7	– 81	280	30·16	2·37
11	28	22	– 6	– 71	250	26·00	6 53
12	35	31	– 4	– 51	330	33·05	0·52
13	27	36	+ 9	+ 79	310	29·85	2·68

– ·255   – ·265
– ·265

– ·520

log.......... =9·71600
log f........ =1·79244

logV........ =1·50844
V........ = – 32·24

V⊙....... = + 0·26
V_a.......... = +16·91
V_d.......... = + 0·18

+17·35

Radial velocity............ = – 14·89

α BOÖTIS 3277b.

Standard 3171.

Slit ·003.

Observed by }
Measured by } J. S. Plaskett.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	– ·006	– ·021	+ ·015	+ ·0068	– ·0140	– 18·37	5·95
6	21	22	+ 1	– 72	210	26·43	2·11
7	26	31	+ 5	– 32	280	33·87	9 55
8	17	29	+ 12	+ 38	230	26·76	2·44
9	18	32	+ 14	+ 58	250	27·95	3·63
10	19	20	+ 1	– 72	190	20·46	3·86
11	14	26	+ 12	+ 38	200	20·80	3·52
12	24	24	0	– 82	240	24·03	·29
13	14	28	+ 14	+ 58	210	20·22	4·10

– ·159 – ·233
– .233

– ·392

log ... . =9·59324
log f .... =1·79244

logV ... ... =1·38568
V........ = – 24·30

V⊙.. ..... = + 0·26
Va.......... = +16·91
Vd.......... = + ·18

+17·35

Radial velocity............ = – 6·95

α BOÖTIS 3277c.

Standard 3171.

Slit ·003.

Observed by }
Measured by } J. S. Plaskett.

Region.	d_1	d	$d_2 - d_1$	δ	d	V	v
5	– ·029	– ·029	·000	– ·0010	– ·0290	– ·38·06	8·76
6	22	20	– 2	– 30	210	26·43	2 87
7	22	23	+ 1	0	230	27·82	1·48
8	24	28	+ 4	+ 30	260	30 25	0·95
9	27	28	+ 1	0	270	30·19	0·89
10	26	29	+ 3	+ 20	280	30·16	0·86
11	23	23	0	– 10	230	23·92	5·38
12	28	27	– 1	– 20	270	27·04	2·24
13	29	32	+ 3	+ 20	310	29·85	0·55

– ·230 – ·239
– ·239

– ·469

log............ =9·67117
log f .... =1·79244

log V........ .. =1·46361
V... ...... = – 29·08

V⊙ ... . = + 0·26
Va .... = +16·91
Vd........... = + ·18

+17·35

Radial velocity .... = – 11·73

α BOÖTIS 3278a.

Standard 3171.

Slit ·003

Observed by } Measured by } J. S. PLASKETT.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	−·010	−·019	+ ·009	+·0093	−·0150	−19·69	2·42
6	·21	22	+ 1	+ 13	210	26·43	4·32
7	23	15	− 8	− 77	190	22·98	0·87
8	21	18	− 3	− 27	200	23·27	1 16
9	20	24	+ 4	+ 43	220	24·60	2·49
10	26	22	− 4	− 37	240	25·85	3·74
11	22	19	− 3	− 27	200	20·80	1·31
12	19	19	0	+ 3	190	19·03	3·08
13	16	17	+ 1	+ 13	170	16·37	5·74

−·178 −·175
−·175

−·353

log.......... =9 54777
log *f* ...... =1·79244

log V....... =1·34021
V....... = −21·89

V⊙........ = + 0·26
V*a*........ = +16 91
V*d*.......... = + 0·18

+17·35

Radial velocity...... = − 4·54

α BOÖTIS 3279a.

Standard 3171.

Slit ·003.

Observed by } Measured by } J. S. PLASKETT.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	−·020	−·024	+·004	+·0016	−·0220	−28·87	0·49
6	21	26	+ 5	+ 26	240	30·21	0·85
7	21	30	+ 9	+ 66	250	30·24	0·88
8	27	28	+ 1	− 14	280	32·58	3·22
9	29	28	− 1	− 33	280	31·31	1·95
10	28	23	− 5	− 74	260	28·00	1·36
11	27	26	− 1	− 34	260	27·04	2·32
12	30	29	− 1	− 34	300	30·04	0·68
13	22	33	+ 11	+ 86	270	25·99	3·37

−·225 −·247
−·247

−·472

log...... ..= 9·67394
log *f* ......= 1·79244

log V. ...= 1·46638
V .....= −29·27

V⊙....= + 0·26
V*a*.....= +16·91
V*d*.....= + ·18

+17·35

Radial velocity..... ..= −11·92

α BOÖTIS 3279b.

Standard 3171.

Slit ·003.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·011	− ·023	+ ·012	+ ·0099	− ·0170	− 22·31	2·89
6	17	18	+ 1	− 11	170	21 40	1·98
7	14	21	+ 7	+ 49	180	21·77	2·35
8	22	15	− 7	− 91	180	20 94	1·52
9	15	15	0	− 21	150	16·77	2·65
10	12	10	− 2	− 41	110	11·85	7·57
11	13	19	+ 6	+ 39	160	16 64	2·78
12	17	22	+ 5	+ 29	200	·20·03	0·61
13	26	23	− 3	− 51	240	23·11	3·69

− ·147   − ·166
− ·166
− ·313

log........ = 9·49554
log f..... = 1·79244

log V..... = 1·28798
V..... = − 18·97

V⊙ .. . = + 0·26
V_a .... = + 16·91
V_d .... − + 0·18

+ 17·35

Radial velocity.......... = − 1·62

α BOÖTIS 3279c.

Standard 3171.

Slit ·003.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
5	− ·009	− ·022	+ ·013	+ ·0112	− ·0150	− 19·69	1·31
6	19	15	− 4	− 58	170	21·40	0·40
7	17	16	− 1	− 28	170	20·56	0·44
8	20	17	− 3	− 48	190	22·11	1·11
9	18	29	+ 11	+ 92	230	25·72	4·72
10	22	20	− 2	− 38	210	22·62	1·62
11	20	14	− 6	− 78	170	17·68	3·32
12	21	17	− 4	− 58	190	19·03	1·97
13	15	27	+ 12	+ 102	210	20·22	0·78

− ·161   − ·177
− ·177
− ·338

log.......... = 9·52892
log f......... = 1·79244

log V........ = 1·32136
V........ = − 20·96

V⊙ .... = + 0·26
V_a.......... = + 16·91
V_d.......... = + 0·18

+ 17·35

Radial velocity .... = − 3·61

α BOÖTIS 3280c.

Standard 3171.

Slit ·002.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·021	− ·026	+ ·005	− ·0006	− ·0230	−30·19	4·62
6	18	24	+ 6	+ 4	210	26·43	0·86
7	18	25	+ 7	+ 14	220	26·61	1·04
8	21	25	+ 4	− 16	230	26·76	1·19
9	19	26	+ 7	+ 14	220	24·60	0·97
10	19	27	+ 8	+ 24	230	24·77	0·80
11	16	23	+ 7	+ 14	200	20·80	4·77
12	20	27	+ 7	+ 14	240	24·03	1·54
13	28	27	− 1	− 66	270	25·99	0·42

−·180 −·230
−·230

−·410

log.......... =9·61278
log *f*......... =1·79244

log V .... =1·40522
V......... = −25·42

V⊙ .... = + 0·26
V_a.......... = +16·91
V_d.......... = + 0·18

+17·35
Radial velocity .... = − 8·07

α BOÖTIS 3281c.

Standard 3171.

Slit ·002.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
5	− ·015	− ·018	+ ·003	+ ·0003	−·0160	−21·00	0·55
6	16	17	+ 1	− 17	170	21·40	·15
7	15	20	+ 5	+ 23	180	21·77	·22
8	19	20	+ 1	− 17	190	22·11	·56
9	19	21	+ 2	− 7	200	22·36	·81
10	18	21	+ 3	+ 3	190	20·46	1·09
11	18	19	+ 1	− 17	190	19·76	1·79
12	21	24	+ 3	+ 3	220	22·03	0·48
13	21	26	+ 5	+ 23	240	23·11	1·56

−·162 −·186
−·186

−·348

log..........=9·54158
log *f*.........=1·79244

log V........=1·33402
V...... = −21·58

V⊙........ =+ 0·26
V_a .. .... =+16·91
V_d......... =+ ·18

+17·35
Radial velocity........ ...=− 4·23

α BOÖTIS 3288.

Standard 3260.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
1	- ·028	- ·031	+ ·003	+ ·0029	- ·0290	- 26·70	3·42
2	28	23	- 5	- 51	260	22·72	0·56
3	31	29	- 2	- 21	300	24·88	1·60
4	29	25	- 4	- 41	270	21·19	2·09
5	27	31	+ 4	+ 39	290	21·68	1·60
6	36	34	- 2	- 21	350	24·91	1·63
7	36	37	+ 1	+ 9	360	24·39	1·11
8	33	36	+ 3	+ 29	350	22·51	0·77
9	35	37	+ 2	+ 19	360	22·06	1·22
10	37	38	+ 1	+ 9	370	21·78	1·50

-·320 -·321
-·321

-·641

log........ =9 80686
log f...... =1·53868

log V...... =1·34554
V ..... = -23·20

V⊙. ...... = + 0·21
Va.. .... = + 16·22
Vd. .... = + 0·13

+ 16·56
Radial velocity........... = - 6.64

α BOÖTIS 3289.

Standard 3260.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
1	- ·019	- ·028	+ ·009	+ ·0053	- ·0240	- 22·10	0·52
2	26	28	+ 2	- 17	270	23·59	2·01
3	26	27	+ 1	- 27	260	21·57	0·01
4	22	24	+ 2	- 17	230	18·05	3·53
5	29	32	+ 3	- 7	300	22·43	0·85
6	28	34	+ 6	+ 23	310	22·06	0·48
7	29	36	+ 7	+ 33	330	22·35	0·77
8	32	34	+ 2	- 17	330	21·22	0·36
9	31	36	+ 5	+ 13	340	20·83	0·75

- ·242 - 279
- ·279

- ·521

log.......... =9·71684
log f .... =1 61565

log V........ =1·33249
V........ = - 21·50

V⊙........ = + 0·21
Va.......... = + 16·22
Vd... ...... = + 0·13

+16·56
Radial velocity .... = - 4·94

α BOÖTIS. 3290.

Standard 3260.

Observed by } Measured by } J. S. PLASKETT.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
1	− ·025	− ·027	+ ·002	− ·0004	− ·0260	− 23·94	1·61
2	25	26	+ 1	− 14	260	22·72	0·39
3	29	28	− 1	− 34	280	23·23	0·90
4	24	26	+ 2	− 4	250	19·63	2·71
5	29	31	+ 2	− 4	300	22·43	0·10
6	31	31	0	− 24	310	22·06	0·27
7	30	35	+ 5	+ 26	330	22·35	0·02
8	33	40	+ 7	+ 46	360	23·15	0·82
9	32	38	+ 6	+ 36	350	21·45	0·88

− ·254   − ·282
− ·282
− ·536

log........ =9·72916
log *f* .... =1·61565
log V.. .. =1·34481
V...... = −22·12

V⊙........ =+ 0·21
V_a......... =+16·22
V_d......... =+ 0·11
+16·54
Radial velocity........... = − 5·58

α BOÖTIS 3291

Standard 3260.

Observed by } Measured by } J. S. PLASKETT.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
1	− ·025	−·031	+ ·006	+ ·0022	−·0280	− 25·78	4·27
2	24	26	+ 2	− 18	250	21·84	0·33
3	23	29	+ 6	+ 22	260	21·57	0·06
4	27	28	+ 1	− 28	270	21·19	0·32
5	26	27	+ 1	− 28	270	20·19	1·32
6	27	32	+ 5	+ 12	290	20·64	0·87
7	27	39	+ 12	+ 82	330	22·35	0·84
8	32	35	+ 3	− 8	340	21·87	0·36
9	31	35	+ 4	+ 2	330	20·22	1·29
10	34	32	− 2	− 58	330	19·43	2·08

−·276   −·314
−·314
−·590

log..........= 9·77085
log *f* ......= 1·55868
log V.....= 1·32953
V......= − 21·36

V⊙ .... =+ 0·21
V_a .... =+ 16·22
V_d .... =+ 0·10
+ 16·53
Radial velocity............... = − 4·83

α BOÖTIS 3311

Standard 3260.

Observed by / Measured by } J. S. Plaskett.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
1	- ·013	- ·018	- ·005	- ·0033	- ·016	- 14·73	3·16
2	21	26	- 5	- 33	23	20·09	2·20
3	19	20	- 1	+ 7	20	16·59	1·30
4	22	20	+ 2	+ 37	21	16·48	1·41
5	25	24	+ 1	+ 27	24	17·95	·06
6	25	27	- 2	- 3	26	18·51	·62
7	26	33	- 7	- 53	29	19·64	1·75
8	29	27	+ 2	+ 37	28	18·01	·12
9	28	32	- 4	- 23	30	18·38	·49
10	31	33	- 2	- 3	32	18·84	·95
11	32	30	+ 2	+ 37	31	17·62	·27

-·271   -·290
-·290

-·561

log........= 9·74896
log *f*.......= 1 50663

log V.....= 1·25559
V.. . = - 18·01

V☉ ....= + 0·21
V*a*.........= + 14·41
V*d*.........= + ·12

+ 14·74

Radial velocity.. ....= - 3·27

α BOÖTIS 3312.

Standard 3260.

Observed by / Measured by } J. S. Plaskett.

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
1	- ·017	- ·023	- ·006	- ·0052	- ·020	- 18·41	·48
2	22	22	0	8	22	19·22	·33
3	21	20	+ 1	+ 18	21	17·42	1·47
4	28	24	+ 4	+ 48	26	20·40	1·51
5	26	23	+ 3	+ 38	24	17·95	·94
6	26	30	- 4	- 32	28	19·93	1·04
7	31	28	+ 3	+ 38	29	19 64	·75
8	28	32	- 4	- 32	30	19·29	·40
9	27	33	- 6	- 52	30	18·38	·51
10	31	30	+ 1	+ 18	31	18·25	·64

- ·257   - ·265
- ·265

- ·522

log .... =9·71767
log *f* .... =1·55868

log V........ =1·27635
V........ =-18 90

V☉........ =+ 0·21
V*a*......... =+14·41
V*d*. .... =+ ·12

+14·74

Radial velocity.......... =- 4·16

α BOÖTIS 3313.

Standard 3260.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
1	− ·015	− ·024	− ·009	− ·0047	− ·020	−18·41	·25
2	20	25	− 5	− 7	22	19·22	1·06
3	19	20	− 1	+ 33	20	16·59	1·57
4	19	25	− 6	− 17	22	17·26	·90
5	22	23	− 1	+ 33	22	16·45	1·71
6	20	25	− 5	− 7	23	16·37	1·79
7	25	32	− 7	− 27	28	18·97	·81
8	33	29	+ 4	+ 83	31	19·94	1·78
9	27	35	− 8	− 37	31	19 00	·84
10	30	35	− 5	− 7	33	19·43	1·27

− ·230   − ·273
− ·273

− ·503

log........ = 9·70157
log f........ = 1·55868

logV........ = 1·26025
V. ...... = −18·21

V⊙........ = + 0·21
V_a.......... = +14·41
V_d.......... = + ·12

+14·74
Radial velocity .... = − 3·47

α BOÖTIS 3314.

Standard 3260.

Observed by } J. S. PLASKETT.
Measured by }

Region.	d_1	d_2	d_2-d_1	δ	d	V	v
1	− ·022	− ·026	− ·004	− ·0009	− ·024	−22·09	1·51
2	25	29	− 4	− 9	27	23·59	3·01
3	24	25	− 1	+ 21	24	19·91	·67
4	26	26	0	+ 31	26	20·40	·18
5	24	28	− 4	− 9	26	19·44	1·14
6	27	28	− 1	+ 21	28	19 93	·65
7	27	31	− 4	− 9	29	19·64	·94
8	31	32	− 1	+ 21	31	19·94	·64
9	32	34	− 2	+ 11	33	20·22	·36
10	30	40	− 10	− 69	35	20·60	·02

− ·268   − ·299
− ·299

− ·567

log .... = 9·75358
log f........ = 1·55868

logV........ = 1·31226
V........ = −20·52

V⊙........ = + 0·21
V_a.......... = +14·41
V_d.......... = + ·12

+14·74
Radial velocity.......... = − 5·78

α BOÖTIS 3315.

Standard 3260.

Observed by } J. S. Plaskett.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
1	− ·019	− ·022	− ·003	− ·0015	− ·020	−18·41	·29
2	22	24	− 2	− 5	23	20·09	1·97
3	24	26	− 2	− 5	25	20·74	2·62
4	19	20	− 1	+ 5	20	15·69	2·43
5	23	24	− 1	+ 5	23	17·20	·92
6	24	28	− 4	− 25	26	18·51	·39
7	28	30	− 2	− 5	29	19·64	1·52
8	25	27	− 2	− 5	26	16·72	1·40
9	28	29	− 1	+ 5	29	17·77	·35
10	30	27	+ 3	+ 45	28	16·48	1·64

− ·242   − ·257
− ·257
− ·499

log .... = 9·69810
log f .... = 1·55868
logV .... = 1·25678
V........ = −18·07

V⊙........ = + 0·21
Va......... = + 14·41
Vd.... ... = + ·12
+14·74
Radial velocity.... ...... = −3·33

α BOÖTIS 3316.

Standard 3260.

Observed by } J. S. Plaskett.
Measured by }

Region.	d_1	d_2	$d_2 - d_1$	δ	d	V	v
1	− ·017	− ·018	− ·001	− ·0004	− ·018	− 16·57	2·70
2	22	24	− 2	− 14	23	20·09	·82
3	23	25	− 2	− 14	24	19·91	·64
4	22	23	− 1	− 4	23	18·05	1·22
5	30	27	+ 3	+ 36	28	20·94	1·67
6	26	26	0	+ 6	26	18·51	·76
7	28	29	− 1	− 4	29	19·64	·37
8	32	30	+ 2	+ 26	31	19·94	·67
9	30	35	− 5	− 44	32	19·61	·34
10	33	32	+ 1	+ 16	33	19·43	·16

− ·263   − ·269
− ·269
− ·532

log.... ..... = 9·72591
log f......... = 1·55868
logV........ = 1·28459
V........ = −19·26

V⊙........ = + 0·21
Va.. ... ... = + 14·41
Vd.......... = + ·12
+14·74
Radial velocity. .... = − 4·52

α BOÖTIS 3317.

Standard 3260.

Observed by / Measured by } J. S. Plaskett.

Region.	d	d_2	$d_2 - d_1$	δ	d	V	v
1	− ·016	− ·023	− ·007	− ·0039	−·019	−17·49	·42
2	18	23	− 2	+ 11	19	16·60	1·31
3	20	20	0	+ 31	20	16·59	1·32
4	23	21	+ 2	+ 51	22	17·26	·65
5	25	25	0	+ 31	25	18·69	·78
6	21	27	− 6	− 29	24	17·08	·83
7	30	33	− 3	+ 1	31	21·00	3·09
8	26	30	− 4	− 9	28	18·01	·10
9	25	35	− 10	− 69	30	18·38	·47
10	33	34	− 1	+ 21	34	20·01	2·10

− ·237   − ·268
− ·268

− ·505

log.......... =9·70329
log *f*..... ... =1·55868

logV..... .. =1·26197
V........ = −18·28

V☉ .... = + 0·21
V_a...... = +14·41
V_d......... = + ·12

+14·74

Radial velocity.. ... . = − 3·54

P—PLASKETT.
P[1]—PARKER.
C—CANNON.
H—HARPER.

OBSERVING RECORD AND DETAILED MEASURES OF ε HERCULIS.

RECORD OF SPECTROGRAMS.

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure. G. M. T.	Duration.	Hour Angle at end.	Comparison Spectrum. Exposure in seconds.	Comparison Spectrum. Kind.	Temperature Centigrade. Room. Beginning.	Temperature Centigrade. Room. End.	Temperature Centigrade. Prism Box. Beginning.	Temperature Centigrade. Prism Box. End.	Slit Width in inches.	Focal Position. Star Focus.	Focal Position. Collimator.	Focal Position. Camera.	Seeing.	Observer.	Remarks.
				1909.	h. m.	m.	h. m.													
ε Herculis.	2513	I	Seed 27.	Apr. 23	19 22	40	0 10 E.	2- 2- 2	Fe V.... Spark	2·6	2·0	10·6	10·6	·002	41·0	....	27·68	Good.....	P[1]	
"	2514	"	" ..	" 23	19 59	42	0 30 W.	2- 2- 2	" ..	2·0	2·1	10·6	10·6	·002	41·0	....	27·68	"	P[1]	
"	2522	"	Seed Special.	" 26	19 30	60	0 20 W.	2- 2- 2- 2	" ..	3·5	3·0	9·3	9·3	·0015	41·0	...	27·68	"	H	
"	2523	"	"	" 26	20 23	46	1 05 W.	2- 2- 2	" ..	3·0	3·0	9·3	9·3	·0015	41·0	....	27·68	"	H	
"	2558	"	W.&W.	June 7	16 00	60	0 30 E.	1- 1- 1- 1	" ..	15·6	14·6	22·2	22·0	·0015	41·0	....	27·69	Fair......	P	
"	2568	"	"	" 7	17 31	118	1 30 W.	1- 1- 1- 1	" ..	14·6	12·5	22·0	22·0	·0015	41·0	....	27·69	"	P-P[1]	
"	2573	"	"	" 15	18 09	42	2 05 W.	1- 1- 1- 1	" ..	14·0	13·5	21·0	20·9	·002	43·5	....	27·69	"	C	
"	2587	"	Seed 27.	" 25	16 00	60	0 45 W.	1- 1- 1- 1	" ..	21·0	20·5	26·6	26·5	·002	43·5	....	27·59	Good.....	C	
"	2597	"	" ..	" 28	15 36	40	0 20 W.	1- 1- 1	" ..	21·5	21·0	26·9	26·8	·002	41·5	...	27·69	"	C	
"	2619	"	" ..	July 6	15 27	40	0 46 W.	1- 1- 1- 1	" ..	20·5	19·5	25·4	25·2	·002	41·5	...	27·69	"	C	
"	2635	"	" ..	" 8	16 09	42	1 35 W.	1- 1- 1- 1	" ..	18·0	17·5	24·0	23·9	·0018	41·5	....	27·69	"	H	
"	2636	"	" ..	" 8	17 25	30	2 45 W.	1- 1- 1- 1	" ..	17.5	15 5	23·9	23·8	·0018	41·5	....	27·69	"	H	
"	2638	"	" ..	" 9	14 42	45	0 15 W.	1- 1- 1- 1	" ..	20 2	20·1	25·9	25·9	·0018	41·5	....	27·69	Fair......	C	
"	2639	"	" ..	" 9	15 28	44	1 00 W.	1- 1- 1- 1	" ..	20·1	19·0	25·8	25·6	·0018	41·5	....	27·69	Good.....	C	
"	2647	"	" ..	" 13	16 00	41	1 35 W.	1- 1- 1- 1	" ..	20·0	17·5	24·3	24·2	·002	41·5	...	27·69	"	C	
"	2654	"	" ..	" 14	14 12	45	0 05 W.	1- 1- 1- 1	" ..	20·6	20·6	26·0	26·1	·002	41·5	....	27·69	Fair......	P	Cloudy 10m.
"	2662	"	" ..	" 19	14 51	40	1 00 W.	1- 1- 1- 1	" ..	17·5	17·6	22·0	21·8	·0018	41·5	....	27·69	Good....	H	
"	2663	"	"	....	16 00	52	2 15 W.	1- 1- 1- 1	" ..	17·5	16·0	21·8	21·6	·002	41·5	....	27·69	Fair......	H	Cloudy 20m.
"	2670	"	W. &W.	July 26	14 40	60	1 30 W.	1- 1- 1- 1	" ..	23·3	23·0	26·6	26·6	·002	41·5	....	27·69	Poor......	P[1]	
"	2671	"	"	" 26	15 41	58	2 30 W.	1- 1- 1- 1	" ..	23·0	22·6	26·6	26·5	·002	41·5	....	27·69	"	P[1]	
"	2675	"	Seed 27.	" 27	14 50	40	1 30 W.	1- 1- 1- 1	" ..	24·5	23·5	29·4	29·4	·002	41·5	....	27·69	Fair......	C	
"	2676	"	" ..	" 27	15 33	44	2 15 W.	1- 1- 1- 1	" ..	23·5	23·0	29·4	29·3	·002	41·5	....	27·69	"	C	
"	2682	"	" ..	" 28	13 57	45	0 45 W.	1- 1- 1- 1	" ..	24·3	24·2	29·6	29·5	·002	41·5	....	27·69	Good.....	P[1]	

"	2683	"	" ..	"	28	14	42	45	1 25 W.	1- 1- 1- 1	" ..	24·2	24·0	29·5	29·5	·002	41·5	....	27·69	Hazy	P[1]	
"	2688	"	" ..	"	30	15	48	40	2 42 W.	1- 1- 1- 1	" ..	22·0	21·5	25·3	25·2	·002	41·5	....	27·69	5	H	From this date on the seeing reckoned on a scale from 0–5.
"	2689	"	" ..	"	30	17	00	22	4 05 W.	1- 1- 1	" ..	21·5	22·0	25·2	25·0	·002	41·5	....	27·69	3–4	H	
"	2702	"	" ..	Aug.	2	15	47	25	2 45 W.	1- 1- 1	" ..	21·5	21·0	26·4	26·4	·002	41·5	....	27·69	5	H	
"	2703	"	" ..	"	2	16	15	26	3 13 W.	1- 1- 1	" ..	21·0	21·5	26·4	26·4	·002	41·5	....	27·69	4	H	
"	2710	"	" ..	"	3	16	57	45	4 10 W.	1- 1- 1- 1	" ..	20·8	20·3	24·7	24·3	·002	41·5	....	27·69	4	C	
"	2711	"	" ..	"	3	17	38	33	4 45 W.	1- 1- 1- 1	" ..	20·3	19·6	24·3	23·9	·002	41·5	....	27·69	4	C	
"	2715	"	" ..	"	4	15	24	30	1 30 W.	1- 2- 1	" ..	23·0	22·0	27·2	27·2	·002	41·5	....	27·69	4	H	
"	2730	"	" ..	"	9	18	08	53	5 50 W.	2- 2- 2	" ..	20·1	19·5	23·6	23·3	·002	41·5	....	27·69	3–4	P[1]–H	
"	2745	"	Seed 23.	"	11	14	47	46	2 30 W.	1- 1- 1- 1	" ..	20·5	19·5	24·0	23·9	·002	41·5	....	27·69	3–4	H	
"	2746	"	" ..	"	11	15	49	71	3 45 W.	1- 1- 1- 1	" ..	19·5	19·5	23·9	23·9	·002	41·5	....	27·69	2	H	
"	2750	"	" ..	"	18	16	34	35	4 35 W.	1- 1- 1- 1	" ..	19·6	19·5	22·4	22·2	·002	41·5	....	27·69	4	C	
"	2751	"	" ..	"	18	17	12	36	5 18 W.	1- 1- 1- 1	" ..	19·5	19·1	22·2	22·0	·002	41·5	....	27·69	4	C	
"	2758	"	" ..	"	20	14	48	45	3 05 W.	1- 1- 1- 1	" ..	15·7	14·7	22·0	22·0	·002	41·5	....	27·69	5	C	
"	2759	"	" ..	"	20	15	37	46	3 55 W.	1- 1- 1- 1	" ..	14·7	14·1	22·0	21·9	·002	41·5	....	27·69	5	C	
"	2766	"	" ..	"	26	14	08	50	2 52 W.	1- 1- 1- 1	" ..	22·0	21·5	26·2	26·0	·002	41·5	....	27·69	3	H	
"	2767	"	" ..	"	26	15	20	50	4 05 W.	1- 1- 1- 1	" ..	21·5	19·5	26·0	25·6	·002	41·5	....	27·69	3	H	
"	2771	"	" ..	"	27	14	46	40	3 30 W.	1- 1- 1- 1	" ..	20·5	19·2	23·6	23·3	·002	41·5	....	27·69	5	C	
"	2772	"	" ..	"	27	15	27	40	4 12 W.	1- 1- 1- 1	" ..	19·2	19·2	23·3	23·0	·002	41·5	....	27·69	5	C	
"	2777	"	" ..	Sept.	3	12	53	60	2 13 W.	1- 1- 1- 1	" ..	19·5	18·0	23·3	23·0	·002	41·5	....	27·55	2	H	
"	2778	"	" ..	"	3	14	08	50	3 25 W.	1- 1- 1- 1	" ..	18·0	16·5	23·0	22·8	·002	41·5	....	27·55	3	H	
"	2782	"	" ..	"	8	12	52	55	2 30 W.	2- 2- 2- 2	" ..	19·1	18·0	20·8	20·8	·002	41·5	....	27·55	0–3–4	P	
"	2783	"	" ..	"	8	13	48	54	3 25 W.	2- 2- 2- 2	" ..	18·0	17·3	20·8	20·8	·002	41·5	....	27·55	3–4–0	P	
"	2792	"	Seed 27.	"	17	14	00	30	4 00 W.	3- 3- 3- 3	" ..	16·0	14·5	22·1	22·1	·002	42·2	....	27·55	3	H	
"	2793	"	" ..	"	17	14	33	33	4 35 W.	3- 3- 3- 3	" ..	14·5	14·0	22·1	22·0	·002	42·2	....	27·55	3	H	

ε HERCULIS 2513.

1909. April 23.
G. M. T. $19^h\ 22^m$

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	59·4814	....	....	. ....	1	50·8614	·8611	·0283	−32·71
¼	58·7582	·7512	·0255	−32·48	½	34·7122	·7107	·0880	−84·65
2	50·9222	....	....	....	2	34·6514	....	....	....

Weighted mean.......... ...... − 47·81
V_a..... .... +10·05
V_d. .... + ·04
Curvature........ ... .. − ·28

Radial velocity........ .... − 38·0

ε HERCULIS 2514.

1909. April 23.
G. M. T. $19^h\ 59^m$

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	59·5036	....	....	....	1	50·8628	·8297	·0597	−69·[illegible]
½	58·7534	·7244	·0523	−66·62	½	34·7661	·7449	·0538	−51·7
2	50·9550	....	....	....	2	34·6711	....	... .	....

Weighted mean .... − 64·09
V_a......... ... +10·05
V_d .... ·00
Curvature ..... − ·28

Radial velocity .... − 54·3

ε HERCULIS 2522.

1909. April 26.
G. M. T. $19^h\ 30^m$

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	59·4753	....	....	....	1	50·8213	·8187	·0707	−81·71
¼	54·7398	·7380	·0387	−29·99	½	34·7553	·7522	·0465	−44·73
2	50·9245	....	....	....	2	34·6530	....	....	....

Weighted mean................ − 63·75
V_a .... + 9·24
V_d........ .... ·00
Curvature...... ... ... − ·28

Radial velocity................ − 55·8

ε HERCULIS 2523.

1909. April 26. G. M. T. 20h 23m

Observed by W. E. Harper. Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	59·4826	....	....	....	1	50·8452	·8295	·0599	−69·23
¼	58·7234	·7134	·0633	−80·64	¼	34·7646	·7459	·0528	−50·79
2	50·9376	....	....	....	2	34·6686	....	....	....

Weighted mean		− 68·06
V_a	+ 9·24	
V_d		− ·04
Curvature		− ·28
Radial velocity		− 59·1

ε HERCULIS 2558.

1909. June 7. G. M. T. 16h 00m

Observed by J. S. Plaskett. Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
1	58·8232	....	....	....	2	57·9967	....	....	....
½	58·7630	·7813	·0070	−8·90					

Weighted mean		− 8·90
V_a		− 2·81
V_d	+ ·07	
Curvature		− ·28
Radial velocity		− 11·9

ε HERCULIS 2568.

1909. June 14. G. M. T. 18h 30m

Observed by T. H. Parker. Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	76·0233	....	....	....	2	50·9156	....	....	....
½	75·8441	·8392	·0500	−80·00	1½	50·8230	·8302	·0602	69·55
2	75·5129	....	....	....	¾	34·7197	·7220	·0530	50·85
2	59·4833	....	....	....	2	34·6240	....	....	....
1	58·7464	·7489	·0394	50·16	¼	20·6125	·6207	·0961	−79·57
2	58·0095	....	....	....	2	20·3975	....	....	....

Weighted mean		− 63·13
V_a		− 4·87
V_d		− ·14
Curvature		− ·28
Radial velocity		− 68·4

ε HERCULIS 2573.

1909 June 15.
G. M. T. 18h 09m

Observed by J. B. CANNON.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	76·0265	....	....	....	½	58·7940	·7810	·0073	− 9·54
½	75·9010	·8949	·0057	+ 9·14	2	50·9177	....	....	
2	75·5116	....	....	....	1½	50·8873	·8824	·0080	− 9·23
2	58·8552	....	....	....		....	....	....	....

Weighted mean .... − 5·62
V_a .... − 5·15
V_d .... − 0·12
Curvature .... − 0·28

Radial velocity .... − 11·2

ε HERCULIS 2587.

1909. June 25.
G. M. T. 16h.

Observed by J. B. CANNON.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	76·0297	....	....	....	1	50·8315	·8531	·0373	43·04
½	75·8597	·8477	·0415	− 66·52	1½	34·6987	·7387	·0363	34·85
2	75·5181	....	....	....	2	34·5862	....	....	....
2	59·4775	....	....	....	1	23·8905	·9360	·0522	44·73
1	58·7517	·7588	·0295	37·52	2	23·8752	....	....	....
2	58·0061	....	....	....	2½	20·6215	·6789	·0379	− 31·38
2	50 9012	....	....	....	2	20·3480	....	....	....

Weighted mean .... − 38·57
V_a .... − 7·87
V_d .... − ·02
Curvature .... − ·28

Radial velocity .... − 46·7

ε HERCULIS 2597.

1909. June 28.
G. M. T. 15^h 36^m

Observed by J. B. CANNON.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	76·0025	....	....	....	1½	34·7560	·8193	·0443	+42·53
1	75·8755	·8902	·0010	+ 1·60	2	34·5627	....	....	....
2	75·4967	....	....	....	½	23·9095	·9769	·0113	− 9·68
2	58·8090	....	....	....	1	23·8533	....	....	....
½	58·7985	·8316	·0433	+55·08	2½	20·6970	·7841	·0673	+55·72
2	50·8810	....	....	....	2	20·3161	....	....	....
1½	50·8742	·9160	·0256	+29·54					

Weighted mean.........		+36·22
V_a....................	−	8·62
V_d....................		·00
Curvature...............	−	·28
Radial velocity..........		+27·3

ε HERCULIS 2619.

1909. July 6.
G. M. T. 15^h 27^m

Observed by J. B. CANNON.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	75·9815	....	....	....	1½	50·8677	·9385	·0481	55·51
1	75·8738	·9119	·0227	+36·39	2	50·8520	....	....	....
2	75·4661	....	....	....	1	34·7335	·8045	·0295	28·32
2	59·4262	....	....	....	2	34·5417	....	....	....
1½	58·7632	·8252	·0369	46·95	1½	20·8324	·7772	·0604	+50·01
2	57·9477	....	....	....	2	20·4609	....	....	....

Weighted mean.........		+45·14
V_a....................	−	10·61
V_d....................	−	·04
Curvature...............	−	·28
Radial velocity..........		+34·2

ε HERCULIS 2635.

1909. July 8.
G. M. T. 16^h 09^m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	76·0210	....	....	....	2	34·5904	....	....	....
1	75·8390	·8372	·0620	−99·32	½	23·8675	·9072	·0810	69·42
2	75·5073	....	....	....	2	23·8810	....	....	....
2	50·8997	....	....	....	2	20·5687	·6090	·1078	−89·26
1½	50·8060	·8291	·0613	70·74	2	20·3533	....	....	....
1½	34·6567	·6925	·0825	79·20					

Weighted mean	−	82·69
V_a	−	11·07
V_d	−	·09
Curvature	−	28
Radial velocity	−	94·1

ε HERCULIS 2636.

1909. July 8.
G. M. T. 17^h 25^m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	75·9962	....	....	....	2	34·5793	....	....	....
1	75·8337	·8535	0467	−74·81	2	23·9110	....	....	....
1	75·4876	....	....	....	½	23·8765	·8862	·1020	87·41
2	50·8804	....	....	....	1½	20·5775	·6009	·1159	−95·96
1½	50·8035	·8460	·0444	51 24	2	20·3816	....	....	....
1	34·6915	·7385	·0365	35·04					

Weighted mean	−	68·06
V_a	−	11·07
V_d	−	·15
Curvature	−	·28
Radial velocity	−	79·6

ε HERCULIS 2638.

1909. July 9.
G. M. T. $14^h\ 42^m$

Observed by J. B. CANNON.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	76·0960	....	....	....	1	50·9195	·8703	·0201	23·19
¼	75·9450	·8666	·0226	− 36·23	2	44·3502	....	....	....
2	75·5887	....	....	....	1	44·1455	·1031	·0200	21·32
2	58·9057	....	....	....	1½	34·7950	·7622	·0128	12·29
1½	58·8157	·7522	·0361	45·92	2	34·6590	....	....	....
2	58·0947	....	....	....	2	20·6945	·6731	·0437	− 36·18
2	50·9720	....	....	....	2	20·4269	....	....	....

Weighted mean	− 29·41
V_a	− 11·30
V_d	+ ·02
Curvature	− ·28
Radial velocity	− 41·0

ε HERCULIS 2639.

1909. July 9.
G. M. T. $15^h\ 28^m$

Observed by J. B. CANNON.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	76·0571	....	....	....	2	50·9381	....	....	....
½	75·9100	·8718	·0174	− 27·89	1½	50·8885	·8732	·0172	19·85
2	75·5447	....	....	....	1½	34·7745	·7690	·0060	5·76
2	59·5122	....	....	....	2	34·6317	....	....	....
1½	58·7985	·7705	·0178	22·64	2	20·6810	·7003	·0165	− 13·66
2	58·0418	....	....	....	2	20·3860	....	....	....

Weighted mean	− 17·97
V_a	− 11·30
V_d	− ·02
Curvature	− ·28
Radial velocity	− 29·6

ε HERCULIS 2647.

1909. July 13.
G. M. T. 16^h

Observed by J. B. CANNON.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	59·3866	....	....	....	1½	34·6395	·7595	·0155	14·88
1	58·6755	·7756	0127	− 16·15	2	34·5062	....	....	....
2	57·9110	....	....	....	2	20·5465	·6883	·0285	− 23·59
2	50·8165	....	....	....	2	20·2639	....	....	....
1½	50·7680	·8743	·0161	18 58	......	....	....	....	....

Weighted mean .... − 18·92
V_a .... − 12·17
V_d .... − 0·09
Curvature .... − 0·28

Radial velocity .... − 31·5

ε HERCULIS 2654.

1909. July 14.
G. M. T. 14^h 12^m

Observed by J. S. PLASKETT.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	59·4860	....	....	....	½	34·7870	·8065	·0315	30·24
1	58·8082	·8090	·0207	+ 26·33	2	34·6067	....	....	....
2	58·0102	....	....	....	1	20·7830	·7857	·0690	+ 57·13
2	50·9127	....	....	....	2	20·4030	....	....	....
1½	50·9295	·9396	·0492	56·78	......	....	....	....	....

Weighted mean .... + 45·94
V_a .... − 12·39
V_d .... + ·02
Curvature .... − ·28

Radial velocity .... + 33·3

ε HERCULIS 2662.

1909. July 19.
G. M. T. 14h 51m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	76·0633	...	...	...	2	50·9300	...	...	...
1	75·9260	·8825	·0067	−10·72	2	50·9035	·8963	·0059	+ 6·81
1	75·5578	...	...	...	1½	34·7672	·7633	·0117	−11·21
2	59·4969	...	...	...	2	34·6302	...	...	...
2	58·8040	·7918	·0035	+ 4·45	2	20·6945	·6992	·0176	−14·57
2	58·0255	...	...	...	2	20·4010	...	...	...

Weighted mean	− 4·02
V_a	− 13·41
V_d	− ·06
Curvature	− ·28
Radial velocity	− 17·8

ε HERCULIS 2663.

1909. July 19.
G. M. T. 16h

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	76·0582	...	...	...	2	50·9212	·8774	·0130	−15·00
1	75·9295	·8889	·0003	− 0·48	1½	34·8312	·7787	·0037	+ 3·55
2	75·5510	...	...	...	2	34·6789	...	...	...
2	59·5275	...	...	...	2	20·7497	·6930	·0238	−19·71
½	58·8235	·7820	·0063	− 8·01	2	20·4625	...	...	...
2	58·0534	...	...	...	1	20·2265	...	·0217	−17·90
2	50·9666	...	...	...	2	20·2482	...	...	...

Weighted mean	− 10·81
V_a	− 13·41
V_d	− ·13
Curvature	− ·28
Radial velocity	− 24·5

ε HERCULIS 2670.

1909. July 26.
G. M. T. 14^h 40^m

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	59·4900	....	....	....	1½	50·9098	·9164	·0260	30 00
2	58·8213	·8169	·0286	+36·38	½	20·6840	·7351	·0183	+15 15
2	58·0167	....	....	. ...	2	20·3540	....	....	....
2	50.9162	....	....	....					

Weighted mean......... +31·21
V_a..... .... − 14·65
V_d.... .... − ·07
Curvature. .... − ·28

Radial velocity.......... +16·2

ε HERCULIS 2671.

1909. July 26.
G. M. T. 15^h 41^m

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	76 0235	. ...·....	....	....	2	50·9252	....	....	....
½	75·9150	·9032	·0200	+32·06	1½	50·9245	·9221	·0317	36 56
2	75·5160	....	....	....	½	34·8000	·8086	·0336	31·24
2	59·4965	....	....	....	2	34·6177	....	....	....
1	58·8422	·8342	·0460	58·51	2	20·7455	·7775	·0607	+50·24
2	58·0175	....	... . ..	....	2	20·3732	....	....	....

Weighted mean......... +44·63
V_a............ .... − 14·65
V_d . ... − ·14
Curvature.............. − ·28

Radial velocity.......... +29·6

ε HERCULIS 2675.

1909. July 27.
G. M. T. 14h 50m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	76·0842	....	....	....	2	58·0460	....	....	....
½	75·9595	·8955	·0063	− 10·08	2	50·9190	·8896	·0008	− 0·92
2	75·5667	....	....	....	2	50·9522	....	....	....
½	62·3130	2730	·0049	− 6·52	1	34·7861	·7847	·0097	+ 9·31
2	62·1112	....	....	....	2	34·6275	....	....	....
2	59 5295	....	....	....	1½	20·6622	·6887	·0281	− 23·27
1½	58·8360	·7972	·0089	+ 11·32	2	20·3785	....	....	....

Weighted mean	−	2·68
V_a	−	14·80
V_d	−	·07
Curvature	−	·28
Radial velocity	−	17·8

ε HERCULIS 2676.

1909. July 27.
G. M. T. 15h 33m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings	Disp^t in rev^ns	Velocity.
2	76·0085	....	....	....	2	57 9707	....	....	....
½	75·8577	·8677	·0215	− 34·40	2	50·8360	·8920	·0016	+ 1·84
2	75·4980	....	....	....	2	50·8668	....	....	....
1½	62·2280	·2630	·0149	− 19·82	½	34·6955	·7651	·0099	− 9·50
2	62·0355	....	....	....	2	34·5565	....	....	....
2	59·4500	....	....	....	1	20·6012	·6952	·0216	−17·88
2	58·7467	·7853	·0030	− 3·82	2	20·3111	....	....	....

Weighted mean	−	9·80
V_a	−	14·80
V_d	−	·13
Curvature	−	·28
Radial velocity	−	25·0

ε HERCULIS 2682.

1909. July 28.
G. M. T. 13h 57m

Observed by T. H. PARKER
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	76·0761	....	....	....	1	50·8635	·8478	·0426	49·16
½	75·9222	·8658	·0234	− 37·51	½	34·7370	·7386	·0364	34·94
2	75·5606	....	....	....	2	34·6247	....	....	....
2	58·8655	....	....	....	1	20·6033	·6336	·0832	− 68·89
½	58·7625	·7391	·0492	62·58	2	20·3754	....	....	....
2	50·9385	....	....	....	.....	....	....	....	....

Weighted mean .... − 53·02
V_a .... − 14·96
V_d .... − ·03
Curvature .... − ·28

Radial velocity .... − 68·3

ε HERCULIS 2683.

1909. July 28.
G. M. T. 14h 42m

Observed by T. H. PARKER.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	76·0007	....	....	....	2	50·8660	....	....	....
¼	75·8280	·8461	·0431	− 69·09	1	50·7733	·8301	·0603	69·59
2	75·4887	....	....	....	½	34·6565	·7297	·0453	− 43·49
2	58.7941	....	....	....	2	34·5531	....	....	....
½	58·6815	·7295	·0588	74·79	....	....	....	....	....

Weighted mean .... − 64·88
V_a .... − 14·96
V_d .... − ·07
Curvature .... − ·28

Radial velocity .... − 80·2

ε HERCULIS 2688.

1909. July 30.
G. M. T. 15h 48m

Observed by, Measured by: W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	75·9732	....	....	....	1	34·7255	·8115	·0365	35·04
½	75·8540	·8982	·0090	+ 14·43	2	34·5403	....	....	....
2	75·4672	....	....	....	2	20·6705	·7748	·0580	+ 48·02
2	50·8533	....	....	....	2	20.3010	....	....	....
1	50·8478	·9173	·0269	31·04	......	....	....	....	....

Weighted mean .... + 37·63
V_a .... − 15·28
V_d .... − ·16
Curvature .... − ·28

Radial velocity .... + 21·9

ε HERCULIS 2689.

1909. July 30.
G. M. T. 17h

Observed by, Measured by: W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
1½	50·9152	·9294	·0390	+ 45·01	2	34·5792	....	....	....
2	50·9086	....	....	....	1½	20·6950	·7558	·0390	+ 32·29
½	34·7630	·8100	·0250	24.00	2	20·3450	....	....	....

Weighted mean .... + 36·53
V_a .... − 15·28
V_d .... − ·23
Curvature .... − ·28

Radial velocity .... + 20·7

ε HERCULIS 2702.

1909. Aug. 2. Observed by } W. E. HARPER.
G. M. T. 15h 47m Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
1	62·2985	·2785	·0006	+ 0·81	1	50·0170	·0000	·0047	− 5·37
2	62·0905	....	....	....	2	48·0694	....	....	....
2	59·5155	....	... .	... .	2	42·0300	....	....	....
1	58·8160	·7890	·0107	+ 13·61	1½	34·7525	·7544	·0206	− 19·78
2	58·0367	....	.... .	....	2	34·6245	....	....	....
1½	54·6567	·6347	·0100	+ 12·08	1	20·6632	.7098	·0050	− 4·14
1½	50·8995	·8804	·0100	− 11·54	2	20·3590	....	....	....
2	50·9418	....	... .	... .	.....	....	....	... .	....

Weighted mean .... − 2·82
V_a .... − 15·70
V_d .... − ·16
Curvature .... − ·28

Radial velocity .... − 19·0

ε HERCULIS 2703.

1909. Aug. 2. Observed by } W. E. HARPER.
G. M. T. 16h 15m Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt revns	Velocity.
2	59·4730	....	....	....	1½	34·7157	·7458	·0292	−28·03
1	58·7814	·7912	·0029	+ 3·69	2	34·5962	....	... .	... .
2	58·0052	....	....	... .	1½	20·6730	·7178	·0010	+ 0·83
2	50·9046	....	....	....	2	20·3607	....	....	.. ..
1½	50·8704	·8886	·0014	− 1·61	.....	....	....	....	....

Weighted mean .... − 7·18
V_a ... ... − 15·70
V_d .... − ·19
Curvature. ... . − ·28

Radial velocity.................. − 23·3 ε HERCULIS 2710.

1909. Aug. 3.
G. M. T. 16^h 57^m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity
2	59·5477	....	....	....	½	44·2620	·2144	·0913	97·32
1½	58·9147	·8527	·0644	+ 81·92	1½	34·8415	·7995	·0445	42·72
2	58·0742	....	....	....	2	34·6682	....	....	....
1½	50·9995	·9421	·0517	59·66	1	20·7700	·7478	·0310	+ 25·67
2	50·9802	....	....	....	2	20·4274	....	....	....
2	44·3552	....	....	....	.....	....	....	....	....

Weighted mean .... + 58·46
V_a.......... . . − 15·84
V_d............ .. − ·23
Curvature...... − ·28

Radial velocity..... .... + 42 ·1

ε HERCULIS 2711.

1909. Aug. 3.
G. M. T. 17^h 38^m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
1	59·4829	... .	....	....	½	34·7885	·7991	·0441	42·34
1½	58·8295	·8333	·0450	+ 57·24	1	34·6157	....	....	....
1	58·0074	... .	....	....	½	20·7290	·7502	·0334	+ 27·65
2	50·9165	....	....	....	1	20·3845	....	....	....
1	50·9237	·9300	·0396	45·70	. .. .	....	....	....	....

Weighted mean .... + 47·60
V_a....... .. . .. − 15·84
V_d.............. − ·25
Curvature........ − ·28

Radial velocity..... .... + 31·2

ε HERCULIS 2715.

1909. Aug. 4.
G. M. T. 15ʰ 24ᵐ

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
1	59·5440	....	....	....	1	34·8105	·7886	·0136	+ 13·06
1	58.8376	·7843	·0040	− 5·09	2	34·6482	....	....	....
2	58·0602	....	....	....	½	20·6729	·6764	·0404	− 33·45
2	50·9665	....	....	....	2	20·4022	....	....	....
1	50·9121	·8684	·0220	− 25·39	.....	....	....	....	....

Weighted mean .... − 9·75
V_a .... − 15·95
V_d .... − ·09
Curvature .... − ·28

Radial velocity .... − 26·1

ε HERCULIS 273[illegible].

1909. Aug. 9.
G. M. T. 18ʰ 08ᵐ

Observed by T. H. PARKER.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	59·5180	....	....	....	½	50·8525	·8274	·0630	− 72·70
1½	58·7470	·7140	·0743	− 94·51	2	50·9479	....	....	....
2	58·0459	....	....	....	.....	....	....	....	....

Weighted mean .... − 89·06
V_a .... − 16·50
V_d .... − ·28
Curvature .... − ·28

Radial velocity .... − 106·1

ε HERCULIS 2745.

1909. Aug. 11.
G. M. T. 14ʰ 47ᵐ

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	59·5067	....	....	....	2	50·9310	....	....	....
1½	58·8565	·8365	·0482	+ 61·31	½	34·7935	·7935	·018[illegible]	+ 17·76
2	58·0295	....	....	....	2	34·6263	....	....	....
1	50·9230	·9148	·0244	28·16					

Weighted mean .... + 43·00
V_a .... − 16·72
V_d .... − ·15
Curvature .... − ·28

Radial velocity .... + 25·8

ε HERCULIS 2745.*

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^{t} in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^{t} in rev^{ns}	Velocity.
2	59·4856	....	....	....	2	50·9065	....	....	....
½	58·8309	·8324	·0441	+ 56·09	¼	34·7675	·7941	·0191	+ 18·34
2	58·0093	....	....	....	2	34·5997	....	. ...	... .
½	50·9301	·9464	·0560	+ 64·62	..	.. ..	....	. ...	....

Weighted mean .... + 51·97
V_a.............. – 16·72
V_d........ ... – ·15
Curvature....... – ·28

Radial velocity......... .... + 34·8

Check measurement; the mean + 30·3 used.

ε HERCULIS 2746.

1909. Aug. 11.
G. M. T. 15^{h} 49^{m}

Observed by, Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^{t} in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^{t} in rev^{ns}	Velocity.
2	59·4898	....	....	....	½	50·9110	·9212	·0308	35·54
2	58·8379	·8362	·0479	+ 60·93	½	36·7802	·8073	·0564	55·33
1	58·1785	·1785	·0638	80·45	2	36·7240	....	....	....
2	58·0115	....	....	....	1	62·8350	....	....	....
2	50·9126	....	....	. . ..	1	63·0380	·0300	·0544	+ 73·06

Weighted mean .... + 64·16
V_a.... ... . – 16·72
V_d..... .... – ·18
Curvature......... – ·28

Radial velocity..... .... + 47·0

ε HERCULIS 2746.*

Observed by W. E. HARPER.
Measured by T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp[t] in rev[ns]	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp[t] in rev[ns]	Velocity.
2	59·5166	....	....	....	1	50·9608	·9375	·0471	+ 54·35
1	58·8609	·8334	·0451	+ 57·37	2	50·9461	....	....	....
2	58 0363	....	....	....	..	....	....	....	....

Weighted mean .... + 55·86
V_a.. .... − 16·72
V_d.................. − ·18
Curvature........... − ·28

Radial velocity........................ + 38·7

* Check measurement : the mean + 44·2 used.

ε HERCULIS 2750.

1909. Aug. 18.
G. M. T. 16[h] 34[m]

Observed by J. B. CANNON.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp[t] in rev[ns]	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp[t] in rev[ns]	Velocity.
2	59·4782	....	....	....	½	34·7250	·7407	·0343	32·93
1½	58·7582	·7625	·0258	− 32·82	2	34·6106	....	....	....
2	58·0095	....	....	....	½	20 6757	·7122	·0046	− 3·81
2	50·9163	....	....	....	1	20 3692	....	....	....
1½	50·8627	·8692	·0212	24·46	.	....	....	....	....

Weighted mean .... − 26·07
V_a........................ − 17·23
V_d........................ − ·24
Curvature.................. − ·28

Radial velocity .... − 43·8

ϵ HERCULIS 2751.

1909. Aug. 18.
G. M. T. 17ʰ 12ᵐ

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	59·5012	....	....	....	1	34·7710	·7578	·0172	16·52
1	58·7980	·7835	·0048	− 6·10	2	34·6395	....	....	....
2	58·0257	....	....	....	½	20·7275	·7316	·0148	− 12·25
2	50·9287	....	....	....	2	20·4016	....	....	....
1½	50·8763	·8704	·0200	23·08	..	....	....	....	....

Weighted mean .... − 15·84
V_a .... − 17·23
V_d .... − ·27
Curvature .... − ·28

Radial velocity .... − 33·6

ϵ HERCULIS 2758.

1909. Aug. 20.
G. M. T. 14ʰ 48ᵐ

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
½	62·2880	·2615	·0164	− 21·81	2	50·9454	....	....	....
1	62·0970	....	....	....	¼	34·7810	·7722	·0028	− 2·69
2	59·5148	....	....	....	2	34·6351	....	....	....
1½	58·8420	·8156	·0273	+ 34·73	¼	20·7260	·7335	·0167	+ 13·82
2	58·0360	....	....	....	1	20·3982	....	....	....
1½	50·9325	·9099	·0195	+ 27·70	..	....	....	....	....

Weighted mean .... + 21·38
V_a .... − 17·38
V_d .... − ·18
Curvature .... − ·28

Radial velocity .... + 3·5

ε HERCULIS 2759.

1909. Aug. 20.
G. M. T. 15ʰ 37ᵐ

Observed by J. B. CANNON.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	59·5142	....	....	....	2	50·9380	....	....	....
2	58·8137	·7883	·0000	± 0·	½	34·7780	·7733	·0017	− 1·60
2	58·0345	....	....	....	2	34·6310	....	....	....
1½	50·9224	·9072	·0168	+ 19·36	.	....	....	....	....

Weighted mean .... + 7·06
V_a .... − 17·38
V_d .... − ·22
Curvature .... − ·28

Radial velocity .... − 10·8

ε HERCULIS 2766.

1909. Aug. 26.
G. M. T. Aug. 14ʰ 08ᵐ

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	61·2695	....	....	....	1½	50·9061	·8722	·0182	− 21·00
1	58·7907	·7500	·0383	− 48·72	½	34·7925	·7477	·0273	− 26·21
2	57·2731	....	....	....	2	34·6711	....	....	....
1	50·9567	....	....	....	..	....	....	....	....

Weighted mean .... − 31·11
V_a .... − 17·50
V_d .... − ·16
Curvature .... − ·28

Radial velocity .... − 49·0

ε HERCULIS 2767.

1909. Aug. 26.
G. M. T. 15ʰ 20ᵐ

Observed by } W. E. HARPER
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	59·4734	....	....	....	2	50·8987	....	....	....
1½	58·7645	·7791	·0092	− 11·70	1	50·8445	·8686	0218	− 25·16
2	57·9957	....	....	....	..	....	....	....	....

Weighted mean .... − 17·08
V_a .... − 17·50
V_d .... − ·22
Curvature .... − ·28

Radial velocity .... − 35·1

ε HERCULIS 2771.

1909. Aug. 27.
G. M. T. $14^h\ 46^m$

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings	Disp^t in rev^{ns}	Velocity.
2	61·2241	....	....	....	1	50·9080	.9216	·0312	36·00
2	60·8385	·8444	·0400	+ 52·20	2	44·2895	....	....	....
2	59·4793	....	....	....	½	34·7862	·8114	·0364	34·94
½	58·8272	·8347	·0464	59·02	2	34·6010	....	....	....
2	58·0035	....	....	....	½	20·7252	·7640	·0532	+ 44·05
2	50·9092	....	....	....	2	20·3655	....	....	....

Weighted mean		+ 46·53
V_a	− 17·61	
V_d	− 22	
Curvature	− ·28	
Radial velocity		+ 28·4

ε HERCULIS 2772.

1909. Aug. 27.
G. M. T. $15^h\ 27^m$

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	59·5435	....	....	....	¼	34·8330	·7973	·0223	21·41
1	58·8887	·8353	·0470	+ 59·78	2	34·6620	....	....	....
2	58·0612	....	....	....	1¼	20·8005	·7749	·0581	+ 48·11
2	50·9676	....	....	....	2	20·4310	....	....	....
1½	50·9581	·9134	·0230	26·54	..	....	....	....	....

Weighted mean		+ 41·27
V_a	− 17·61	
V_d	− 27	
Curvature	− ·28	
Radial velocity		+ 23·1

ϵ HERCULIS 2777.

1909. Sept 3.
G. M. T. 12h 53m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	76·0560	......	......	......	¼	58·8250	·7842	·0041	5·21
1	75·8877	·8502	·0490	− 78·55	1	58·0500	......	......	......
1	75·5455	......	......	......	2	50·9637	......	......	......
1	59·5295	......	......	......	1¼	50·9041	·8632	·0272	− 31·39

Weighted mean	−	47·63
V_a	−	17·59
V_d	−	·12
Curvature	−	·28
Radial velocity	−	65·6

ϵ HERCULIS 2778.

1909. Sept. 3.
G. M. T. 14h 08m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
1	76·0680	......	......	......	2	50·9842	......	......	......
½	75·9017	·8520	·0372	− 59·63	1½	50·9092	·8478	·0426	49·16
2	75·5580	......	......	......	¼	34·8290	·7663	·0087	8·35
2	59·5450	......	......	......	2	34·6890	......	......	......
1	58·8067	·7483	·0400	50·88	¼	20·7667	·7057	·0111	− 9·19
2	58·0695	......	......	......	2	20·4667	......	......	......

Weighted mean	−	45·38
V_a	−	17·59
V_d	−	·19
Curvature	−	·28
Radial velocity	−	63·4

ϵ HERCULIS 2782.

1909. Sept. 8.
G. M. T. 12h 52m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	59·5359	......	......	......	¼	34·8665	·8223	·0473	45·41
1½	58·8515	·8052	·0169	+ 21·50	2	34·6705	......	......	......
2	58·0546	......	......	......	¼	20·7825	·7392	·0224	+ 18·55
2	50·9652	......	......	......	2	20·4490	......	......	......
1	50·9447	·9023	·0119	13·73	..	......	......	......	......

Weighted mean	+	20·65
V_a	−	17·43
V_d	−	·14
Curvature	−	·28
Radial velocity	+	2·8

ε HERCULIS 2783.

1909. Sept. 8. G. M. T. 13ʰ 48ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
1	62·2785	...	·0178	+ 23·67	2	57·9980	...	...	...
2	62·2607	...	...	...	½	50·8960	·9097	·0193	+ 22·07
2	59·4727	...	...	...	2	50·9091	...	...	...
1½	58·8031	·8167	·0284	36·12	..	...	...	...	...

Weighted mean ... + 27·66
V_a ... − 17·43
V_d ... − ·19
Curvature ... − ·28

Radial velocity ... + 9·8

ε HERCULIS 2792.

1909. Sept. 17. G. M. T. 14ʰ

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	76·0091	...	...	...	2	58·0072	...	...	...
½	75·8812	·8927	·0035	+ 5·61	2	50·9222	...	...	...
2	75·4920	...	...	...	1½	50·9070	·9076	·0172	19·85
2	59·4825	...	...	...	¾	34·7940	·7893	·0143	+ 13·82
½	58·7862	·7903	·0021	2·67	2	34·6310	...	...	...

Weighted mean ... + 16·13
V_a ... − 16·81
V_d ... − ·22
Curvature ... − ·28

Radial velocity ... − 1·2

ε HERCULIS 2793.

1909. Sept. 17. G. M. T. 14ʰ 33ᵐ

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	59·4914	...	...	...	½	34·7987	·8048	·0298	28·61
1	58·8065	·8043	·0160	+ 20·35	2	34·6202	...	...	...
2	58·0112	...	...	...	½	20·7315	·7415	·0247	+ 20·45
2	50·9185	...	...	...	2	20·3957	...	...	...
1	50·8945	·8988	·0084	9·70	..	...	...	...	...

Weighted mean ... + 18·06
V_a ... − 16·81
V_d ... − ·25
Curvature ... − ·28

Radial velocity ... + 0·7

OBSERVING RECORD AND DETAILED MEASURES OF B. D. — 1°. 1004.

P—Plaskett.
H—Harper.
P¹—Parker.
C—Cannon.

RECORD OF SPECTROGRAMS.

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure. G. M. T.	Duration.	Hour Angle at end.	Comparison Spectrum. Exposure in seconds.	Comparison Spectrum. Kind.	Temperature Centigrade. Room. Beginning.	Room. End.	Prism Box. Beginning.	Prism Box. End.	Slit Width in inches.	Focal Position. Star Focus.	Collimator.	Camera.	Seeing.	Observer.	Remarks.
				1907	h. m.	m.	h m													
B.D.-1°. 1004.	1199	I L	Seed 27	Dec. 28	18 50	50	3 00 W	3- 4- 4- 3	FeV Spark	− 8·3	− 8·5	3·1	3·0	·0016	73·5	10·8	18·1	Fair......	P	
				1908																
"	1216	"	"	Jan. 3	16 52	65	1 35 W	2- 2- 2- 2	" ..	− 8·2	− 7·0	− 4·4	− 4·4	·0013	72·6	10·8	18·1	Fair.. ...	P	Cloudy 20m.
"	1234	"	"	Jan. 16	12 30	30	2 15 E	"	" ..	−13·5	−13·5	− 6·0	− 6·0	"	72·0	"	18·1	"	P	
"	1260	"	"	Jan. 22	17 46	62	3 40 W	1- 1 1- 1	" ..	−10·0	−10·2	0·2	0·1	"	72·5	"	18·1	"	H	
"	1272	"	"	Jan. 24	13 26	37	0 30 E	"	" ..	−16·0	−15·5	− 9·0	− 9·0	"	"	"	18·0	"	P	
"	1281	"	"	Jan. 27	13 08	50	0 45 E	"	" ..	−12·0	−13·3	−11·1	−11·1	"	"	"	18·0	Good	P	
"	1299	"	"	Jan. 29	13 20	50	0 24 E	"	" .	−19·5	−21·5	− 8·4	− 8·4	"	"	"	18·1	"	H	
"	1300	"	"	"	14 11	52	0 28 W	"	" ..	−21·5	−22·0	− 8 4	− 8·5	"	"	"	18·1	" ...	H	
"	1313	"	"	Feb 3	14 09	52	0 45 W	"	" .	−17·5	−19·5	− 7·9	− 7·7	"	"	"	18·1	Fair	H	
"	1318	"	"	Feb. 8	15 43	30	2 35 W	"	" ..	−17·6	−17·8	−10·2	−10·2	"	"	"	18·1	Good.....	P	
"	1346	"	"	Feb. 22	15 42	45	3 30 W	"	" ..	−13·0	−13·3	− 4·3	− 4·4	"	"	"	18·2	Fair	P	
"	1351	"	"	Feb. 24	14 09	51	2 10 W	"	" ..	−10·2	−11·8	− 2·1	− 2·1	"	"	"	18·2	....	P	
"	1375	"	"	Mar. 4	14 30	60	3 10 W	2- 2- 1- 1	" ..	− 6·0	− 6·5	0 8	0·6	"	"	"	18·2	Poor.	H	
"	1915	"	"	Oct. 2	21 15	60	0 30 W	3- 3- 3- 3	" ..	2·8	3·3	13·0	13·0	·0015	73·0	"	18·6	....	C	
"	1924	"	"	Oct. 9	21 02	85	0 20 W	"	" ..	4 5	3·5	14·8	14·2	"	"	"	18·6	Good.....	P¹	
"	1960	"	"	Nov. 9	20 37	75	1 51 W	"	" ..	4·0	3·0	7 2	7·2	"	"	"	18·6	Fair. ...	H	
"	1967	"	"	Nov. 13	18 45	90	0 20 W	"	" ..	1·1	0·6	6 6	6·6	"	"	"	18·5	Good.....	P¹	
"	2017	"	"	Dec. 9	18 55	70	2 05 W	"	" ..	−16·4	−17·0	− 1 4	− 1·8	"	"	"	18·5	Fair. ...	C	
"	2018	"	"	"	20 03	63	3 10 W	"	" ..	−17·0	−20·0	− 1·8	− 2·0	"	"	"	18·5	" ...	C	
"	2026	"	"	Dec. 10	17 15	70	0 25 W	"	. ..	−17·5	−17·5	− 7·8	− 7·8	"	"	"	18·5	Bad..	P	
"	2033	"	"	Dec. 16	18 37	75	2 20 W	2- 3- 3- 4	" ..	−10·0	−10·5	2·8	2·8	"	"	"	18·5	Good.....	C	
"	2050	"	"	Dec. 18	19 34	82	3 25 W	"	" ..	−11·3	−13·0	− 5·1	− 4·0	"	"	"	18·5	....	P¹	
"	2060	"	"	Dec. 21	19 20	75	3 15 W	3- 3- 3- 3	" ..	−12·5	−13·8	− 1·9	− 2·0	"	"	"	18·5	.. ..	C	

				1909.																	
"	2091	"	"	Jan. 6	16	02	90	1 11 W	3 3 3 3	" ..	−15·5	−16·5	− 2·5	− 2·8	"	73·1	"	18·5	Fair.	H	
"	2096	"	"	"	17	57	76	3 00 W	"	" ..	−17·5	−17·0	− 3·1	− 3·4	"	"	"	18·5	.. ..	H C	
"	2109	"	"	Jan. 7	13	47	65	1 10 E	"	" ..	−16·4	−16·5	− 9·3	− 9·3	"	"	"	18·6	Fair.	P	
"	2110	"	"	"	14	48	54	0 15 E	"	" ..	−16·8	−17·0	− 9·3	− 9·4	"	"	"	18·6	Better...	P	
"	2132	"	"	Jan. 13	17	37	75	3 07 W	2 2 2 2	" ..	−15·0	−15·0	−12·0	−12·0	"	"	"	18·7	Poor......	H	
"	2146	"	"	Jan. 15	17	37	85	3 20 W	4 4 4 4	" ..	−16·4	−17·5	− 5·3	− 5·5	·0016	"	"	18·6	Good.....	C P[1]	
"	2172	"	"	Jan. 18	18	02	72	3 48 W	2 2 5	" ..	−20·0	−22·0	−13·8	−13·8	"	"	"	18·7	Poor......	P[1] H	Hazed
"	2192	"	"	Jan. 28	14	54	98	1 30 W	2 2 2 2	" ..	− 9·5	− 9·6	− 7·6	− 7·6	"	"	"	18·7	"	P[1]	over
"	2210	"	"	Jan. 31	16	40	60	3 15 W	2 2 2 2	" .	−16·0	−19·0	− 6·0	− 6·0	·0018	73·0	"	18·6	Fair.	H	Clouds
"	2224	"	"	Feb. 3	13	57	70	0 47 W	"	" ..	− 8·5	−11·0	− 3·3	− 3·6	·0016	"	"	18·6	"	H	30m.
"	2225	"	"	"	15	09	72	2 02 W	"	" ..	−11·0	−11·5	− 3·6	− 3·7	"	"	"	18·6	"	H	
"	2444	I	"	Mar. 31	13	10	60	3 35 W	1 1 1 1	" ..	6·6	..	10·7	......	·002	38·5	"	27·7	....	H	
"	2445	"	"	"	14	07	45	4 25 W	"	" ..	......	5·0	.....	10·0	"	"	"	27·7	....	H	
"	2859	"	"	Oct. 6	20	06	68	0 55 E	"	" ..	13·5	13·0	20·6	20·6	"	42·2	"	27·6	4-5 2	C	
				1910.																	
"	3200	"	"	Feb. 19	12	39	62	0 25 W	"	" ..	− 4·6	− 6·0	− 2·0	− 2·0	"	"	"	"	3	P	

B. D. – 1°. 1004. 1199.

1907. Dec. 28. Observed by J. S. PLASKETT.
G. M. T. $18^h\ 50^m$ Measured by C. R. WESTLAND.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	73·0282	....	....	....	1½	45·1872	·2242	·0145	− 15·14
1½	72·8984	·8798	·0150	+ 21·76	2	30·8141	....	....	....
2	72·4639	....	....	....	½	30·8165	·8728	·0028	− 2·51
2	54·7263	....	....	....	¼	27·3634	·4296	·0077	+ 6·68
1	53·3667	·3864	·0159	− 18·17	2	27·1798	....	....	....
2	53·0915	....	....	....	½	20·6787	·7530	·0276	− 22·46
2	45·2366	....	....	....	2	20·4455	....	....	....

Weighted mean	−	3·63
V_a	−	6·21
V_d	−	·19
Curv	−	·28
Radial velocity	−	10·3

B. D. – 1°. 1004. 1216.

1908. Jan. 3. Observed by J. S. PLASKETT.
G. M. T. $16^h\ 52^m$ Measured by C. R. WESTLAND.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	54·7246	....	....	....	2	30·8770	·9170	·0414	37·18
2	53·4110	·4305	·0282	+ 32·23	2	30·8304	....	....	....
2	53·0920	....	....	....	2	27·3897	·4384	·0165	14·32
2	48·7429	....	....	....	2	27·1975	....	....	....
2	48·2997	·3262	·0155	16·74	2	20·7520	·8067	·0261	+ 21·24
2	45·2416	....	....	....	2	20·4650	....	....	....
1	45·2244	·2564	·0177	18·48	..	....	....	....	....

Weighted mean	+	23·81
V_a	−	8·96
V_d	−	·09
Curv	−	·28
Radial velocity	+	14·5

B. D. – 1° ·1004. 1234.

1908. Jan. 16.
G. M. T. 12h 30m

Observed by J. S. Plaskett.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	73·0127	....	....	....	1	45·3095	·3147	·0760	79·34
2	72·9285	·9260	·0612	+ 88·80	2	45·2684	....	....	....
2	72·4455	....	....	....	1	30·9924	9916	·1160	104·16
2	54·7365	....	....	....	2	30·8712	....	....	....
2	53·4648	·4593	·0570	65·15	1	27·4903	·4883	·0664	57·64
2	53·1065	....	....	....	2	27·2486	....	....	....
2	48·7622	....	....	....	1½	20·8690	·8641	·0835	+ 67·97
1	48·3942	·4017	·0910	98·28	2	20·5250	....	....	....

Weighted mean	+ 78·87
V_a	– 14·51
V_d	+ ·19
Curv	– ·28
Radial velocity	+ 64·3

B.D. – 1° ·1004. 1260.

1908. Jan. 22.
G. M. T. 17h 46m

Observed by W. E. Harper.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7474	....	....	....	2	30·8456	....	....	....
1	53·4020	·3889	·0134	– 15·32	1	30·8025	·8273	·0483	43·37
2	53·1266	......	....	....	1	20·7106	·7470	·0336	– 27·35
2	48·7701	....	....	....	2	20·4836	....	....	....
2	48·2680	·2692	0415	44·82	..	....	....	....	....

Weighted mean	– 35·14
V_a	– 16·96
V_d	– ·23
Curv	– ·28
Radial velocity	– 52·6

B. D. − 1°. 1004. 1272.

1908. Jan. 24.
G. M. T. 13ʰ 26ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	73·0336	...	...	...	2	45·2933	...	...	...
½	72·9125	·8889	·0241	+ 34·97	1½	45·2536	·2339	·0048	− 5·01
2	72·4680	...	...	...	2	30·9095	·8764	·0008	+ 0·63
2½	56·6995	·6804	·0122	+ 14·48	2	30·9035	...	...	...
2	56·6875	...	...	...	½	27·4698	·4373	·0144	+ 12·50
1½	54·0480	...	...	...	2	27·2789	...	...	...
½	54·0137	·9945	·0247	+ 28·43	1	20·8296	·7902	·0096	+ 7·81
1½	53·4341	·4338	·0315	+ 36·00	2	20·5597	...	...	...
2	53·1323	...	...	...	½	15·5490	·5065	·0332	+ 25·70
2	48·7904	...	...	...	2	15·4412	...	...	...
1½	48·3412	·3209	·0102	+ 11·02	...	...	...	...	...

Weighted mean	+	12·76
V_a	−	17·63
V_d	+	·06
Curv	−	·28
Radial velocity	−	5·1

B. D. − 1°. 1004. 1281.

1908, Jan. 27
G. M. T. 13ʰ 08ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	73·0428	...	...	...	1	48·3619	·3577	·0570	61·56
1½	72·9232	·8902	·0254	+ 36·85	2	45·2728	...	...	...
2	72·4778	...	...	...	1½	45·2537	·2543	·0156	16·29
2	54·0379	...	...	...	1½	30·9057	·9133	·0377	33·88
1½	53·4343	·4256	·0233	26·63	1	30·8628	...	...	...
2	53·1203	...	...	...	½	27·4577	·4731	·0512	+ 44·44
2	48·7748	...	...	...	2	27·2306	...	...	...

Weighted mean	+	33·90
V_a	−	18·70
V_d	+	·09
Curv	−	·28
Radial velocity	+	15·0

B. D. – 1°. 1004. 1299.

1908. Jan. 29.
G. M. T. 13h 20m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·0420	....	....	....	1½	30·9367	·9024	·0268	24·07
1	54·0195	·0058	·0360	+ 41·44	2	30·9047	....	....	....
2	53·4548	·4378	·0355	40·58	1	29·0777	·0448	·0410	36·12
2	53·1305	....	....	....	1½	27·4845	·4525	·0306	26·56
2	48·7853	....	....	....	2	27·2782	....	....	....
1½	48·3570	·3416	·0309	33·37	1½	20·8328	·8008	·0202	+ 16·44
2	45·2898	....	....	....	2	20·5520	....	....	....
1½	45·2885	·2723	·0336	35·08	..	....	....	....	....

Weighted mean	+	31·05
V_a	–	19·39
V_d	+	·06
Curv	–	·28
Radial velocity	+	11·4

B. D. – 1°. 1004. 1300.

1908. Jan. 29.
G. M. T. 14h 11m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
1½	73·0310	....	....	....	2½	45·2841	·2650	·0263	27·46
¼	72·9075	·8863	·0215	+ 31·20	1½	30·9290	9000	·0244	21·91
1	72·4659	....	....	....	2	30·8994	....	....	....
1	54·0543	....	....	....	1	29·0837	·0513	·0475	41·85
¼	54·0204	·9950	·0252	29·00	1½	27·4885	·4335	·0116	10·07
2	53·4471	·4246	·0223	25·49	2	27·2821	....	....	....
1	53·1335	....	....	....	2	20·8472	·8090	·0284	23·12
2	48·7892	....	....	....	2	20·5582	....	....	....
2	48·3431	·3239	·0132	14·26	1	19·2912	·2528	·0367	+ 29·34
2	45·2928	....	....	....	2	15·4378	....	....	....

Weighted mean	+	23·36
V_a	–	19·39
V_d		·00
Curv	–	·28
Radial velocity	+	3·7

B. D. – 1°. 1004. 1313.

1908. Feb. 3.
G. M. T. 14^h 09^m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	72·4612	...	...	...	½	45·3006	·2802	·0415	43·32
1½	66·2372	·2180	·0300	+ 43·53	1	40·2816	·2560	·0462	45·69
2	60·2363	...	...	...	1	30·9677	·9337	0581	52·17
1½	54·0477	...	...	...	2	30·9046	...	...	...
½	54·0247	0060	·0362	41·67	1	29·0986	·0650	·0612	53·92
1½	53·4370	·4190	·0167	19 09	½	27·5390	·5060	·0841	73·00
2	53·1295	...	...	...	2	27·2795	...	...	...
2	48·7885	...	...	...	1	20·8645	·8255	·0449	+ 36·55
2	48·3722	·3534	·0427	46·12	2	20·5595	...	...	...
2	45·2940	...	...	...	..	...	...	...	...

Weighted mean	+	43·18
V_a	–	21·15
V_d	–	·03
Curv	–	·28
Radial velocity	+	21· 7

B. D. – 1°. 1004. 1318.

1908. Feb. 8.
G. M. T. 15^h 43^m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	73·0124	...	...	...	1½	45·3131	·2972	·0585	61·07
1	72·9143	·9101	·0453	+ 65·73	½	40·2981	·2727	·0629	62·21
2	72·4538	...	...	...	1½	30·9818	·9400	·0644	57·83
2	54·0418	...	...	...	2	30·9123	...	...	...
½	54·0116	·9986	·0288	33·15	1½	29·1259	·0823	·0785	69·16
1½	53·4686	·4556	·0533	60·92	1	27·5370	·4919	·0700	60·76
2	53·1250	...	...	...	2	27·2917	...	...	...
2	48.7836	...	...	...	1	20·9016	·8463	·0657	+ 53·48
2	48·4021	·3882	·0775	83·70	2	20·5757	...	...	...
2	45·2895	...	...	...	..	...	...	...	...

Weighted mean	+	64·04
V_a	–	22·47
V_d	–	·19
Curv	–	·28
Radial velocity	+	41·1

B. D. – 1°. 1004. 1346.

1908. Feb. 22.
G. M. T. 15h 42m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	54·0571				2	45·2963			
2½	53·4562	·4203	·0180	+ 20·57	1½	45·2977	·2750	·0363	37·90
2	53·1370				1½	20·8175	·7968	·0162	+ 13·19
2	48·7891				2	20 5407			
1	48·3672	·3476	·0369	39·85					

Weighted mean	+	25·83
V_a	–	25·54
V_d	–	·22
Curv	–	·28
Radial velocity	–	0·2

B. D. – 1°. 1004. 1351.

1908. Feb. 24.
G. M. T. 14h 09m

Observed by J. S. Plaskett.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	73·0045				2	45·3187			
1	72·8959	·9008	·0360	+ 52·24	½	45·3151	·2700	·0313	32·68
2	72·4415				½	30·9875	·9005	·0249	22·36
2	54·7678				2	30·9574			
1	53·4617	·4328	·0305	34·86	½	27·5451	4504	·0285	24·74
2	53·1417				2	27·3417			
2	48·8105				1½	20·9424	·8297	·0491	+ 39·97
1	48·3880	·3470	·0363	39·20	2	20·6335			

Weighted mean	+	37·69
V_a	–	25·98
V_d	–	·14
Curv	–	·28
Radial velocity	+	11·3

B. D. – 1°. 1004. 1375.

1908. Mar. 4.
G. M. T. 14ʰ 30ᵐ

Observed by W. E. Harper.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	54·7276				½	30·8902	·9254	·0498	44·72
2	53·4431	·4588	·0565	+ 64·58	2	30·8351			
2	53·0960				½	27·4334	·4758	·0539	46·78
2	48·7507				2	27·2038			
2	48·3380	·3575	·0468	50·54	¼	20·7927	·8445	·0639	+ 52·01
1½	45·2798	·3012	·0625	65·25	2	20·4677			
2	45·2522								

Weighted mean	+	57·31
V_a	−	27·96
V_d	−	·21
Curv	−	·28
Radial velocity	+	28·9

B. D. – 1°. 1004. 1915.

1908. Oct. 2.
G. M. T. 21ʰ 53ᵐ

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	72·4302				2	45·3052			
¾	66·1842	·1874	·0005	− 0·66	½	45·2475	·2159	·0228	− 23·80
2	60·2227				½	40·2385	·1989	·0109	− 10·78
2	54·7477				2	39·7766			
½	53·4157	·4091	·0068	+ 7·77	2	38·0045			
2	53·1222				2	30·9384			
2	48·7938				½	30·9292	·8612	·0144	− 12·93
¼	48·3070	·2821	·0286	− 30·88					

Weighted mean	−	9·36
V_a	+	25·85
V_d		·00
Curv	−	·28
Radial velocity	+	16·2

B. D. − 1°. 1004. 1924.

1908. Oct. 9.
G. M. T. 21ʰ 02ᵐ

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ.	Velocity.
2	54·7502				½	48·3712	·3549	·0430	46·57
½	53·4402	·4192	·0290	− 33·23	2	45·2945			
2	53·1221				¼	45·2815	·2706	·0219	22·93
¼	51·4150	·3950	·0218	24·42	½	30·9462	·9555	·0196	− 17·68
2	48·7870				2	30·9214			

Weighted mean	−	30·28
V_a	−	24·75
V_d	−	·04
Curv	−	·28
Radial velocity	−	53·8

B. D. − 1°. 1004. 1960.

1908. Nov. 9.
G. M. T. 20ʰ 37ᵐ

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ.	Velocity.
2	72·9744				2	54·7550			
½	72·8474	·8830	·0182	+ 26·61	2	53·4678	·4518	·0405	56·63
2	72·4087				2	53·1287			
½	66·2202	·2347	·0468	62·34	2	48·8015			
2	60·2212				½	48·3890	·3545	·0438	− 47·30

Weighted mean	−	51·82
V_a	−	15·80
V_d	−	·09
Curv	−	·28
Radial velocity	−	67·2

B. D. - 1°. 1004. 1960.*

1908. Nov. 9.
G. M. T. 20h 37m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	72·9415	....	....	....	2	53·1029	....	....	....
½	72·8245	·8461	·0274	+ 39·81	2	48·7725	....	....	....
2	72·3800	....	....	....	¼	48·3505	·3485	·0366	39·64
2	54·7272	....	....	....	2	45·2813	....	....	....
2	53·4405	·4386	·0484	55·47	½	45·2887	·2910	·0423	+ 44·29

* Check measurement.

Weighted mean	+	50·15
V_a	+	15·80
V_d	−	·09
Curv	−	·28
Radial velocity	+	65·6

B. D. - 1°. 1004. 1967.

1908. Nov. 13.
G. M. T. 18h 45m

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	72·9712	....	....	....	2	53·1209	....	....	....
¼	72·8756	·8833	·0646	+ 93·86	2	48·7899	....	....	....
2	72·4072	....	....	....	½	48·4311	·4112	·0995	107·73
½	66·2366	·2343	·0838	111·83	½	45·3521	·3318	·0831	86·89
2	59·7975	....	....	....	2	45·3039	....	....	....
1	54·0990	·0790	·1224	140·88	¼	31·0612	·0365	·1006	+ 90·72
2	54·7445	....	....	....	2	30·9554	....	....	....
1	53·4796	·4602	·0700	80·24	..	....	....	....	....

Weighted mean	+	105·12
V_a	+	14·19
V_d	+	·09
Curv	−	·28
Radial velocity	+	119 1

B. D. - 1°. 1004. 2017.

1908. Dec. 9. Observed by J. B. CANNON.
G. M. T. 18h 55m Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7203	....	....	....	1	48·4276	·4176	·1044	113·08
1	53·4801	·4714	·0932	+ 107·09	¼	45·3675	·3624	·1035	+ 108·67
2	53·0980	... .	....	....	2	45·2987	....	.. . .	....
2	48·7805	....	....	....	...	....	....	... .	....

Weighted mean .... + 109·93
V_a .... + 2·50
V_d....... .... — ·12
Curv .... — ·28

Radial velocity .... + 112·0

B. D. - 1°. 1004. 2018.

1908. Dec. 9. Observed by J. B. CANNON.
G. M. T. 20h 03m Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7302	....	....	....	½	48·4150	·4000	·0868	94·26
¼	53·4925	·4710	·0928	+ 106·63	¼	45·3970	·3770	·1181	124·00
2	53·1114	. . ..	....	....	¼	21·1155	·1240	·1352	+ 110 97
2	48·7944	....	....	....	2	20·7221	....	....	....

Weighted mean .... + 106·03
V_a.... .. .. + 2·50
V_d .... — ·19
Curv.. .. .. — ·28

Radial velocity .... + 108·1

B. D. – 1°. 1004. 2026.

1908. Dec. 10.
G. M. T. 17h 15m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7097	....	....	....	¼	45·3602	·3495	·0906	100·80
2	53·5002	·5026	·1244	+ 142·94	2	45·3043	....	....	....
2	53·0865	....	....	....	½	31·1760	·1673	·1610	+ 144·70
2	48·7787	....	....	....	2	30·9998	. ...	....	....
½	48·4402	·4317	·1185	128·22	..	....	. ...	....	....

Weighted mean .... + 137·70
V_a .... + 2·07
V_d .... ·00
Curv .... – ·28

Radial velocity .... + 139·5

B. D. – 1° 1004. 2033.

1908. Dec. 16.
G. M. T. 18h 37m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7445	....	....	. ...	2	46·3127	....	....	.. ..
½	53·3925	·3625	·0157	– 18·04	½	30·9820	·9877	·0686	7·78
2	53·1187	....	....	....	2	30·9833	....	....	....
2	48·7928	....	... .	... .	½	20·9230	·9663	·0225	– 18·48
1	48·2980	·2757	·0375	40·72	2	20·6862	....	....	....

Weighted mean .... – 15·76
V_a .... – 0·84
V_d .... – ·14
Curv .... – ·28

Radial velocity .... – 17·0

B. D. − 1°. 1004. 2050.

1908. Dec. 18.
G. M. T. 19h 34m

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
1	54·7445	....	....	....	1	45·2670	·2386	·0203	− 21·31
½	53·4066	·3698	·0094	− 10·80	¼	30·9835	·9662	·0301	− 27·24
1	53·1270	....	....	....	1	31·0083	....	....	....
1	48·7972	....	....	....	1	20·9822	·9822	·0066	− 5·22
½	48·3537	·3264	·0132	+ 14·33	1½	20·7305	....	....	....
1	45·3220	....	....	....	..	....	....	....	....

Weighted mean.............. − 9·72
V_a.............................. − 1·81
V_d.............................. − ·20
Curv............................... − ·28

Radial velocity.............. − 12·0

B. D. − 1°. 1004. 2060.

1908. Dec. 21.
G. M. T. 19h 20m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	72·8752	....	....	....	2	45·2621	....	....	....
½	72·7515	·7925	·0204	+ 29·66	1½	40·2351	2681	·0061	5·48
2	72·3145	....	....	....	2	39·7580	....	....	....
2	54·6854	....	....	....	1	30·9655	·0154	·0191	17·28
1	53·3585	·3857	·0075	8·61	2	30·9411	....	....	....
2	53·0629	....	....	....	½	27·5482	·6106	·0488	42·70
1	51·3547	·3825	·0163	18·30	2	27·3310	....	....	....
2	48·7415	....	....	....	1	20·9280	·0086	·0198	+ 16·26
1	48·2950	·3239	·0107	11·62	2	20·6490	....	....	....
1	45·2677	·2992	·0403	42·31	..	....	....	....	....

Weighted mean.................. + 18·68
V_a.................................. − 3·26
V_d.................................. − ·20
Curv................................... − ·28

Radial velocity.................. + 14·9

B. D. – 1°. 1004. 2091.

1909. Jan. 6.
G. M. T. 16h 02m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	72·9165	....	....	....	2	45·2814	....	....	....
½	72·8536	·8539	·0818	+ 118·94	½	31·1005	·1365	·1402	126·88
2	72·3530	....	....	....	2	30·9550	....	....	....
2	54·7105	....	....	......	2	29·2450	·2955	·1559	138·60
½	53·5066	·5099	·1317	151·32	2	29·6786	....	....	......
2	53·0855	....	......	......	2	27·3471	......	....	....
2	48·7654	....	....	....	½	27·6692	·7192	·1574	137·72
1	48·4285	·4439	·1307	141·94	½	21·0690	·1370	·1482	+121·67
1½	45·3645	·3767	·1178	123·69	2	20·6615	....	....	....

Weighted mean............. +136·13
V_a .... – 10·61
V_d........................ – ·04
Curv......................... – ·28

Radial velocity.............. +125·2

B. D. – 1°. 1004. 2096.

1909. Jan. 6.
G. M. T. 17h 57m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	72·9168	....	....	......	2	48·7722	....	....	....
½	72·8545	·8544	·0823	+ 119·56	½	48·4195	·4176	·1044	113·38
2	72·3540	....	....	....	¾	45·3845	·3850	·1261	132·40
2	54·7172	....	....	......	2	45·2931	....	....	......
2	53·5055	·4958	·1176	135·12	1	31·1197	·1475	·1512	+136·84
2	53·1002	....	....	....	1	30·9632	....	....	....

Weighted mean............. +130·60
V_a .... – 10·61
V_d........................ – ·18
Curv......................... – ·28

Radial velocity.............. + 118·5

B. D. - 1°. 1004. 2109.

1909. Jan. 7.
G. M. T. 13h 47m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	72·9251	...	...	...	2	45·3315	...	...	...
1	72·8037	·7961	·0240	+ 34·90	1½	45·3252	·2873	·0284	29·82
2	72·3578	...	...	...	½	40·3579	·3196	·0576	57·37
2	54·7461	...	...	...	2	39·8295	...	...	...
2	53·4405	·4032	·0250	28·72	1	31·0800	·0451	·0478	43·26
2	53·1272	...	...	...	1	31·0259	...	...	...
½	51·4255	·3866	·0204	22·91	1	21·0481	·0328	·0440	+ 36·12
2	48·8100	...	...	...	2	20·7453	...	...	...
1½	48·3865	·3568	·0136	47·35	..	...	...	...	...

Weighted mean .... + 36·40
V_a .... − 11·91
V_d .... + ·14
Curv .... − ·28

Radial velocity .... + 24·4

B. D. - 1°. 1004. 2110.

1909. Jan. 7.
G. M. T. 14h 48m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	72·8981	...	...	...	2	45·3031	...	...	...
1	72·7852	·8028	·0307	+ 44·64	1½	45·3092	·2997	·0408	42·84
2	72·3400	...	...	...	½	31·0624	·0630	·0667	60·36
¼	66·1555	·1602	·0474	63·37	2	30·9904	...	...	...
2	54·7231	...	...	...	½	27·6205	·6265	·0647	56·61
2	53·4362	·4239	·0457	52·51	2	27·3906	...	...	...
2	53·1017	...	...	...	1½	20·9996	0184	·0296	+ 24·30
1	48·3570	·3428	·0296	32·14	2	20·7101	...	...	...
2	48·7849	...	...	...		...	...	...	...

Weighted mean .... + 43·25
V_a .... − 11·91
V_d .... + ·06
Curv .... − ·28

Radial velocity .... + 31·1

B. D. − 1°. 1004 2132.

1909. Jan. 13.
G. M. T. 17^h 37^m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	72·8798				2	45·2817			
½	72·7242	7612	·0109	− 15·85	1	45·2756	·2875	·0286	+ 30·03
1	72·3162				½	40·2842	·3012	·0392	+ 39·04
2	54·6992				2	39·7737			
1½	53·3740	·3881	·0099	+ 11·37	2	30·9730			
2	53·0747				1	30 9855	·0035	·0072	+ 6·51
2	48·7586				½	20·9647	9964	·0076	+ 6·24
¾	48·2917	·3032	·0100	− 10·86	2	20·6985			

Weighted mean	+	10·46
V_a	−	14·14
V_d	−	·19
Curv	−	·28
Radial velocity	−	4·1

B. D. − 1°. 1004. 2146.

1909. Jan. 15.
G. M. T. 17^h 37^m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^ns	Velocity.
2	72·3371				½	40·2650	·2769	·0149	14·38
½	66·1267	·1380	·0152	+ 20·31	2	39·7787			
2	54·7094				1	31·0087	·0224	·0261	23·62
1	53·3970	·4009	·0227	26·08	1	30·9773			
2	53·0839				¼	27·5802	·6088	·0470	41·15
2	48·7656				2	27·3675			
1	48·3325	·3369	·0237	25·73	1	20 9595	·0053	·0165	+ 13·55
2	45·2895				2	20·6840			
2	45·2777	·2818	·0229	24·04	..				

Weighted mean	+	22·71
V_a	−	14·50
V_d	−	·20
Curv	−	·28
Radial velocity	+	7·7

B. D. - 1°. 1004 2172.

1909. Jan. 18.
G. M. T. 18h 02m

Observed by T. H. PARKER.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·7287	....	....	....	¼	48·3811	·3585	·0453	49·20
½	53·4464	·4262	·0480	+ 55·15	¼	45·3432	·3216	·0627	65·83
2	53·1102	....	....	....	2	45·3152	....	....	....
¼	51·4295	·4077	·0415	46·60	½	31·0443	·0306	·0343	+ 31·04
2	48·7927	....	....	....	2	31·0047	....	....	....

Weighted mean	+	49·83
V_a	−	15·60
V_d	−	·23
Curv	−	·28
Radial velocity	+	33·7

B. D. - 1°. 1004. 2192.

1909. Jan. 28.
G. M. T. 14h 54m

Observed by T. H. PARKER.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	54·6625	....	....	....	2	45·2398	....	....	....
1	53·3982	·4512	·0730	+ 83·86	1	40·3070	·3657	·1037	103·28
2	53·0439	....	....	....	2	39·7320	....	....	....
2	48·7167	....	....	....	½	31·0012	·0722	·0759	+ 71·49
1	48·3615	·4148	·1016	110·34	1	30·9230	....	....	....
½	45·2745	·3283	·0696	73·08	..	....	....	....	....

Weighted mean	+	92·44
V_a	−	19·25
V_d	−	·06
Curv	−	·28
Radial velocity	+	72·8

B. D. – 1°. 1004. 2210.

1909. Jan. 31.
G. M. T. 16h 40m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	54·6634				½	45·3185	·3742	·1153	121·06
1	53·4202	·4684	·0902	+103·64	2	45·2379			
2	53·0410				½	31·0390	·1118	·1155	+104·53
2	48·7185				2	30·9182			
1	48·3600	·4120	·0988	107·30					

Weighted mean	+107·91
V_a	– 20·34
V_d	– ·20
Curv	– ·28
Radial velocity	+ 87·1

B. D. – 1°. 1004. 2224.

1909. Feb. 3.
G. M. T. 13h 57m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	72·9098				2	45·3207			
½	72·8098	·8171	·0450	+ 65·43	1	40·3822	·3560	·0940	99·00
2	72·3440				2	39·8174			
2	54·0319				1	31·1025	·0808	·0845	76·47
1½	53·4561	·4280	·0498	57·59	1	31·0127			
2	53·1165				1	27·6759	·6548	·0930	81·37
2	48·8016				2	27·4087			
2	48·4234	·3923	·0791	90·88	1	21·0895	·0914	·1026	+ 84·29
1½	45·3647	·3376	·0787	90·50	2	20·7295			

Weighted mean	+ 81·87
V_a	– 21·24
V_d	– ·02
Curv	– ·28
Radial velocity	+ 60·3

B. D. − 1°. 1004. 2225.

1909. Feb. 3.
G. M. T. 15h 09m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	72·9130	....	....	....	2	45·3236	....	....	....
½	72·8460	·8498	·0777	+112·97	1	45·3630	·3330	·0741	77·80
2	72·3491	....	....	....	1½	31·1177	·0922	·0959	86·79
2	54·0351	....	....	....	1	31·0165	....	....	....
2	53·4756	·4429	·0647	73·80	½	27·6547	·6377	·0759	66·41
2	53·1170	....	....	....	2	27·4140	....	....	....
2	48·8002	....	....	....	1	21·0815	·0780	·0892	+ 73·28
1	48·3910	·3608	·0476	51·70	2	20·7335	....	....	....

Weighted mean............	+ 77·37
V_a............................	− 21·24
V_d............................	− ·12
Curv............................	− ·28
Radial velocity...............	+ 55·7

B. D. − 1°. 1004. 2444.

1909. Mar. 31.
G. M. T. 13h 10m

Observed by } W. E. HARPER.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispt in revns	Velocity.
2	59·4547	....	....	....	2	50·9101	....	....	....
1½	58·2395	·2456	·0073	− 9·25	1½	50·8820	·8930	·0045	+ 5·22
2	57·9864	....	....	....	2	37·9188	....	....	....
2	54·0647	....	....	....	1	37·9077	·9057	·0359	− 35·79
1	53·6310	·6417	·0176	− 20·86	...	....	....	....	....

Weighted mean............	− 12·54
V_a............................	− 26·01
V_d............................	− ·22
Curv............................	− ·28
Radial velocity...............	− 39·1

B. D. – 1°. 1004. 2445.

1909. Mar. 31.
G. M. T. 14h 07m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	59·4714				½	53·6292	·6289	·0304	36·39
1	58·2372	·2297	·0232	– 29·39	2	50·9187			
2	57·9976				¼	50·8627	·8650	·0235	– 27·19
2	54·0757								

Weighted mean .... – 31·08
V_a .... – 26 01
V_d .... – ·28
Curv .... – ·28

Radial velocity .... – 57·7

B. D. – 1°. 1004. 2859.

1909. Oct. 6.
G. M. T. 20h 06m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Disp^t in rev^{ns}	Velocity.
2	59·5069				¼	50·8675	·8493	·0411	47·43
½	58·2400	·2256	·0491	– 62·06	½	46·3184	·2993	·0436	47·70
2	58 0247				1	45·9325			
2	54·1042				1½	37 9297			
¾	53·6017	·5811	·0878	104·83	½	37·8734	·8537	·0511	– 50·79
2	50·9406								

Weighted mean .... – 68·30
V_a .... + 25 32
V_d .... + ·12
Curv .... – ·28

Radial velocity .... – 43· 1

B. D. − 1°. 1004. 3200.

1910. Feb. 19.
G. M. T. 12ʰ 39ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.	Wt.	Mean of Settings.	Corrected Star Settings.	Dispᵗ in revⁿˢ	Velocity.
2	59·4597	....	....	....	¾	37·9500	·9506	·0090	+ 8·61
¾	58·2602	·2638	·0109	+ 13·81	2	37·9362	....	....	....
2	57·9866	....	....	....	½	36·2777	·2803	·0218	+ 21·41
2	54·0683	....	....	....	¾	34 8230	·8270	·0049	+ 4·72
½	53·6500	·6566	·0027	− 3·23	2	34·6692	....	....	....
1	50·8879	·8928	·0043	+ 4·97	¾	28·8457	·8502	·0005	+ 0·45
2	50·9160	....	....	....	2	28·6145	....	....	....

Weighted mean	+	6·45
V_o	−	25·08
V_d		·00
Curv	−	·28
Radial velocity.....	−	18·9

C.—CANNON.
H.—HARPER.
Pl.—PARKER.

OBSERVING RECORD AND DETAILED MEASURES OF α DRACONIS.

RECORD OF SPECTROGRAMS.

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure. G. M. T.	Duration.	Hour Angle at end.	Comparison Spectrum. Exposure in seconds.	Comparison Spectrum. Kind.	Temperature Centigrade. Room. Beginning.	Room. End.	Prism Box. Beginning.	Prism Box. End.	Slit Width in inches.	Focal Position. Star Focus.	Collimator.	Camera.	Seeing.	Observer.	Remarks.
				1909.	h. m.	m.	h. m.													
α Draconis	2596	I	Seed 27	June 28	14 47	45	2 30 W	1- 1- 1	Fe V Spark	21·5	21·0	26·9	26·8	·002	41·5	..	27·69	Fair.....	C	Windy.
"	2605	"	W & W	June 30	15 32	80	3 42 W	"	" ..	26·0	24·5	29·9	29·5	"	"	...	"	Hazy.....	H	
"	2731	"	Seed 27	Aug. 9	19 05	30	9 35 W	2- 2- 2	" ..	19·5	18·5	23·3	23·2	"	"	....	"	3	H	
"	2740	"	"	Aug. 10	18 41	30	9 05 W	1- 1- 1- 1	" ..	16·9	15·3	18·7	18·6	"	"	....	"	5	C	
"	2741	"	"	Aug. 10	19 14	32	9 40 W	"	" .	15·3	15·0	18·6	18·5	"	"	....	"	5	C	
"	2747	"	"	Aug. 12	15 33	35	6 10 W	"	" ..	20·5	20·5	25·3	25·2	"	"	....	"	4	C	
"	2748	"	"	Aug. 12	16 33	83	7 30 W	"	" ..	20·5	18·6	25·2	25·1	"	"	...	"	2 0- 5- 2	C	
"	2760	"	"	Aug. 20	16 21	30	7 20 W	"	" ..	14·1	13·6	21·9	21·9	"	"	....	"	5	C	
"	2761	"	"	Aug. 20	16 53	33	8 05 W	"	" ..	13·6	12·8	21·9	21·9	"	"	....	"	5	C	
"	2847	"	"	Oct. 4	22 15	32	7 40 E	"	" ..	9·5	9·5	22·6	22·6	"	42·2	....	"	4	H	
"	2851	"	"	Oct. 5	22 21	28	7 15 E	"	" ..	10·9	11·0	12·8	12·8	"	"	....	"	4	Pl	Hazy.
"	2879	"	"	Oct. 8	22 30	30	7 10 E	"	" .	11·7	11·5	22·5	22·4	"	"	...	"	4- 3	Pl	
				1910.																
"	3115	"	"	Jan. 14	22 20	30	50 E	1- 2- 2- 2	" ..	—15·8	—16·5	—8·2	—8·3	"	"	...	27·55	5	Pl	

α DRACONIS 2596.

1909. June 28.
G. M. T. 14h 47m

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
1	58·7986	·7960	·0077	+9·79	1	34·7676	·8021	·0271	26·02
2	58·8448	....	....	....	2	34·5915	....	....	....
1	50·8936	·9024	·0120	13·85	1½	20·6885	·7464	·0296	+24·54
2	50·9141	....	....	....	2	20·3476	....	....	....

Weighted mean.................. +19·22
V_a.................. −10·12
V_d.................. − ·07
Curvature........ − ·28

Radial velocity.................. +8·7

α DRACONIS 2605.

1909. June 30.
G. M. T. 15h 32m

Observed by }
Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	58·8517	....	....	....	1½	20·6685	·7270	·0102	+8·46
¾	58·8014	·7920	·0037	+4·71	2	20·3466	....	....	....

Weighted mean.......... +7·21
V_a.......................... −9·91
V_d.......................... − ·13
Curvature.................. − ·28

Radial velocity.................. −3·1

α DRACONIS 2731.

1909. Aug. 9.
G. M. T. 18h 08m

Observed by }
Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	59·4675	....	....	....	1	36·9769	·0100	·0496	48·76
1½	58·7911	·8088	·0205	+26·08	½	36·7469	·7800	·0291	+28·55
2	57·9960	....	....	....	2	36·7178	....	....	....

Weighted mean..........+34·05
V_a.......................... −3·77
V_d.......................... − ·13
Curvature.................. − ·28

Radial velocity..... +29·9

a DRACONIS 2740.

1909. Aug. 10.
G. M. T. 18h 41m

Observed by J. B. CANNON.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	58·8275	....	....	....	2	36·7360	....	....	....
½	58·8003	·8149	·0266	+33·83	1	34·8035	·8182	·0432	41·47
2	50·9085	....	....	....	2	34·6116	....	....	....
1½	50·8982	·9125	·0221	25·50	2	20·7546	·7746	·0578	+47·92
1	36·9857	·0007	·0403	39·61	2	20·3855	....	....	....

Weighted mean.......... +38·68
V_a........................ −3·57
V_d........................ − ·13
Curvature.................. − ·28

Radial velocity......... +34·7

a DRACONIS 2741.

1909. Aug. 10.
G. M. T. 19h 14m

Observed by J. B. CANNON.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	58·7565	....	....	....	¼	34·7490	·7990	·0240	23·04
¾	58·7345	·8201	·0318	+40·45	2	34·5764	....	....	....
2	50·8717	....	....	....	1¼	20·7259	·7792	·0624	+51·73
1	50·8657	·9168	·0264	30·46	2	20·3524	....	....	....

Weighted mean......... +40·37
V_a........................ −3·57
V_d........................ − ·11
Curvature.................. − ·28

Radial velocity........... +36·4

a DRACONIS 2747.

1909. Aug. 12.
G. M. T. 15h 33m

Observed by J. B. CANNON.
Measured by W. E. HARPER.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	58·8070	....	....	....	¾	36·9312	·9943	·0339	33·32
2	58·7956	·8307	·0424	+53·93	2	36·6876	....	....	....
1	50·8782	·9190	·0286	33·00	¾	20·7048	·7755	·0587	+48·60
2	50·8820	....	....	....	2	20·3350	....	....	....

Weighted mean.......... +44·95
V_a........................ −3·17
V_d........................ − ·18
Curvature.................. − ·28

Radial velocity......... +41·3

α DRACONIS 2748.

1909. Aug. 12.
G. M. T. $16^h 33^m$

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	58·8245	....	....	....	½	34·7950	·8325	·0575	55·20
½	58·7985	·8161	·0278	+35·36	2	34·5887	....	....	....
1	50·9146	·9362	·0458	52·85	1	20·7252	·7770	·0602	+49·9
2	50·9012	....	....	....	2	20·3535	....	....	....

Weighted mean.......... +49·34	
V_a........................	−3·17
V_d........................	− ·18
Curvature..................	− ·28
Radial velocity..... +45·8	

α DRACONIS 2760.

1909. Aug. 20.
G. M. T. $16^h 21^m$

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9227	....	....	....	2	34·6200	....	....	....
1	50·8870	·8871	·0033	−3·81	1¾	20·7007	·7267	·0099	+8·20
¾	34·7699	·7762	·0012	+1·15	2	20·3791	....	....	....

Weighted mean.......... +3·26	
V_a........................	−1·65
V_d........................	− ·13
Curvature..................	− ·28
Radial velocity......... + 1·2	

α DRACONIS 2761.

1909. Aug. 20.
G. M. T. $16^h 53^m$

Observed by J. B. Cannon.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	62·3008	....	....	....	2	58·8075	....	....	....
1	62·3005	·2776	·0003	−0·40	¾	58·7449	·7795	·0068	−11·32

Weighted mean....................	− 5·08
V_a..............................	− 1·65
V_d..............................	− ·13
Curvature........................	− ·28
Radial velocity..................	− 7·1

α DRACONIS 2847.

1909. Oct. 4.
G. M. T. 22^h 15^m

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9160	....	....	....	½	44·1571	·1792	·0561	59·80
1	50·9133	·9201	·0297	+34·27	½	20·7437	·7569	·0401	+33·20
2	44·2955	....	....	....	2	20·3925	....	....	....

Weighted mean............. +40·38
V_a....................... + 7·07
V_d....................... + ·12
Curvature....................... − ·28

Radial velocity........... + 47·3

α DRACONIS 2851.

1909. Oct. 5.
G. M. T. 22^h 21^m

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	59·4760	....	....	....	2	50·9244	....	....	....
1	58·7958	·8052	·0169	+21·50	2	44·3235	....	....	....
2	58·0021	....	....	....	½	44·1510	·1350	·0119	+12·68
1	50·9154	·9138	·0234	27·00					

Weighted mean......... +25·94
V_a.................. + 7·23
V_d.................. + ·17
Curvature.................. − ·28

Radial velocity .... +33·1

α DRACONIS 2879.

1909. Oct. 8.
G. M. T. 22^h 30^m

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	58·8394	....	....	....	½	50·8830	·8945	·0041	4·73
1	58·7875	·7902	·0019	+2·42	½	36·7393	·7514	·0005	+0·50
2	50·9113	....	....	....	2	36·7390	....	....	....

Weighted mean......... + 2·51
V_a.................. + 7·71
V_d.................. + ·12
Curvature.................. − ·28

Radial velocity......... +10·1

α DRACONIS 3115.

1910. Jan. 14.
G. M. T. 22^h 20^m

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	59·4399	....	....	....	2	44·3599	....	....	....
1½	58·7852	·8049	·0397	+50·60	1	44·2215	·1863	·0454	48·53
2	57·9726	....	....	....	1½	20·9280	·8695	·0567	+47·17
1	50·9580	·9259	·0374	43·27	2	20·5606	....	....	....
2	50·9530	....	....	....					

Weighted mean.........	+47·48	
V_a..................	+ 8·11	
V_d..................	+ ·04	
Curvature..................		— ·28
Radial velocity.........	+55·3	

OBSERVING RECORD AND DETAILED MEASURES OF η BOÖTIS.

P.—Plaskett.
P[1].—Parker.
H.—Harper.

RECORD OF SPECTROGRAMS.

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure G. M. T.	Duration.	Hour Angle at end.	Comparison Spectrum.		Temperature Centigrade.				Slit Width in inches.	Focal Position.			Seeing.	Observer.	Remarks.
								Exposure in seconds.	Kind.	Room. Beginning.	Room. End.	Prism Box. Beginning.	Prism Box. End.		Star Focus.	Collimator.	Camera.			
				1909.	h. m.	m.	h. m.													
η Boötis.	2734	III. L	Seed 27	Aug. 10	13 30	60	4 25 W	20-20-20-20	FeV spark	20·0	19·3	23·1	23·0	·002	72·2	....	27·5	4	P	
"	2776	"	"	Aug. 30	13 20	80	5 40 W	30-30-30-30	" ..	14·7	14·3	18·0	17·8	·002	72·2	....	27·5	5	P[1]	
				1910.																
"	3184	III. S.	"	Feb. 10	18 43	53	2 25 E	20-20-20-20	" ..	-16·1	-17·5	- 6·9	- 6·9	·0017	....	....	......	3-4	P	
"	3225	"	"	Feb. 24	16 55	60	3 15 E	6- 6- 6- 6	" ..	-14·0	-15·0	0·3	0·4	·0017	....	...	......	4-5	H	
"	3325	III. R	"	Mar. 11	19 38	103	0 55 W	10-10-10-10	" ..	- 1·5	- 2·5	3·0	2·6	·0017	....	....	......	1-3-5	P[1]	

η BOÖTIS 2734.

1909. Aug. 10.
G. M. T. 12h 30m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
½	77·3351	·3431	·0376	+17·51	½	69·9334	·9369	·0548	24·11
½	77·0162	·0242	·0305	13·88	1	68·8210	·8245	·0380	16·72
2	76·9854	....	....	....	2	68·7781	....	....	....
1	76·6835	·6905	·0423	19·20	½	68·2880	·2910	·0471	20·16
1	75·2942	·3002	·0239	10·68	1	67·8995	·9025	·0343	14·58
½	74·1087	·1147	·0423	18·86	1	66·7712	·7747	·0497	21·27
2	73·6181	....	....	....	1	64·5425	·5445	·0369	15·57
1	72·9472	·9522	·0246	10·92	2	63·4375	....	....	....
½	72·6585	·6630	·0248	10·99	1½	60·4682	·4702	·0434	17·66
½	72·4165	·4210	·0308	13·64	2	58·8565	....	....	....
2	72·0007	·0047	·0374	16·46	½	58·9037	·9067	·0489	+19·80
2	71·3335	....	....	....					

Weighted mean..........	+16·39	
V_a..........................		− 22·37
V_d..........................		− ·28
Curvature..................		− ·28
Radial velocity.................		− 6·5

η BOÖTIS 2776.

1909. Aug. 30.
G. M. T. 13h 20m

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
1	77·2975	·2600	·0307	+13·97	1	71·9530	·9210	·0154	6·79
2	76·9553	....	....	....	2	71·3102	....	....	....
¾	76·4450	·4080	·0087	3·96	1	67·8770	·8510	·0342	14·67
1	74·0618	·0270	·0221	9·88	¾	63·4145	·3918	·0062	+ 2·58
2	73·5892	....	....	....	2	63·4228	....	....	....
1	72·3912	·3590	·0315	13·92					

Weighted mean..........	+ 9·87	
V_a..........................		− 16·46
V_d..........................		− ·30
Curvature..................		− ·28
Radial velocity.................		− 7·2

η BOÖTIS 3184.

1910. Feb. 10.
G. M. T. 18ʰ 43ᵐ

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	65·9872	....	....	....	2	47·8876	....	....	....
2	62·8343	·8171	·0164	—12·46	1	47·8600	....	·0276	17·53
2	62·4884	....	....	....	½	43·0085	·9890	·0220	13·09
2	57·8815	....	....	....	2	41·7780	....	....	....
½	56·1076	....	·0141	9·83	1	39·9705	....	....	....
2	56·1217	....	....	....	1	39·9390	....	·0315	18·08
2	50·0061	....	....	....	2	37·7930	....	....	....
1	49·9870	....	·0190	12·28	1	37·7527	....	·0403	22·60
2	48·9169	....	....	....	2	31·6845	....	....	....
1	48·8845	....	·0324	20·66	1	31·6350	....	·0495	—24·90

Weighted mean.................. — 16·93
V_a.................. +22·30
V_d.................. + ·19
Curvature.................. — ·28

Radial velocity.......... + 5·3

η BOÖTIS 3225.

1910. Feb. 24.
G. M. T. 16ʰ 55ᵐ

Observed by / Measured by } W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	66·0037	....	....	....	1	47·8760	....	....	....
1	64·7742	·7317	·0187	—14·57	½	47·8655	....	·0105	6·70
2	62·8542	·8220	·0149	11·32	2	41·7556	....	....	....
2	62·5046	....	....	....	1	41·6767	·6766	·0151	8·80
1½	61·6412	·6152	·0130	9·72	2	39·9419	....	....	....
2	57·8888	....	....	....	½	39·9080	·9060	·0330	18·94
2	55·2137	....	....	....	2	37·7612	....	....	....
½	55·1945	·1837	·0192	13·23	1	37·7360	·7293	·0252	14·02
1	49·9765	·9750	·0236	15·23	2	31·6397	....	....	....
2	48·8995	....	....	....	1	61·0155	....	....	....
1½	48·8875	....	·0120	7·65	½	61·0035	....	·0120	—8·88

Weighted mean.................. —11·38
V_a.................. +18·12
V_d.................. + ·26
Curvature.................. — ·28

Radial velocity .... + 6·7

η BOÖTIS 3325.

1910. Mar. 11.
G. M. T. $19^h 38^m$

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	63·6679	....	....	....	1	50·0042	·0002	·0022	+1·68
1	62·6215	·5864	·0107	−9·69	1	49·0782	·0769	·0040	+3·01
2	60·9670	·9384	·0133	−11·77	2	48·2060	....	....	....
2	60·6655	....	....	....	1	48·1925	·1817	·0145	−10·81
1½	59·9455	·9197	·0051	+4·45	1	44·1007	·1055	·0016	−1·13
1	58·9400	·9194	·0071	+6·11	2	43·0407	....	....	....
2	56·7237	....	....	....	1½	39·6701	·6839	·0104	−6·97
1	55·2110	·1992	·0036	−2·94	1½	38·2227	·2410	·0061	−4·02
1½	54·2675	·2595	·0012	−1·00	2	38·2288	....	....	....
1	53·4435	·4386	·0000	±0·00	2	34·5525	....	....	....
2	53·2077	....	....	....	1½	34·5350	·5685	·0175	−11·03
1	53·0825	·0785	·0089	+7·07					

Weighted mean.................		−4·39
V_a..................	+12·43	
V_d..................	+ ·13	
Curvature..................		− ·28
Radial velocity.........	+ 7·9	

OBSERVING RECORD AND DETAILED MEASURES OF φ PERSEI.

P.—Plaskett.
C.—Cannon.
H.—Harper.
P¹.—Parker.

RECORD OF SPECTROGRAMS.

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure. G. M. T.	Duration.	Hour Angle at end.	Comparison Spectrum. Exposure in seconds.	Comparison Spectrum. Kind.	Temperature Centigrade. Room. Begin-ning.	Room. End.	Prism Box. Begin-ning.	Prism Box. End.	Slit Width in inches.	Focal Position. Star Focus.	Collimator.	Camera.	Seeing.	Observer.	Remarks.
				1908.	h. m.	m.	h. m.													
φ Persei...	1996	II.	Seed 27	Dec. 2	14 24	50	0 54 W	3- 3- 3- 3	Fe V Spark	— 8·0	— 8·4	—2·0	—2·0	·0016	73·0	10·8	18·2	Good.....	H	
" ..	2012	"	"	" 9	13 12	45	0 10 W	"	" ..	—12·0	—14·0	—1·0	—1·0	·0015	"	"	18·45	Fair......	H	
" ..	2028	"	"	" 16	13 10	32	0 25 W	2- 1½- 2½	" ..	— 5·0	— 6·0	3·0	3·0	"	"	"	18·50	Good.....	H	
" ..	2042	"	"	" 18	13 57	45	1 23 W	4- 5- 5- 5	" ..	— 7·3	— 7·8	—4·2	—4·3	"	"	"	18·45	" ...	C	
" ..	2053	"	"	" 21	14 53	33	2 40 W	3- 2- 2- 3	" ..	—10·6	—11·0	—1·5	—1·6	"	"	"	"	"	P¹	
				1909.																
" ..	2088	"	"	Jan. 6	11 27	25	0 05 W	2- 2- 2- 2	" ..	— 9·8	—10·0	—3·0	—3·0	"	73·1	"	18·56	"	P	
" ..	2136	"	"	" 15	11 58	44	1 15 W	3- 3- 3- 3	" ..	—11·5	—13·8	—4·5	—4·4	·0016	73·0	"	18·50	"	C	
" ..	2167	"	"	" 18	13 37	25	3 00 W	2- 2- 2- 2	" ..	—19·0	—19·6	--13·8	--13·8	·0015	"	"	18·70	"	P¹	
" ..	2168	"	"	" 18	14 05	30	3 30 W	"	" ..	—19·6	—19·8	"	"	"	"	"	"	"	P¹	
" ..	2221	"	"	Feb. 3	10 45	30	1 13 W	3- 4- 3	" ..	— 5·5	— 5·5	—3·2	—3·2	·0016	"	"	18·45	"	H	
" ..	2246	"	"	" 8	10 55	30	1 45 W	2- 2- 2- 2	" ..	— 9·0	— 9·8	—5·0	—5·0	"	"	"	18·30	"	P¹	
" ..	2377	I	"	Mar. 15	13 10	30	6 25 W	1- 1- 1	" ..	— 1·5	— 1·2	2·3	1·9	·002	39·0	....	27·7	"	P¹	
" ..	2406	"	"	" 22	13 00	24	6 30 W	1- 1- 1- 1	" ..	2·5	1·4	5·5	5·5	"	"	....	"	"	P¹	
" ..	2426	"	"	" 23	13 30	30	7 10 W	2- 2	" ..	2·5	2·0	7·8	7·8	"	"	....	"	"	C	
" ..	2505	"	"	Apr. 19	21 31	18	7 10 E	2- 2- 2- 2	" ..	1·8	1·5	6·4	6·4	"	41·0	....	27·68	"	P¹	Daylight.
" ..	2515	"	"	" 23	20 50	30	7 25 E	3- 3	" ..	2·0	2·0	10·6	10·4	"	"	....	"	"	P¹	
" ..	2516	"	"	" 23	21 18	23	7 0(E	2- 1- 1- 2	" ..	"	"	10·4	10·2	"	"	....	"	Fair......	P¹	
" ..	2531	"	"	" 28	18 20	50	9 35 E	2- 3- 3- 2	" ..	1·2	0·0	9·0	9·0	"	"	....	27·65	Hazy.....	C	
" ..	2534	"	"	" 28	20 50	30	7 15 E	4- 4	" ..	— 1·0	— 2·0	8·9	8·8	"	"	....	"	Good.....	C	
" ..	2556	"	"	May 31	20 14	35	5 30 E	1- 1- 1- 1	" ..	14·1	13·7	20·8	20 8	"	"	....	27·69	"	P¹	
" ..	2561	"	"	June 7	20 02	35	5 00 E	"	" ..	11·5	10·9	21·9	21·4	"	"	....	"	....	P¹	
" ..	2570	"	W & W	" 14	20 00	27	4 55 E	"	" ..	11·3	12·4	19·6	19·6	"	"	....	"	"	P¹	
" ..	2603	"	"	" 28	20 00	50	4 00 E	1- 1- 1	" ..	17·0	17·5	26·8	26·6	"	41·5	....	"	....	H	
" ..	2616	"	"	July 4	19 29	42	4 00 E	1- 1- 1- 1	" ..	14·5	14·0	17·9	17·9	"	"	....	"	"	C	
" ..	2622	"	Seed 27	" 6	18 25	45	4 50 E	"	" ..	16·5	16·5	25·1	25·1	"	"	....	"	"	C	
" ..	2632	"	"	" 7	20 30	30	2 50 E	1- 2- 1	" ..	18 0	17·5	23·9	23·8	"	"	....	"	"	P	

"	..	2643	"	"	"	9	19	36	48	3 30 E	1- 1- 1- 1	"	..	16·2	15·0	25·7	25·3	·0018	"	....	"	"	C	
"	..	2650	"	"	"	13	18	32	40	4 25 E	"	"	..	19·0	18·5	21·0	21·0	·002	"	....	"	"	C	
"	..	2651	"	"	"	13	19	05	25	3 57 E	"	"	..	18·5	"	"	"	"	"	....	"	"	C	
"	..	2661	"	"	"	14	20	30	40	2 30 E	"	"	..	17·5	17·6	26·2	26·2	"	"	....	"	Hazy.....	P	
"	..	2664	"	"	"	19	17	40	30	5 00 E	1 1 1	"	..	15·5	15·5	21·5	21·3	"	"	....	"	Good.....	H	
"	..	2668	"	"	"	20	16	30	40	6 00 E	1- 1- 1- 1	"	..	20·5	19·0	25·7	25·5	"	"	....	"	"	C	Off 10^m^
"	..	2673	"	W&W	"	26	18	25	45	3 35 E	"	"	..	22·0	22·0	......	27·4	"	"	....	"	½ faint....	H	
"	..	2678	"	Seed 27	"	27	17	22	45	4 35 E	"	"	..	22·5	22·2	29·2	29·0	"	"	....	"	Fair......	C	
"	..	2692	"	"	"	30	19	15	30	2 38 E	"	"	..	19·5	"	25·0	24·85	"	"	...	"	3- 4	C	
"	..	2707	"	"	Aug.	2	19	14	42	2 15 E	"	"	..	18·0	17·2	26·5	26·2	"	"	....	"	4........	P^1^	
"	..	2713	"	"	"	3	19	09	38	2 35 E	"	"	..	19·5	18·5	23·6	23·4	"	"	....	"	4- 5.....	C	
"	..	2714	"	"	"	3	19	40	20	2 00 E	"	"	..	18·5	"	"	"	"	"	....	"	5.........	C	
"	..	2727	"	"	"	6	19	40	31	1 45 E	1- 1- 1	"	..	21·5	21·5	24·2	24·0	"	"	....	"	4.........	P	
"	..	2728	"	"	"	6	20	08	24	1 20 E	"	"	..	"	21·3	24·0	"	"	"	....	"	4.........	P^1^	
"	..	2732	"	"	"	9	19	52	35	1 18 E	1- 1- 1- 1	"	..	18·5	18·0	23·2	23·1	"	"	....	"	3- 4......	H	
"	..	2733	"	"	"	9	20	21	20	0 56 E	"	"	..	18·0	"	23·1	"	"	"	....	"	4.........	H	
"	..	2742	"	"	"	10	19	57	35	1 10 E	"	"	..	15·0	14·6	18·5	18·4	"	"	....	"	5.........	C	
"	..	2749	"	"	"	12	17	37	20	3 20 E	"	"	..	18·6	18·6	25·1	25·1	"	"	....	"	3.........	C	
"	..	2753	"	"	"	18	19	07	35	1 30 E	"	"	..	18·7	18·7	22·0	21·9	"	"	....	"	4- 5......	C	
"	..	2762	"	"	"	20	17	35	30	2 55 E	"	"	..	12·8	12·6	21·85	21·85	"	"	....	"	5........	C	
"	..	2764	"	"	"	23	17	57	35	2 20 E	"	"	..	19·8	19·5	23·3	23·2	"	"	....	"	5.........	P^1^	
"	..	2769	"	"	"	26	17	10	27	3 00 E	1½- 1½- 1½	"	..	19·5	19·5	25·3	25·2	"	"	....	"	5.........	H	
"	..	2785	"	W&W	Sept.	14	13	40	30	4 05 E	2- 2- 2- 2	"	..	22·0	21·5	27·2	27·2	"	"	....	"	3- 4.....	H	
"	..	2786	"	Seed 27	"	14	14	47	46	3 03 E	"	"	..	21·5	21·0		27·1	"	"	....	"	3- 4	H	
"	..	2787	"	"	"	14	15	41	34	2 27 E	"	"	..	21·0	20·0	27·1	27·0	"	"	....	"	4.........	H	
"	..	2797	"	"	"	17	19	36	38	1 00 W	3- 3- 3- 3	"	..	10·8	9·9	21·8	21·8	"	42·2	....	27·55	4.........	P^1^	
"	..	2803	"	"	"	20	17	30	30	1 00 E	1- 1- 1- 1	"	..	13·0	11·8	20·4	20·4	"	"	...	"	5.........	P^1^	
"	..	2804	"	"	"	20	18	00	30	0 30 E	"	"	..	11·8	11·5	"	"	"	"	....	"	5.........	C	
"	..	2812	"	"	"	21	15	13	23	3 15 E	"	"	..	18·0	18·0	21·43	21·43	"	"	....	"	4.........	H	
"	..	2813	"	"	"	21	15	46	38	2 35 E	"	"	..	18·0	15·5	"	21·38	"	"	....	"	4- 3- 2...	H	
"	..	2820	"	"	"	24	17	50	30	0 20 E	"	"	..	10·9	9·5	12·9	12·8	"	"	....	"	4........	P^1^	
"	..	2823	"	"	"	27	16	05	30	1 55 E	"	"	..	9·6	8·6	13·3	13·3	"	"	....	"	3- 4......	C	
"	..	2824	"	"	"	27	16	36	30	1 24 E	"	"	..	8·6	9·2	"	"	"	"	....	"	3........	C	
"	..	2827	"	"	"	28	18	31	30	0 35 W	"	"	..	9·0	8·8	11·1	10·9	"	"	....	"	4- 5	C	
"	..	2828	"	"	"	28	18	59	25	1 00 W	"	"	..	8·8	8·5	10·9	10·8	"	"	....	"	5.........	C	
"	..	2833	"	"	"	30	15	09	31	2 40 E	"	"	..	11·1	11·0	14·0	14·0	"	"	....	"	5.........	P^1^	
"	..	2834	"	"	"	30	15	39	27	2 15 E	"	"	..	11·0	10·1	"	"	"	"	.. .	"	5.........	P^1^	
"	..	2840	"	"	Oct.	4	16	35	30	0 55 E	"	"	..	13·1	12·3	23·00	22·9	"	"	....	"	5.........	C	
"	..	2841	"	"	"	4	17	02	22	0 32 E	"	"	..	12·3	12·0	22·9	22·85	"	"	....	"	5.........	C	
"	..	2853	"	"	"	6	13	33	29	3 47 E	"	"	..	16·4	16·0	20·9	20·8	"	"	....	"	4.........	P^1^	
"	..	2854	"	"	"	6	14	07	35	3 20 E	"	"	..	16·0	15·5	20·8	20·6	"	"	....	"	5.........	P^1^	
"	..	2870	"	"	"	8	15	48	20	1 35 E	"	"	..	17·5	15·5	22·9	22·9	"	"	....	"	5....... .	H	
"	.	2871	"	"	"	8	16	12	24	1 10 E	"	"	..	15·5	14·5	"	22·95	"	"	....	"	5........	H	
"	..	2880	"	"	"	12	18	48	27	1 41 W	"	"	..	4·0	4·5	6·2	6·35	"	"	....	"	4.........	H	Clear, but windy.
"	..	2881	"	"	"	12	19	13	24	2 06 W	"	"	..	4·5	"	6·4	6·6	"	"	....	"	3-4......	H	
"	..	2885	"	"	"	15	18	58	55	2 20 W	"	"	..	5·5	4·5	10·7	10·7	"	"	....	"	1- 4.	P^1^	
"	..	2886	"	"	"	15	19	51	48	3 15 W	"	"	..	4·5	"	"	10·6	"	"	....	"	4- 2- 4...	P	
	..	2893	"	"	"	19	18	22	25	1 45 W	1- 2- 1	"	..	3·0	3·0	8·0	8·0	"	"	...	"	5..... ...	C	
	..	2894	"	"	"	19	18	48	24	2 10 W	"	"	..	"	"	"	7·9	"	"	....	"	5.........	C	

OBSERVING RECORD AND DETAILED MEASURES OF φ PERSEI.

P.—Plaskett.
C.—Cannon.
H.—Harper.
P¹.—Parker.

RECORD OF SPECTROGRAMS—*Continued.*

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure. G. M. T.	Duration.	Hour Angle at end.	Comparison Spectrum. Exposure in seconds.	Comparison Spectrum. Kind.	Temperature Centigrade. Room. Beginning.	Room. End.	Prism Box. Beginning.	Prism Box. End.	Slit Width in Inches.	Focal Position. Star Focus.	Focal Position. Collimator.	Focal Position. Camera.	Seeing.	Observer.	Remarks.
				1909.	h. m.	m.	h. m.													
φ Persei..	2903	1	Seed 27	Oct. 20	17 38	25	1 06 W	1- 1- 1- 1	FeVSpark	2·0	2·0	6·8	6·8	·002	42·2	....	27·55	5.........	P¹-C	
" ..	2904	"	"	" 20	18 04	25	1 32 W	"	" ..	2·0	1·8	"	"	"	"	....	"	5.	C	
" ..	2911	"	"	" 27	13 42	38	2 15 E	"	" ..	7·2	7·1	10·4	10·3	"	"	....	"	5- 1......	P¹	
" ..	2912	"	"	" 27	14 06	8	....	"	" ..	7·1	"	10·3	"	"	"	....	"	1- 0......	P¹	Cloudy.
" ..	2914	"	"	" 28	16 47	25	0 45 W	1- 1- 2	" ..	2·0	1·1	6·8	6·8	"	"	....	"	5.........	C	
" ..	2915	"	"	" 28	17 10	20	1 05 W	2- 2	" ..	1·1	0·6	"	6·7	"	"	....	"	5.........	C	
" .	2925	"	"	" 29	19 23	28	3 30 W	1- 1- 1- 1	" ..	— 0·8	— 1·0	5·6	5·5	·0017	"	....	"	4.........	P¹	
" ..	2926	"	"	" 29	19 55	32	4 00 W	"	" ..	— 1·1	— 1·5	5 5	5·6	"	"	....	"	4.........	P¹	
" ..	2930	"	"	Nov. 4	13 40	29	1 50 E	"	" ..	5·6	5·0	9·2	9·0	"	"	....	"	4-5.......	P¹	
" ..	2931	"	"	" 4	14 12	32	1 20 E	"	" ..	5·0	4·8	9·0	8·8	"	"	....	"	5- 0	P¹	Clouded.
" ..	2935	"	"	" 8	15 52	55	0 50 W	"	" ..	3·4	2·8	5·6	5·6	·002	"	....	"	5.........	C	Wide for comp.
" ..	2936	"	"	" 8	16 47	45	1 40 W	"	" ..	2·8	2·5	"	"	"	"	....	"	0- 5......	C	Clouds.
" ..	2944	"	"	" 12	15 56	18	0 48 W	2- 2	" ..	9·5	9·0	15·5	15·5	"	"	....	"	5...	H	
" ..	2945	"	"	" 12	16 18	24	1 14 W	"	" ..	9·0	8·5	"	"	"	"	....	"	5.........	H	
" ..	2952	"	"	" 15	16 47	25	1 58 W	1- 1- 1- 2	" ..	4·5	4·0	15·8	15·7	"	"	....	"	5.........	C	
" .	2953	"	"	" 15	17 10	19	2 18 W	2- 3- 3- 5	" ..	4·0	3·4	15·7	15·6	"	"	....	"	5.........	C	
" ..	2954	"	"	" 15	17 29	16	2 35 W	1- 2- 2- 2	" ..	3·4	2·8	15·6	"	"	"	....	"	5.........	C	
" ..	2962	"	"	" 18	12 30	18	2 11 E	6- 6	" ..	— 2·5	— 2·5	1·2	1·2	"	"	....	"	5.........	H	
" ..	2963	"	"	" 18	12 50	20	1 50 E	"	" ..	— 2·5	— 3·0	"	"	"	"	....	"	5	H	
" ..	2973	"	"	" 26	12 57	20	1 12 E	2- 6- 2	" ..	1·5	1·5	6 4	6·8	"	"	....	"	4.........	H	
" ..	2974	"	"	" 26	13 17	18	0 53 E	"	" ..	"	"	6·8	6·6	"	"	....	"	4.........	H	
" ..	2976	"	"	" 26	15 00	33	1 00 W	6- 6	" ..	"	1·0	6·4	6·5	"	"	....	"	5.........	H	
" ..	2989	"	"	Dec. 1	11 57	25	1 50 E	1- 1- 1- 1	" ..	2·0	1·9	6·6	6·6	"	"	....	"	4.........	P	Cloudy ⅓
" ..	2990	"	"	" 1	12 22	15	1 30 E	"	" ..	1·9	"	"	"	"	"	....	"	4.........	P	time.
" ..	3020	"	"	" 10	14 17	35	1 10 W	1- 2- 1	" ..	— 5·0	— 5·5	—3·7	—3·65	"	"	....	"	3- 4- 2...	H	
" ..	3032	"	"	" 16	13 40	10	0 40 W	1- 1- 1- 1	" ..	— 2·5	— 2·5	0·7	0·6	"	"	....	"	1...... ...	P¹	
" ..	3033	"	"	" 16	14 29	18	1 30 W	"	" ..	— 4·5	— 6·1	0·6	"	"	"	....	"	5...	P¹	
" ..	3034	"	"	" 16	14 51	23	1 55 W	"	" ..	— 6 1	— 6·5	"	"	"	"	....	"	4...... .	P¹	

" ..	3051	"	"	"	18	19	07	15	6 25 W	½- 1- ½	" ..	— 9·4	— 9·5	—7·4	—7·4	"	"	....	"	4.........	P	
" ..	3052	"	"	"	18	19	31	28	6 55 W	"	" ..	— 9·5	"	"	"	"	"	....	"	4- 3.....	P	
" ..	3054	"	"	"	27	12	05	20	0 03 E	2- 1 1- 1	" ..	— 9·4	— 9·8	—6·4	—6·4	"	"	....	"	4.......	C	
" .	3055	"	"	"	27	12	31	30	0 30 E	1- 1- 1- 1	" ..	— 9·8	—11·0	"	"	"	"	....	"	4- 1.....	C	
" ..	3062	"	"	"	29	13	21	55	1 37 W	1- 1- 1- 1	" ..	—15·5	—16·0	—8·0	—8·0	"	"	....	"	2........	H	
" ..	3078	"	"	"	31	12	27	21	0 34 W	1- 2- 1	" ..	— 7·5	— 7·5	—6·2	—6·2	"	"	....	"	5.......	H	
" ..	3079	"	"	"	31	12	51	24	1 00 W	"	" .	— 7·5	— 8·0	"	"	"	"	..	"	4.......	H	
				1910.																		
" ..	3082	"	"	Jan.	4	12	09	18	0 30 W	1- 1- 1- 1	" ..	—15·8	—16·5	—7·6	—7·7	"	"	....	"	3- 4.....	P	
" ..	3083	"	"	"	4	12	29	21	0 50 W	"	" ..	—16·5	—17·0	—7·7	—7·8	"	"	....	"	3- 4.....	P	
" ..	3088	"	"	"	10	11	30	24	0 17 W	"	" ..	—14·0	—14·0	—3·15	—3·35	"	"	....	"	4.......	H	
" ..	3089	"	"	"	10	12	17	55	1 23 W	"	" ..	—14·0	—13·5	—3·35	—3·45	"	"	....	"	4- 5.....	H	
" ..	3095	"	"	"	12	11	36	23	0 30 W	"	" ..	— 5·5	— 6·0	—2·8	—2·9	"	"	....	"	4......	P¹	Wide spectrum.
" ..	3096	"	"	"	12	12	01	25	0 55 W	"	" ..	— 6·0	— 6·2	—2·9	—3·0	"	"	....	"	4........	P¹	
" ..	3097	"	"	"	12	12	26	23	1 20 W	"	" ..	— 6·2	— 6·5	—3·0	"	"	"	....	"	4......	P¹	
" .	3109	"	"	"	14	17	05	30	6 14 W	1- 2- 2- 1	" ..	—12·5	—14·0	—8·8	—7·8	"	"	....	"	5........	H	
" ..	3110	"	"	"	14	17	35	25	6 42 W	"	" ..	—14·0	"	—7·8	"	"	"	....	"	5........	H	
" ..	3124	"	"	"	15	18	15	30	7 30 W	1½- 3- 1½	" ..	"	"	—9·3	9·3	"	"	....	"	4........	P	
" ..	3152	"	"	"	28	12	40	30	2 45 W	2- 2- 2- 2	" ..	— 4·5	— 5·5	1·4	1·4	"	"	....	"	4........	C	
" ..	3153	"	"	"	28	13	12	32	3 18 W	"	" ..	— 5·5	— 5·6	"	"	"	"	....	"	4......	C	

φ PERSEI 1996.

1908. Dec. 2.
G. M. T. 14ʰ 24ᵐ

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	73·0080	....	....	....	2	27·6785	27·5911	·0201	+17·58
½	72·8877	72·7952	·0231	+32·52	2	·4842	....	....	....
2	·4507	....	....	....	1½	15·8282	15·7770	·0439	+34·33
2	45·4072	....	....	....	2	·7102	....	....	....
2	·3900	45·2764	·0175	+18·37					

Weighted mean................. +22·97
V_a................. −10·97
V_d................. − ·03
Curvature.......... − ·28

Radial velocity................. +11·7

φ PERSEI 2012.

1908. Dec. 9.
G. M. T. 13ʰ 12ᵐ

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	72·9717	....	....	....	2	27·6452	27·6188	·0478	+41·82
½	·8644	72·8079	·0358	+52·05	2	·4240	....	....	....
2	·4144	....	....	....	2	15·7970	15·8135	·0824	+62·87
2	45·3530	....	....	....	2	·6420	....	....	....
2	·3622	45·3028	·0439	+46·20					

Weighted mean................. +50·43
V_a................. −13·77
V_d................. − ·01
Curvature.......... − ·28

Radial velocity................. +36·4

φ PERSEI 2028.

1908. Dec. 16.
G. M. T. 13ʰ 10ᵐ

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	72·9877	....	....	....	2	27·6515	27·6340	·0630	+55·12
½	·8852	72·8129	·0408	+59·32	2	·4142	....	....	....
2	·4295	....	....	....	1½	15·7752	15·8057	·0726	+56·17
2	45·3575	....	....	....	2	·6280	....	....	....
2½	·3755	45·3116	·0527	+55·33					

Weighted mean................. +55·77
V_a................. −16·57
V_d................. − ·01
Curvature.......... − ·28

Radial velocity................. +38·9

φ PERSEI 2042.

1908. Dec. 18.
G. M. T. 13h 57m

Observed by} J. B. Cannon.
Measured by}

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	45·3794	....	....	....	2	·4672	....	....	....
2	·4044	45·3186	·0597	+62·68	1½	15·8486	15·8111	·0780	+61·00
2	27·6979	27·6277	·0562	+49·61	2	·6962	....	....	....

Weighted mean.................. +57·47
V_a.................. −16·74
V_d.................. − ·05
Curvature.......... − ·28

Radial velocity................. +40·4

φ PERSEI 2053.

1908. Dec. 21.
G. M. T. 14h 53m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·8995	....	....	....	2	27·5755	27·6203	·0493	+43·14
1	·8060	72·8226	·0505	+73·42	2	·3518	....	....	....
2	·3385	....	....	....	1	15·7187	15·8038	·0707	+55·28
2	45·2792	....	....	....	2	·5735	....	....	....
2	·2992	45·3136	·0547	+57·43					

Weighted mean.................. +54·97
V_a.................. −17·61
V_d.................. − ·15
Curvature.......... − ·28

Radial velocity................. +36·9

φ PERSEI 2088.

1909. Jan. 6.
G. M. T. 11h 27m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9283	....	....	....	1	27·5353	27·5823	·0205	+17·94
1	·8048	72·7927	·0206	+29·95	2	·3496	....	....	....
2	·3670	....	....	....	½	15·6756	15·7782	·0451	+35·27
2	45·2903	....	....	....	2	·5558	....	....	....
2	·2763	45·2796	·0207	+21·74					

Weighted mean.................. +24·44
V_a.................. −21·53
V_d.................. + ·01
Curvature.......... − ·28

Radial velocity................. + 2·6

ϕ PERSEI 2136.

1909. Jan. 15.
G. M. T. 11h 58m

Observed by } J. B. Cannon.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
1	72·9324	....	....	....	2	27·5884	27·5772	·0154	+13·48
1	·7996	72·7826	·0105	+15·27	2	·4081	....	....	....
1	·3740	....	....	....	½	15·7476	15·7766	·0435	+34·02
2	45·3264	....	....	....	2	·6296	....	....	....
2	·3114	45·2786	·0197	+20·68					

Weighted mean.................		+18·20
V_a..................	−23·00	
V_d..................	− ·07	
Curvature..........	− ·28	
Radial velocity.............	− 5·2	

ϕ PERSEI 2167.

1909. Jan. 18.
G. M. T. 13h 37m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9347	....	....	....	2	27·6357	27·5877	·0259	+22·66
½	·8112	72·7930	·0209	+30·39	2	·4450	....	....	....
2	·3720	....	....	....	2	15·8012	15·7766	·0435	+34·02
2	45·3475	....	....	....	2	·6835	....	....	....
2	·3432	45·2893	·0304	+31·92					

Weighted mean.................		+29·60
V_a..................	−23·37	
V_d..................	− ·14	
Curvature..........	− ·28	
Radial velocity.................		+5·8

φ PERSEI 2168.

1909. Jan. 18.
G. M. T. 14ʰ 15ᵐ

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	72·9410	....	....	....	2	27·6210	27·5952	·0334	+28·92
½	·8282	72·8031	·0310	+45·07	2	·4227	....	....	....
2	·3770	....	....	....	1	15·7797	15·7805	·0474	+37·07
2	45·3384	....	....	....	2	·6580	....	....	....
2	·3297	45·2849	·0260	+27·30					

Weighted mean................. +31·31
V_a.................. −23·37
V_d.................. − ·15
Curvature.......... − ·28

Radial velocity................. + 7·5

φ PERSEI 2221.

1909. Feb. 3
G. M. T. 10ʰ 45ᵐ

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	72·9290	....	....	....	2	27·5913	27·5899	·0281	+24·59
½	·8205	72·8043	·0322	+46·82	2	·3982	....	....	....
2	·3735	....	....	....	2	15·7337	15·7686	·0355	+27·76
2	45·3192	....	....	....	2	·6237	....	....	....
3	·3127	45·2871	·0282	+29·61					

Weighted mean................. +28·31
V_a.................. −24·17
V_d.................. − ·05
Curvature.......... − ·28

Radial velocity................. + 3·8

ϕ PERSEI 2246.

1909. Feb. 8.
G. M. T. 10h 55m

Observed by T. H. PARKER.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9140	....	....	....	2	27·5818	27·5971	·0353	+30·79
1	·7858	72·7885	·0164	+22·85	2	·3815	....	....	....
2	·3508	....	....	....	½	15·7293	15·7743	·0412	+32·12
2	45·3065	....	....	....	2	·6140	....	....	....
2	·2930	45·2804	·0215	+22·57	....				

Weighted mean..................		+26·48
V_a..................	−24·03	
V_d..................	− ·09	
Curvature..........	− ·28	
Radial velocity..................		+ 2·1

ϕ PERSEI 2377.

1909. March 15.
G. M. T. 13h 10m

Observed by T. H. PARKER.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9598	....	....	....	1	·9256	50·9117	·0232	+26·77
½	·8374	75·8329	·0063	+10·10	½	34·8706	34·8556	·0335	+32·16
2	·4573	....	....	....	2	·6888	....	....	....
2	50·9348	....	....	....					

Weighted mean..................		+24·60
V_a..................	−18·19	
V_d..................	− ·18	
Curvature..........	− ·28	
Radial velocity..................		+ 5·3

ϕ PERSEI 2406.

1909. March 22.
G. M. T. 13h

Observed by T. H. PARKER.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9372	....	....	....	½	34·8430	34·7921	·0066	−6·35
1½	·9057	50·8904	·0010	+1·16	2	·6908	....	....	....

Weighted mean.........	−0·72
V_a..................	−16·16
V_d..................	− ·21
Curvature..........	− ·28
Radial velocity.........	−17·4

ϕ PERSEI 2426.

1909. March 23.
G. M. T. 13h 30m

Observed by } J. B. Cannon.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9331	....	....	....	1½	34·8211	34·8050	·0065	+6·25
2	·9020	50·8909	·0015	+1·73	2	·6658	....	....	....

Weighted mean.................. +3·67
V_a.................. −15·83
V_d.................. − ·19
Curvature.......... − ·28

Radial velocity........ − 12·6

ϕ PERSEI 2505.

1909. April 19.
G. M. T. 21h 31m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9414	....	....	....	¼	34·8588	34·8251	·0264	+25·39
1½	·9456	50·9261	·0367	+42·42	2	·6736	....	....	....

Weighted mean.................. +39·99
V_a.................. −6·92
V_d.................. − ·18
Curvature.......... − ·30

Radial velocity.................. +32·6

ϕ PERSEI 2515.

1909. April 23.
G. M. T. 20h 50m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9315	....	....	....	1	34·8550	34·8479	·0492	+47·32
1½	·9365	50·9269	·0375	+43·34	2	·6570	....	....	....

Weighted mean.................. +44·93
V_a.................. −4·39
V_d.................. + ·19
Curvature.......... − ·30

Radial velocity.................. + 40·4

φ PERSEI 2516.

1909. April 23.
G. M. T. 21ʰ 18ᵐ

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	50·9272	....	....	....	1½	34·8594	34·8469	·0482	+46·36
2	·9292	50·9239	·0345	+39·88	2	·6624	....	....	....

Weighted mean................		+42·66
V_a................	−4·39	
V_d........................		+ ·18
Curvature..........	− ·30	
Radial velocity................		+ 38·1

φ PERSEI 2531.

1909. April 28.
G. M. T. 18ʰ 20ᵐ

Observed by} J. B. Cannon.
Measured by}

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	50·9400	....	....	....	1½	·9460	50·9279	·0385	+44·50

Weighted mean................		+44·50
V_a................	−2·43	
V_d........................		+ ·10
Curvature..........	− 30	
Radial velocity..............		+ 41·9

φ PERSEI 2534.

1909. April 28.
G. M. T. 20ʰ 50ᵐ

Observed by} J. B. Cannon.
Measured by}

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	50·9685	....	....	....	1½	·9752	50·9286	·0392	+45·31

Weighted mean................		+45·31
V_a................	−2·43	
V_d........................		+ ·19
Curvature..........	− ·30	
Radial velocity................		+ 42·8

φ PERSEI 2556.

1909. May 31.
G. M. T. 5^h 12^m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9196	....	....	....	1½	34·7474	34·7568	·0182	−17·48
2	·8714	50·8746	·0148	−17·08	2	·6169	....	....	....

Weighted mean.........	−17·25	
V_a..........................		+10·41
V_d..........................		+ ·20
Curvature..........	− ·30	
Radial velocity.........	− 6·9	

φ PERSEI 2561.

1909. June 7.
G. M. T. 20^h 02^m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9172	....	....	....	½	34·7432	34·7503	·0247	−24·01
1½	·8728	50·8784	·0120	−13·84	2	·6192	....	....	....

Weighted mean.........	−16·38	
V_a..........................		+12·82
V_d..........................		+ ·20
Curvature..........	− ·30	
Radial velocity.........	− 3·7	

φ PERSEI 2570.

1909. June 14.
G. M. T. 20^h 20^m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0465	....	....	....	2	·8890	50·8670	·0234	−27·01
1	75·9010	75·8730	·0162	−25·97	1	34·7725	34·7477	·0273	−26·22
2	·5360	....	....	....	2	·6512	....	....	....
2	50·9448	....	....	....					

Weighted mean.........	−26·55	
V_a..........................		+14·84
V_d..........................		+ ·19
Curvature..........	− ·30	
Radial velocity........	− 11·8	

φ PERSEI 2603.

1909. June 28.
G. M. T. 20h

Observed by W. E. HARPER.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0516	....	....	....	2	50·9256	....	....	....
1	75·9044	75·8716	·0176	−28·21	½	·8606	50·8578	·0326	−37·62
2	·5372	....	....	....					

Weighted mean......... −31·35
V_a.......................... +18·92
V_d.......................... + ·18
Curvature.......... − ·30

Radial velocity......... −12·5

φ PERSEI 2616.

1909. July 4.
G. M. T. 19h 29m

Observed by, Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0188	....	....	....	1	·8518	50·8398	·0506	−58·40
½	75·8473	75·8461	·0431	−69·08	½	34·7450	34·7165	·0585	−56·18
2	·5108	....	....	....	2	·6550	....	....	....
2	50·9348	....	....	....					

Weighted mean......... −58·72
V_a.......................... +20·13
V_d.......................... + ·18
Curvature.......... − ·30

Radial velocity......... −38·7

φ PERSEI 2622.

1909. July 6.
G. M. T. 18h 25m

Observed by, Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9049	....	....	....	½	·8385	50·8564	·0340	−39·33

Weighted mean .... −39·33
V_a.......................... +20·53
V_d.......................... + ·20
Curvature.......... − ·30

Radial velocity......... −18·9

φ PERSEI 2632.

1909. July 7.
G. M. T. 20h 30m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9094	....	....	....	¼	34·7045	34·7250	·0500	−48·00
½	·8421	50·8555	·0349	−40·30	2	·6058	....	....	....

Weighted mean......... −43·20
Va........................ +20·72
Vd........................ + ·14
Curvature.......... − ·30

Radial velocity......... −22·7

φ PERSEI 2643.

1909. July 9.
G. M. T. 19h 36m

Observed by / Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0422	....	....	....	½	·8575	50·8608	·0296	−34·16
¼	75·8840	75·8602	·0290	−46·48	¼	34·7115	34·7373	·0377	−36·20
2	·5320	....	....	....	2	·6005	....	....	....
2	50·9195	....	....	....					

Weighted mean......... −37·83
Va........................ +21·08
Vd........................ + ·18
Curvature.......... − ·30

Radial velocity......... −16·9

φ PERSEI 2650.

1909. July 13.
G. M. T. 18h 32m

Observed by / Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0155	....	....	....	½	·8472	50·8595	·0309	−35·66
½	75·8642	75·8665	·0227	−36·38	¼	34·7025	34·7253	·0497	−47·73
2	·5080	....	....	....	2	·6035	....	....	....
2	50·9105	....	....	....					

Weighted mean......... −38·36
Va........................ +21·80
Vd........................ + ·19
Curvature.......... − ·30

Radial velocity......... −16·7

φ PERSEI 2651.

1909. July 13.
G. M. T. 19h 05m

Observed by } J. B. Cannon.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9011	....	....	....	½	34·7094	34·7363	·0387	−37·16
½	·8308	50·8425	·0479	−55·28	2	·5994	....	....	....

Weighted mean.........	−45·23	
V_a.........................		+21·80
V_d.........................		+ ·19
Curvature..........	− ·30	
Radial velocity.........	−23·5	

φ PERSEI 2661.

1909. July 14.
G. M. T. 20h 30m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·8807	....	....	....	1	34·6877	34·7400	·0350	−33·60
1½	·8173	50·8594	·0310	−35·77	2	·5740	....	....	....

Weighted mean.........	−34·68	
V_a.........................		+21·87
V_d.........................		+ ·14
Curvature..........	− ·30	
Radial velocity.........	−13·0	

φ PERSEI 2664

1909. July 19.
G. M. T. 17h 40m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0207	....	....	....	1	·8344	50·8470	·0434	−50·09
½	75·8560	75·8537	·0355	−56·90	1	34·7130	34·7196	·0554	−53·20
2	·5104	....	....	....	2	·6197	....	....	....
2	50·9102	....	....	....					

Weighted mean.........	−52·69	
V_a.........................		+22·49
V_d.........................		+ ·20
Curvature..........	− ·30	
Radial velocity.........	− 29·7	

ϕ PERSEI 2668.

1909. July 20.
G. M. T. 16h 30m

Observed by / Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0126	....	....	....	1	34·6964	34·7301	·0449	−43·12
½	75·8621	75·8676	·0216	−34·62	2	·5926	....	....	....
2	·5034	....	....	....	½	23·9096	23·9465	·0417	−35·75
2	50·8921	....	....	....	2	·8838	....	....	....
1	·8371	50·8678	·0226	−26·08					

Weighted mean......... −35·13
V_a.......................... +22·60
V_d.......................... + ·21
Curvature.......... − ·30

Radial velocity......... − 12·8

ϕ PERSEI 2673.

1909. July 26.
G. M. T. 18h 25m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·8908	....	....	....	2	·5780	....	....	....
2	·8318	50·8638	·0266	−30·70	½	23·9205	23·9523	·0359	−30·77
1	34·6938	34·7421	·0329	−31·59	2	·8682	....	....	....

Weighted mean......... −30·95
V_a.......................... +23·13
V_d.......................... + ·18
Curvature.......... − ·30

Radial velocity......... − 7·8

ϕ PERSEI 2678.

1909. July 27.
G. M. T. 17h 22m

Observed by / Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9865	....	....	....	1½	·7905	50·8623	·0281	−32·43
½	·8352	75·8675	·0217	−34·78	½	34·6280	34·7248	·0466	−44·84
2	·4745	....	....	....	2	·5260	....	....	....
2	50·8510	....	....	....					

Weighted mean......... −35·38
V_a.......................... +23·19
V_d.......................... + ·19
Curvature.......... − ·30

Radial velocity......... − 12·

φ PERSEI 2692.

1909. July 30.
G. M. T. 19h 15m

Observed by / Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0170	....	....	....	2	·5843	....	....	....
½	75·8598	75·8605	·0287	−46·00	1	23·9020	23·9470	·0412	−35·31
2	·5095	....	....	....	2	·8757	....	....	....
2	50·9055	....	....	....	½	20·6338	20·6919	·0249	−20·62
1½	·8340	50·8513	·0391	−45·12	2	·3455	....	....	....
1½	34·7015	34·7435	·0315	−30·24					

Weighted mean......... −38·08
V_a......................... +23·37
V_d......................... + ·14
Curvature.......... − ·30

Radial velocity......... − 14·9

φ PERSEI 2707.

1909. Aug. 2.
G. M. T. 19h 14m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0038	....	....	....	1	34·7095	34·7513	·0237	−22·75
1	75·8555	75·8706	·0186	−29·81	2	·5845	....	....	....
2	·4938	....	....	....	1	23·8985	23·9759	·0123	−10·54
2	50·8785	....	....	....	2	·8433	....	....	....
1	·8310	50·8753	·0151	−17·43					

Weighted mean......... −17·63
V_a......................... +23·44
V_d......................... + ·12
Curvature.......... − ·30

Radial velocity................ + 5·6

φ PERSEI 2713.

1909. Aug. 3.
G. M. T. $19^h 09^m$

Observed by / Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9998	....	....	....	2	34·7155	34·7568	·0182	−17·47
½	·8608	75·8811	·0081	−12·98	2	·5850	....	....	....
2	·4828	....	....	....	1½	23·9262	23·9698	·0193	−16·54
2	50·8880	....	....	....	2	·8780	....	....	....
1½	·8335	50·8683	·0221	−25·50					

Weighted mean.........	−18·99	
V_a........................		+23·46
V_d........................		+ ·13
Curvature..........	− ·30	
Radial velocity................		+ 4·3

φ PERSEI 2714.

1909. Aug. 3.
G. M. T $19^h 49^m$

Observed by / Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0206	....	....	....	2	·5996	....	....	....
¼	75·8678	75·8655	·0237	−37·99	1	23·9236	23·9585	·0297	−25·45
2	·5106	....	....	....	2	·8858	....	....	....
2	50·9008	....	....	....	¼	20·6418	20·6844	·0324	−26·83
2	·8586	50·8806	·0098	−11·43	2	·3631	....	....	....
1½	34·7174	34·7441	·0309	−29·66					

Weighted mean.........	−21·54	
V_a........................		+23·46
V_d........................		+ ·12
Curvature..........	− ·30	
Radial velocity................		+ 1·7

φ PERSEI 2727.

1909. Aug. 6.
G. M. T. 19ʰ 40ᵐ

Observed by T. H. Parker.
Measured by J. B. Cannon

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	76·0182	....	....	....	1½	34·7479	34·7720	·0030	− 2·88
½	75·8739	75·8740	·0152	−24·36	2	·6022	....	....	....
2	·5082	....	....	....	1	23·9479	23·9774	·0108	− 9·26
2	50·9066	....	....	....	2	·8912	....	....	....
1½	·8664	50·8826	·0078	− 9·00					

Weighted mean......... − 8·72
V_a.......................... + 23·47
V_d.......................... + ·10
Curvature.......... − ·30

Radial velocity................. + 14·6

φ PERSEI 2728.

1909. Aug. 6.
G. M. T. 20ʰ 20ᵐ

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	76·0196	....	....	....	2	·8649	50·8843	·0061	− 7·04
½	75·8784	75·8773	·0119	−19·07	1½	34·7366	34·7700	·0050	− 4·80
2	·5089	....	....	....	2	·5929	....	....	....
2	50·9034	....	....	....					

Weighted mean......... − 7·70
V_a.......................... + 23·47
V_d.......................... + ·10
Curvature.......... − ·30

Radial velocity................. + 15·6

φ PERSEI 2732.

1909. Aug. 9.
G. M. T. 19ʰ 52ᵐ

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	76·0210	....	....	....	½	·8740	50·8803	·0101	−11·66
½	75·8913	75·8887	·0005	− 0·80	1½	34·7538	34·7638	·0112	−10·75
2	·5106	....	....	....	2	·6163	....	....	....
2	50·9165	....	....	....					

Weighted mean......... − 9·72
V_a.......................... + 23·42
V_d.......................... + ·09
Curvature.......... − ·30

Radial velocity................. + 13·5

φ PERSEI 2733.

1909. Aug. 9.
G. M. T. 20h 21m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9224	....	....	....	2	·6210	....	....	....
1½	·8830	50·8834	·0070	− 8·06	1	23·9785	23·9864	·0018	− 1·54
1½	34·7637	34·7690	·0060	− 5·76	2	·9125	....	....	....

Weighted mean......... − 5·57
V_a.......................... + 23·42
V_d.......................... + ·09
Curvature.......... − ·30

Radial velocity................. + 17·6

φ PERSEI 2742.

1909. Aug. 10.
G. M. T. 19h 57m

Observed by / Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0193	....	....	....	1½	34·7738	34·7636	·0114	−10·94
1	75·8826	75·8829	·0063	−10·10	2	·6365	....	....	....
2	·5040	....	....	....	1	24·0048	23·9969	·0087	+ 7·46
2	50·9206	....	....	....	2	23·9286	....	....	....
2	·8888	50·8910	·0006	+ 0·69					

Weighted mean. .... − 0·95
V_a.......................... + 23·40
V_d.......................... + ·09
Curvature.......... − ·30

Radial velocity................. + 22·2

φ PERSEI 2749.

1909. Aug. 12.
G. M. T. 17h 37m

Observed by / Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·8910	....	....	....	2	·5785	....	....	....
2	·8592	50·8910	·0006	+ 0·69	½	23·9265	23·9838	·0044	− 3·77
1½	34·7257	34·7735	·0015	− 1·44	2	·8634	....	....	....

Weighted mean......... − 0·66
V_a.......................... + 23·36
V_d.......................... + ·16
Curvature.......... − ·30

Radial velocity................. + 22·6

φ PERSEI 2753.

1909. Aug. 18.
G. M. T. 19ʰ 07ᵐ

Observed by / Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	76·0174	...	...	...	1½	34·7824	34·7923	·0173	+16·61
½	75·8924	75·8942	·0050	+ 8·01	2	·6164	...	...	...
2	·5039	...	...	...	1	24·0036	24·0124	·0242	+20·74
2	50·9142	...	...	...	2	23·9116	...	...	...
2	·8964	50·9050	·0146	+16·85					

Weighted mean................. + 16·67
V_a......................... + 23·28
V_d......................... + ·10
Curvature.......... − 0·28

Radial velocity................. + 39·8

φ PERSEI 2762.

1909. Aug. 20.
G. M. T. 17ʰ 35ᵐ

Observed by / Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	76·0272	...	...	...	1½	34·7852	34·7926	·0176	+16·90
½	75·9059	75·8965	·0073	+11·70	2	·6189	...	...	...
2	·5192	...	...	...	1	24·0012	24·0069	·0187	+16·03
2	50·9202	...	...	...	2	23·9152	...	...	...
2	·8972	50·8998	·0094	+10·85					

Weighted mean................. + 13·79
V_a......................... + 22·75
V_d......................... + ·14
Curvature.......... − 0·28

Radial velocity................. + 36·4

φ PERSEI 2764.

1909. Aug. 23.
G. M. T. 17ʰ 58ᵐ

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	76·0086	...	...	...	1½	·8882	50·9194	·0290	+33·47
¼	75·8894	75·8998	·0106	+16·99	1	34·7619	34·7970	·0220	+21·12
2	·4956	...	...	...	2	·5912	...	...	...
2	50·8916	...	...	...					

Weighted mean................. +27·48
V_a......................... +21·96
V_d......................... + ·12
Curvature.......... −0·28

Radial velocity................. + 50·3

φ PERSEI 2769.

1909. Aug. 26. Observed by W. E. Harper.
G. M. T. 17^h 10^m Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0140	....	....	....	1	34·7635	34·7933	·0183	+17·57
½	75·9048	75·9093	·0201	+32·22	2	·5775	....	....	....
2	·5032	....	....	....	1	23·9515	24·0134	·0252	+21·60
2	50·8888	....	....	....	2	·8588	....	....	....
1½	·8785	50·9125	·0221	+25·51					

Weighted mean.................. +23·40
V_a.......................... +22·04
V_d.......................... + ·15
Curvature.......... −0·28

Radial velocity................. + 45·3

φ PERSEI 2785.

1909. Sept. 14. Observed by W. E. Harper.
G. M. T. 14^h 47^m Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	51·0144	....	....	....	½	34·8792	34·7441	·0309	−29·66
1	50·9709	50·8793	·0111	−12·78	2	·7614	....	....	....

Weighted mean... ...... −18·41
V_a.......................... +18·34
V_d.......................... + ·19
Curvature.......... − ·28

Radial velocity......... − 0·2

φ PERSEI 2786.

1909. Sept. 14. Observed by W. E. Harper.
G. M. T. 15^h 30^m Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9530	....	....	....	1	34·7228	34·7571	·0179	−17·18
½	·8745	75·8699	·0193	−30·93	2	·5920	....	....	....
2	·5120	....	....	....	½	23·9108	23·9563	·0319	−27·34
2	50·9015	....	....	....	2	·8752	....	....	....
1½	·8612	50·8825	·0079	− 9·12					

Weighted mean......... −17·14
V_a.......................... +18·34
V_d.......................... + ·18
Curvature.......... − ·28

Radial velocity................ + 1·1

ϕ PERSEI 2787.

1909. Sept. 14.
G. M. T. 16ʰ 10ᵐ

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	76·0045	....	....	....	1½	·8383	50·8728	·0176	−20·31
¼	75·8493	75·8638	·0254	−40·71	½	34·7210	34·7635	·0115	−11·04
2	·4918	....	....	....	2	·5838	....	....	....
2	50·8883	....	....	....					

Weighted mean.......... −20·52
V_a.......................... +18·34
V_d.......................... + ·17
Curvature.......... − ·28

Radial velocity......... − 2·3

ϕ PERSEI 2797.

1909. Sept. 17.
G. M. T. 19ʰ 36ᵐ

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	50·9178	....	....	....	2	·6224	....	....	....
1½	·8521	50·8571	·0333	−38·43	½	23·9528	23·9574	·0308	−26·40
1	34·7466	34·7505	·0245	−23·52	2	·9161	....	....	....

Weighted mean......... −31·79
V_a.......................... +17·52
V_d.................. − ·04
Curvature.......... − ·28

Radial velocity......... − 14·6

ϕ PERSEI 2803.

1909. Sept. 20.
G. M. T. 17ʰ 30ᵐ

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	76·0241	....	....	....	1	·8656	50·8673	·0231	−26·66
¼	75·8761	75·8701	·0191	−30·61	1	34·7476	34·7411	·0339	−32·54
2	·5152	....	....	....	2	·6328	....	....	....
2	50·9211	....	....	....	....	....	....	....	....

Weighted mean.......... −29·71
V_a .. .. +16·71
V_d.......................... + ·10
Curvature.......... − ·28

Radial velocity.. .... − 13·2

φ PERSEI 2804.

1909. Sept. 20.
G. M. T. 18^h 10^m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Rev^ns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Rev^ns.	Velocity.
2	76·0285	....	....	....	1	34·7762	34·7473	·0277	—26·59
½	75·8890	75·8787	·0105	—16·83	2	·6552	....	....	....
2	·5190	....	....	....	½	24·0040	23·9650	·0236	—20·23
2	50 9377	....	....	....	2	23·9597	....	....	....
1½	·8807	50·8658	·0246	—28·39					

Weighted mean.......	—25·06	
V_a..........................		+16·71
V_d..........................		+ ·10
Curvature..........	— ·28	
Radial velocity.........	— 8·5	

φ PERSEI 2812.

1909. Sept. 21.
G. M. T. 15^h 13^m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Rev^ns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Rev^ns.	Velocity.
2	76·0168	....	....	....	2	·6298	....	....	....
¼	75·8660	75·8681	·0211	—33·82	½	23·9870	23·9765	·0117	—10·03
2	·5045	....	....	....	2	·9312	....	....	....
2	50·9225	....	....	....	¼	20·7062	20·7021	·0147	—12·18
1½	·8765	50·8768	·0136	—15·69	2	·4098	....	....	....
1½	34·7542	34·7507	·0243	—23·33					

Weighted mean..........	—19·20	
V_a..........................		+16·45
V_d..........................		+ ·25
Curvature..........	— ·28	
Radial velocity.........	— 2·8	

φ PERSEI 2813.

1909. Sept. 21.
G. M. T. 15h 55m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0321	....	....	....	1½	34·7598	34·7513	·0237	−22·75
¼	75·8913	75·8771	·0121	−19·40	2	·6348	....	....	....
2	·5236	....	....	....	½	23·9744	23·9627	·0253	−21·68
2	50·9296	....	....	....	2	·9324	....	....	....
1½	·8798	50·8730	·0174	−20·08					

Weighted mean..........	−21·32	
V_a..........................		+16·45
V_d..........................		+ ·25
Curvature..........	− ·28	
Radial velocity..........	− 4·9	

φ PERSEI 2820.

1909. Sept. 24.
G. M. T. 17h 50m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0415	....	....	....	2	·6962	....	....	....
¼	75·9042	75·8802	·0090	−14·43	½	24·0535	23·9698	·0184	−15·77
2	·5344	....	....	....	2	·0042	....	....	....
2	50·9655	....	....	....	½	20·7790	20·6975	·0193	−15·98
1½	·9252	50·8825	·0079	− 9·12	2	·4872	....	....	....
1	34·8167	34·7508	·0242	−23·23					

Weighted mean..........	−15·04	
V_a..........................		+15·53
V_d..........................		+ ·03
Curvature..........	− ·28	
Radial velocity................		+0·2

φ PERSEI 2823.

1909. Sept. 27.
G. M. T. 16ʰ 05ᵐ

Observed by / Measured by } J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0220	....	....	....	1½	34·8247	34·7836	·0151	−14·53
¾	75·8707	75·8352	·0228	−36·58	2	·6910	....	....	....
2	·5140	....	....	....	1	24·0562	24·0092	·0209	−17·95
2	58·8630	....	....	....	2	·0097	....	....	....
1	·2927	58·2601	·0037	− 4·68	¼	20·7617	20·7203	·0443	−36·81
2	50·9532	....	....	....	2	·4945	....	....	....
1½	·9110	50·8797	·0097	−11·21					

Weighted mean..........	−14·47	
V_a..........................		+14·62
V_d..........................		+ 0·11
Curvature...........	− ·28	
Radial velocity.................		± 0·0

φ PERSEI 2824.

1909. Sept. 27.
G. M. T. 16ʰ 45ᵐ

Observed by / Measured by } J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0380	....	....	....	2	34·8197	34·7902	·0085	− 8·18
¼	75·8962	75·8441	·0139	−22·30	2	·6794	....	....	....
2	·5322	....	....	....	¼	24·0224	23·9967	·0334	−28·68
2	58·8720	....	....	....	2	23·9884	....	....	....
½	·3004	58·2586	·0052	− 6·58	¼	20·7810	20·7637	·0009	− 0·75
2	50·9587	....	....	....	2	·4714	....	....	....
1½	·9187	50·8819	·0075	− 8·67					

Weighted mean...........	−8·80	
V_a..........................		+14·62
V_d..........................		+ ·11
Curvature............	− ·28	
Radial velocity.................		+5·6

ϕ PERSEI 2827.

1909. Sept. 28.
G. M. T. $18^h 31^m$

Observed by / Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Rev^ns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Rev^ns.	Velocity.
2	76·0049	....	....	....	2	·6746	....	....	....
½	75·8622	75·8444	·0136	−21·82	1	24·0402	24·0070	·0231	−19·84
2	·4944	....	....	....	2	23·9959	....	....	....
2	50·9379	....	....	....	¼	·5919	23·5587	·0036	− 3·09
1½	·8922	50·8762	·0122	−14·10	¼	20·7861	20·7631	·0015	− 1·24
1½	34·8066	34·7819	·0168	−16·16	2	·4771	....	....	....

Weighted mean.......... −15·44
V_a.......................... +14·32
V_d.................. − ·02
Curvature.......... − ·28

Radial velocity........... −1·4

ϕ PERSEI 2828.

1909. Sept. 28.
G. M. T. $19^h 05^m$

Observed by / Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Rev^ns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Rev^ns.	Velocity.
2	76·0058	....	....	....	2	·6648	....	....	....
½	75·8690	75·8455	·0125	−20·06	1	24·0280	24·0211	·0090	− 7·73
2	·5048	....	....	....	2	23·9758	....	....	....
2	50·9335	....	....	....	½	·5458	23·5389	·0234	−20·08
1½	·8958	50·8842	·0052	− 6·01	½	20·8031	20·7934	·0288	−23·84
2	34·7986	34·7838	·0149	−14·33	2	·4638	....	....	....

Weighted mean.......... −12·90
V_a.......................... +14·32
V_d..................− ·03
Curvature...........− ·28

Radial velocity................ +1·1

ϕ PERSEI 2833.

1909. Sept. 30.
G. M. T. 15h 09m

Observed by T. H. PARKER.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0004	....	....	....	2	·6389	....	....	....
¼	75·8574	75·8434	·0146	−23·42	1	23·9944	24·0092	·0209	−17·95
2	·4924	....	....	....	2	·9479	....	....	....
2	50·9179	....	....	....	½	20·7226	20·7495	·0151	−12·50
1½	·8794	50·8834	·0060	− 6·93	2	·4272	....	....	....
2	34·7752	34·7862	·0125	−12·02					

Weighted mean	−12·91	
V_a		+13·66
V_d		+ ·14
Curvature	− ·28	
Radial velocity		+0·6

ϕ PERSEI 2834.

1909. Sept. 30.
G. M. T. 15h 45m

Observed by T. H. PARKER.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0142	....	....	....	2	34·7922	34·7871	·0116	−11·16
¼	75·8862	75·8578	·0002	−0·32	2	·6550	....	....	....
2	·5048	....	....	....	1	24·0125	24·0112	·0189	−16·23
2	50·9340	....	....	....	2	·9640	....	....	....
1½	·8878	50·8757	·0137	−15·82					

Weighted mean	−13·74	
V_a		+13·66
V_d		+ ·14
Curvature	− ·28	
Radial velocity	− 0·2	

φ PERSEI 2840.

1909. Oct. 4.
G. M. T. 16h 35m

Observed by / Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0230	....	....	....	1½	34·7593	34·7665	·0085	− 8·16
¼	75·8750	75·8708	·0184	−29·49	2	·6191	....	....	....
2	·5108	....	....	....	1	23·9606	23·9725	·0157	−13·45
2	50·9165	....	....	....	2	·9088	....	....	....
1	·8715	50·8778	·0126	−14·54					

Weighted mean.........	−12·25	
V_a........................		+12·28
V_d........................		+ ·05
Curvature..........	− ·28	
Radial velocity.........	− 0·2	

φ PERSEI 2841.

1909. Oct. 4.
G. M. T. 17h 15m

Observed by / Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0194	....	....	....	1½	34·7519	34·7613	·0137	−11·74
¼	75·8816	75·8796	·0096	−15·39	2	·6169	....	....	....
2	·5132	....	....	....	1	23·9714	23·9805	·0077	− 6·38
2	50·9619	....	....	....	2	·9116	....	....	....
1½	·8816	50·8930	·0026	+3·00	....	....	....	....	....

Weighted mean.......	− 4·11	
V_a........................		+ 12·28
V_d........................		+ ·05
Curvature........	− ·28	
Radial velocity.................		+ 7·9

φ PERSEI 2853.

1909. Oct. 6.
G. M. T. 13h 33m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0827	....	....	....	1½	·9281	50·8734	·0170	−19·62
½	75·9480	75·8843	·0049	− 7·85	1	34·8112	34·7503	·0247	−23·71
2	·5699	....	....	....	2	·6872	....	....	....
2	50·9775	....	....	....					

Weighted mean.........	−19·02	
V_a........................		+ 11·63
V_d........................		+ ·18
Curvature..........	− ·28	
Radial velocity.........	− 7·5	

φ PERSEI 2854.

1909. Oct. 6.
G. M. T. 14h 12m

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9999	....	....	....	1½	34·7593	34·7585	·0165	− 15·84
¼	·8520	75·8690	·0202	− 32·38	2	·6565	....	....	....
2	·4957	....	....	....	½	23·9792	23·9689	·0193	− 18·47
2	50·9074	....	....	....	2	·9310	....	....	....
1½	·8722	50·8876	·0028	− 3·23					

Weighted mean.........	−12·25	
V_a..........................		+ 11·63
V_d..........................		+ ·18
Curvature...... ...	− ·28	
Radial velocity..... ...	− 0·5	

φ PERSEI 2870.

1909. Oct. 8.
G. M. T. 15h 48m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0490	....	....	....	1½	·9036	50·8821	·0083	− 9·58
½	75·9033	75·8728	·0164	− 26·29	1½	34·7740	34·7618	·0132	− 12·67
2	·5383	....	....	....	2	·6385	....	....	....
2	58·8650	....	....	....	½	23·9833	23·9762	·0120	− 10·28
¼	·2863	58·2634	·0113	− 14·28	2	·9278	....	....	....
2	50·9443	....	....	....					

Weighted mean.........	−15·51	
V_a..........................		+ 10·87
V_d..........................		+ ·09
Curvature..........	− ·28	
Radial velocity.........	− 4·8	

φ PERSEI 2871.

1909. Oct. 8. G. M. T. 16h 28m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity
2	76·0273	....	....	....	1½	·8763	50·8875	·0029	− 3·35
¼	75·8898	75·8828	·0064	− 10·26	1½	34·7563	34·7633	·0117	− 11·23
1	·5125	....	....	....	2	·6193	....	....	....
2	58·1704	....	....	....	1	23·9708	23·9830	·0052	− 4·46
½	·2668	58·2732	·0015	− 1·90	2	·9085	....	....	....
2	50·9116	....	....	....					

Weighted mean.........	− 6·28	
V_a.........................		+ 10·87
V_d.........................		+ ·09
Curvature..........	− ·28	
Radial velocity................		+ 4·4

φ PERSEI 2880.

1909. Oct. 12. G. M. T. 18h 48m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0197	....	....	....	1½	34·8480	34·8111	·0110	− 10·60
¼	75·8824	75·8177	·0089	− 14·29	2	·7107	....	....	....
2	·5124	....	....	....	1	24·0857	24·0590	·0132	− 11·36
2	50·9720	....	....	....	2	·0317	....	....	....
1½	·9334	50·8823	·0062	− 7·18	½	23·6240	23·5973	·0081	− 6·95

Weighted mean.........	− 9·63	
V_a.........................		+ 9·35
V_d.................	− ·05	
Curvature..........	− ·28	
Radial velocity.........	− 0·6	

φ PERSEI 2881.

1909 Oct. 12.
G. M. T. $19^h\ 28^m$

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9732	....	....	....	1½	34·8124	34·8105	·0116	−11·18
¼	·8342	75·8174	·0092	−14·77	2	·6757	....	....	....
2	·4600	....	....	....	1½	24·0592	24·0590	·0132	−11·36
2	50·9220	....	....	....	2	·0052	....	....	....
2	·8807	50·8796	·0089	−10·30					

Weighted mean.........	−12·58	
V_a.........................		+9·35
V_d.................	− ·03	
Curvature..........	− ·28	
Radial velocity.........	− 3·5	

φ PERSEI 2885.

1909. Oct. 15.
G. M. T. $18^h\ 58^m$

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0294	....	....	....	2	·6916	....	....	....
½	75·8936	75·8503	·0077	−12·35	1	24·0561	24·0149	·0152	−13·05
2	·5226	....	....	....	2	·0039	....	....	....
2	50·9602	....	....	....	¼	20·8146	20·7798	·0152	−12·63
1	·9176	50·8793	·0101	−11·67	2	·4889	....	....	....
1½	34·8234	34·7817	·0170	−16·35					

Weighted mean.........	−13·14	
V_a.........................		+8·20
V_d.................	− ·10	
Curvature..........	− ·28	
Radial velocity.........	− 5·3	

ϕ PERSEI 2886.

1909. Oct. 15.
G. M. T. $19^h\ 40^m$

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0146	....	....	....	1	·9181	50·8802	·0092	−10·63
¼	75·8751	75·8468	·0112	−17·97	1½	34·8236	34·7769	·0218	−20·97
2	·5076	....	....	....	2	·6966	....	....	....
¼	58·3161	58·2796	·0158	−20·00	1	24·0536	24·0037	·0264	−22·67
2	57·2586	....	....	....	2	·0126	....	....	....
2	50·9598	....	....	....					

Weighted mean.........	−18·55	
V_a.........................		+8·20
V_d.................	− ·10	
Curvature..........	− ·28	
Radial velocity.........	−10·7	

ϕ PERSEI 2893.

1909. Oct. 19.
G. M. T. $18^h\ 22^m$

Observed by / Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0098	....	....	....	1	34·8246	34·8108	·0113	−10·89
½	75·8731	75·8186	·0080	−12·85	2	·6876	....	....	....
2	·5013	....	....	....	½	24·0714	24·0608	·0114	− 9·81
2	50·9488	....	....	....	2	·0156	....	....	....
1½	·9048	50·8769	·0116	−13·43	¼	23·5981	23·5875	·0179	−15·35

Weighted mean.........	−12·29	
V_a.........................		+6·65
V_d.................	− ·09	
Curvature..........	− ·28	
Radial velocity.........	− 6·0	

φ PERSEI 2894.

1909. Oct. 19.
G. M. T. 19h 02m

Observed by, Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9968	....	....	....	1½	34·8200	34·8093	·0128	−12·33
½	·8625	75·8212	·0054	− 8·67	2	·6845	....	....	....
2	·4875	....	....	....	1	24·0520	24·0587	·0135	−11·61
2	50·9363	....	....	....	2	23·9983	....	....	....
1½	·8838	50·8684	·0201	−23·26					

Weighted mean.........	−14·09	
V_a........................		+6·65
V_d................	− ·09	
Curvature..........	− ·28	
Radial velocity.........	− 7·08	

φ PERSEI 2903.

1909. Oct. 20.
G. M. T. 17h 38m

Observed by J. S. PLASKETT.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9684	....	....	....	1½	34·7867	34·8088	·0143	−13·78
¼	·8425	75·8285	·0019	+ 3·05	2	·6517	....	....	....
2	·4577	....	....	....	½	24·0317	24·0673	·0049	− 4·22
2	50·9124	....	....	....	2	23·9694	....	....	....
1½	·8712	50·8797	·0088	−10·16					

Weighted mean.........	− 9·94	
V_a........................		+6·26
V_d................	− ·05	
Curvature..........	− ·28	
Radial velocity.........	− 4·0	

ϕ PERSEI 2904.

1909. Oct. 20.
G. M. T. 17ʰ 50ᵐ

Observed by } J. B. Cannon.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	75·9565	....	....	....	1½	34·7877	34·8073	·0148	−14·26
¼	·8275	75·8260	·0006	− 0·97	2	·6542	....	....	....
2	·4492	....	....	....	½	24·0280	24·0536	·0186	−16·00
2	50·9080	....	....	....	2	23·9794	....	....	....
1½	·8667	50·8796	·0089	−10·27					

Weighted mean......... −12·01
V_a.......................... +6·26
V_d................ − ·05
Curvature.......... − ·28

Radial velocity......... − 6·1

ϕ PERSEI 2911.

1909. Oct. 27.
G. M. T. 13ʰ 42ᵐ

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	75·9985	....	....	....	½	34·8087	34·7909	·0078	− 7·50
½	·8540	75·8428	·0152	−24·39	2	·6677	....	....	....
2	·4870	....	....	....	¼	24·0522	24·0297	·0004	− 0·34
2	50·9332	....	....	....	2	23·9852	....	....	....
2	·8890	50·8777	·0117	−13·52					

Weighted mean......... −13·25
V_a.......................... +3·50
V_d.......................... + ·12
Curvature.......... − ·28

Radial velocity........... − 9·9

ϕ PERSEI 2912.

1909. Oct. 27.
G. M. T. 14ʰ 22ᵐ.

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	50·9102	....	....	....	½	34·7677	34·7734	·0253	− 24·34
1	·8744	50·8851	·0043	− 4·97	2	·6442	....	....	....

Weighted mean......... −11·87
V_a.......................... + 3·50
V_d.......................... + ·12
Curvature.......... − ·28

Radial velocity......... − 8·5

φ PERSEI 2914.

1909. Oct. 28.
G. M. T. 16h 47m

Observed by / Measured by } J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9607	....	....	....	½	34·7902	34·7854	·0133	− 12·79
¼	·8185	75·8449	·0131	− 21·02	2	·6547	....	....	....
2	·4495	....	....	....	¼	24·0314	24·0174	·0127	− 10·91
2	50·9045	....	....	....	2	23·9767	....	....	....
1	·8587	50·8761	·0133	− 15·37					

Weighted mean.........	−16·22	
V_a........................		+ 2·84
V_d..................	− ·03	
Curvature..........	− ·28	
Radial velocity.........	− 13·7	

φ PERSEI 2915.

1909. Oct. 28.
G. M. T. 17h 30m

Observed by / Measured by } J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9694	....	....	....	½	34·7692	34·7801	·0186	− 17·89
¼	·8327	75·8503	·0077	− 12·36	2	·6390	....	....	....
2	·4592	....	....	....	¼	24·0242	24·0272	·0029	− 2·50
2	50·9012	....	....	....	2	23·9597	....	....	....
1	·8560	50·8767	·0127	− 14·58					

Weighted mean.........	−13·62	
V_a........................		+ 2·84
V_d..................	− ·03	
Curvature..........	− ·28	
Radial velocity.........	− 11·1	

φ PERSEI 2925.

1909. Oct. 29. Observed by T. H. Parker.
G. M. T. $19^h 23^m$ Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9715	....	....	....	½	34·7980	34·7879	·0108	+ 10·39
¼	·8224	75·8380	·0200	− 32·12	2	·6600	....	....	....
2	·4607	....	....	....	2	23·9942	....	....	....
2	50·9132	....	....	....	¼	·9070	23·8755	·0179	− 15·34
1½	·8717	50·8804	·0090	− 10·39					

Weighted mean......... −13·08
V_a......................... + 2·58
V_d................. − ·24
Curvature.......... − ·28

Radial velocity......... − 11·0

φ PERSEI 2926.

1909. Oct. 29. Observed by T. H. Parker.
G. M. T. $20^h 05^m$ Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9960	....	....	....	2	50·9460	....	....	....
¼	·8555	75·8452	·0128	− 20·56	1½	·9060	50·8819	·0075	− 8·65
2	·4908	....	....	....					

Weighted mean......... −10·35
V_a......................... + 2·58
V_d................. − ·24
Curvature.......... − ·28

Radial velocity......... − 8·3

φ PERSEI 2930.

1909. Nov. 4. Observed by T. H. Parker.
G. M. T. $13^h 40^m$ Measured by J. B Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0019	....	....	....	¼	34·7986	34·7741	·0246	− 23·66
½	75·8704	75·8555	·0025	− 4·02	2	·6744	....	....	....
2	·4917	....	....	....	2	23·9976	....	....	....
2	50·9344	....	....	....	½	·9150	23·8801	·0133	− 11·41
½	·9019	50·8894	·0000	± 0·00					

Weighted mean......... − 7·78
V_a......................... + 0·19
V_d......................... + ·10
Curvature.......... − ·28

Radial velocity......... − 7·8

φ PERSEI 2931.

1909. Nov. 4. G. M. T. 14h 20m

Observed by T. H. Parker. Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0064	....	....	....	1	·9059	50·8809	·0085	− 9·82
½	75·8674	75·8477	·0103	− 16·54	¼	34·8246	34·7916	·0071	− 6·83
2	·4976	....	....	....	2	·6829	....	....	....
2	50·9469	....	....	....					

Weighted mean.........	−11·31	
V_a..........................		+ 0·19
V_d..........................		+ ·10
Curvature..........	− ·28	
Radial velocity.........	− 11·3	

φ PERSEI 2935.

1909. Nov. 8. G. M. T. 15h 52m

Observed by / Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9190	....	....	....	1	·8815	50·8844	·0050	− 5·78

Weighted mean.........	− 5·78
V_a..................	− 1·52
V_d..................	− ·03
Curvature..........	− ·28
Radial velocity.........	− 7·6

φ PERSEI 2936.

1909. Nov. 8. G. M. T. 16h 35m

Observed by / Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9696	....	....	....	½	·8706	50·8754	·0140	− 16·16
¼	·8276	75·8441	·0139	− 22·28	¼	24·0328	24·0177	·0124	− 11·92
2	·4626	....	....	....	2	23·9778	....	....	....
2	50·9171	....	....	....					

Weighted mean.........	−16·63
V_a..................	− 1·52
V_d..................	− ·03
Curvature..........	− ·28
Radial velocity.........	− 18·5

ϕ PERSEI 2944.

1909. Nov. 12.
G. M. T. 15h 56m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9495	....	....	....	1	·9045	50·8778	·0126	− 14·54

Weighted mean.........	−14·54
V_a..................	− 3·18
V_d..................	− ·04
Curvature..........	− ·28
Radial velocity.........	− 18·0

ϕ PERSEI 2945.

1909. Nov. 12.
G. M. T. 16h 35m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9540	....	....	....	¼	34·8150	34·7631	·0119	−11·44
½	·9158	50·8846	·0058	− 6·69	2	·6782	....	....	....

Weighted mean.........	− 8·27
V_a..................	− 3·18
V_d..................	− ·04
Curvature..........	− ·28
Radial velocity.........	−11·8

ϕ PERSEI 2952.

1909. Nov. 15.
G. M. T. 16h 47m

Observed by, Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9463	....	....	....	2	·6626	....	....	....
1	·9123	50·8888	·0016	− 1·85	¼	24·0071	23·9598	·0284	−24·34
1	34·8105	34·7742	·0008	− 0·77	2	23·9680	....	....	....

Weighted mean.........	− 3·91
V_a..................	− 4·35
V_d..................	− ·10
Curvature..........	− ·28
Radial velocity.........	− 8·6

ϕ PERSEI 2953.

1909. Nov. 15. G.M.T. 17ʰ 25ᵐ

Observed by } Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	51·6581	....	....	....	1	34·8194	34·7659	·0091	− 8·75
½	·5824	51·5520	·0154	−17·93	2	·6798	....	....	....
2	50·9558	....	....	....	¼	24·0371	23·9710	·0172	−14·74
1	·9164	50·8834	·0070	− 8·08	2	23·9868	....	....	....

Weighted mean......... −10·72
V_a................. − 4·35
V_d................. − ·10
Curvature.......... − ·28

Radial velocity......... −15·4

ϕ PERSEI 2954.

1909. Nov. 15. G. M. T. 17ʰ 29ᵐ

Observed by } Measured by } J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0202	....	....	....	½	·8934	50·8762	·0142	−16·39
¼	75·8850	75·8838	·0054	− 8·66	½	34·7902	34·7635	·0115	−11·06
2	·5082	....	....	....	2	·6530	....	....	....
2	50·9400	....	....	....	..				

Weighted mean......... −12·71
V_a................. − 4·35
V_d................. − ·10
Curvature.......... − ·28

Radial velocity......... −17·4

ϕ PERSEI 2962.

1909. Nov. 18. G. M. T. 12ʰ 30ᵐ

Observed by W. E. Harper. Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9698	....	....	....	..1	·9091	50·8882	·0003	− 0·35
½	·8438	75·8283	·0017	+ 2·73	½	34·8486	34·8212	·0009	− 0·87
2	·4651	....	....	....	2	·7012	....	....	....
2	50·9418	....	....	....					

Weighted mean......... − 0·28
V_a................. − 5·60
V_d................. − ·12
Curvature.......... − ·28

Radial velocity......... − 6·3

ϕ PERSEI 2963.

1909. Nov. 18.
G. M. T. 13h 10m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9461	....	....	....	1	·9141	50·8889	·0004	+ 0·46

Weighted mean..................		+0·46
V_a..................	− 5·60	
V_d..................	− ·12	
Curvature..........	− ·28	
Radial velocity.........	− 5·5	

ϕ PERSEI 2973.

1909. Nov. 26.
G. M. T. 12h 35m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9957	....	....	....	1	·8997	50·8844	·0050	− 5·77
½	·8632	75·8587	·0007	+ 1·12	1½	34·8384	34·8023	·0036	+ 3·46
2	·4807	....	....	....	2	·6860	....	....	....
2	50·9372	....	....	....					

Weighted mean.........	− 0·01	
V_a..................	− 8·83	
V_d.........................		+ ·05
Curvature..........	− ·28	
Radial velocity.........	− 9·1	

ϕ PERSEI 2974.

1909. Nov. 26.
G. M. T. 13h 17m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9610	....	....	....	2	·6998	....	....	....
1½	·9325	50·8934	·0040	+ 4·62	½	24·0848	24·0240	·0061	− 5·24
1	34·8438	34·7939	·0048	− 4·62	2	·0235	....	....	....

Weighted mean.........	− 0·39	
V_a..................	− 8·83	
V_d.........................		+ ·05
Curvature..........	− ·28	
Radial velocity.........	− ·9·4	

φ PERSEI 2976.

1909. Nov. 26.
G. M. T. 15ʰ

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	75·9976	....	....	....	1	34·8331	34·7971	·0016	− 1·54
¼	·8666	75·8580	·0000	± 0·00	2	·6859	....	....	....
2	·4796	....	....	....	¼	24·0616	24·0137	·0164	−14·09
2	50·9210	....	....	....	2	·0106	....	....	....
½	·8805	50·8814	·0080	− 9·23					

Weighted mean......... − 4·84
V_a.................. − 8·83
V_d.................. − ·05
Curvature.......... − ·28

Radial velocity......... −14·0

φ PERSEI 2989.

1909. Dec. 1.
G. M. T. 11ʰ 57ᵐ

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	50·9318	....	....	....	2	·6780	....	....	....
2	·9020	50·8921	·0027	+ 3·12	1	24·0665	24·0274	·0027	− 2·24
1½	34·8218	34·7937	·0050	− 4·81	2	·0018	....	....	....

Weighted mean......... − 0·71
V_a.................. −10·74
V_d.......................... + ·10
Curvature.......... − ·28

Radial velocity......... − 11·6

φ PERSEI 2990.

1909. Dec. 1.
G. M. T. 12ʰ 05ᵐ

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	76·0008	....	....	....	1½	34·8264	34·7899	·0088	− 8·46
½	75·8676	75·8540	·0040	− 6·42	2	·6864	....	....	....
2	·4901	....	....	....	1	24·0774	24·0293	·0008	− 0·69
2	50·9478	....	....	....	2	·0108	....	....	....
2	·9186	50·8928	·0034	+ 3·93					

Weighted mean......... − 1·75
V_a.................. −10·74
V_d.......................... + ·10
Curvature.......... − ·28

Radial velocity......... − 12·7

φ PERSEI 3020.

1909. Dec. 10.
G. M. T. 14ʰ 17ᵐ

Observed by W. E. HARPER.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	75·9651	....	....	....	2	·7051	....	....	....
½	·8568	75·8471	·0205	+ 32·92	1	24·1511	24·1133	·0411	+ 35·36
2	·4561	....	....	....	2	·0428	....	....	....
2	50·9396	....	....	....	½	20·8894	20·8492	·0364	+ 30·30
1½	·9354	50·9167	·0282	+ 32·64	2	·5421	....	....	....
2	34·8788	34·8475	·0254	+ 24·47					

Weighted mean.................		+ 29·98
V_a..................	−14·05	
V_d..................	− ·04	
Curvature..........	− ·28	
Radial velocity.................		+ 15·6

φ PERSEI 3032.

1909. Dec. 16.
G. M. T. 13ʰ 40ᵐ

Observed by T. H. PARKER.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	50·9430	....	....	....	1	34·8940	34·8650	·0426	+ 41·02
1½	·9535	50·9314	·0428	+ 49·68	2	·7028	....	....	....

Weighted mean.................		+ 46·22
V_a..................	−16·07	
V_d..................	− ·09	
Curvature..........	− ·28	
Radial velocity..............		+ 29·8

φ PERSEI 3033.

1909. Dec. 16.
G. M. T. 14ʰ 29ᵐ

Observed by T. H. PARKER.
Measured by J. B. CANNON.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	75·9709	....	....	....	2	34·8886	34·8625	·0404	+38·90
½	·8769	75·8622	·0356	+57·17	2	·6999	....	....	....
2	·4586	....	....	....	1	24·1449	24·1163	·0441	+37·94
2	50·9145	....	....	....	2	·0336	....	....	....
1½	·9093	50·9157	·0272	+31·48					

Weighted mean.................		+38·30
V_a..................	−16·07	
V_d..................	− ·09	
Curvature..........	− ·28	
Radial velocity.................		+21·9

ϕ PERSEI 3034.

1909. Dec. 16.
G. M. T. 15h 10m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9554	....	....	....	2	34·8692	34·8584	·0363	+34·97
½	·8546	75·8545	·0279	+44·81	2	·6846	....	....	....
2	·4469	....	....	....	1	24·1156	24·1022	·0300	+25·81
2	50·9262	....	....	....	2	·0184	....	....	....
2	·9176	50·9123	·0265	+30·67					

Weighted mean.................. +32·63
V_a.................. −16·07
V_d.................. − ·09
Curvature.......... − ·28

Radial velocity.................. +16·2

ϕ PERSEI 3051.

1909. Dec. 18.
G. M. T. 19h 07m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9455	....	....	....	1½	34·9148	34·8673	·0452	+43·53
1½	·9470	50·9234	·0336	+38·89	2	·7213	....	....	....

Weighted mean.................. +41·20
V_a.................. −16·73
V_d.................. − ·21
Curvature.......... − ·28

Radial velocity.................. +24·0

ϕ PERSEI 3052.

1909. Dec. 18.
G. M. T. 19h 45m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9568	....	....	....	1½	·9540	50·9316	·0431	+49·88
½	·8565	75·8547	·0281	+45·13	1	34·9185	34·8768	·0547	+52·70
2	·4493	....	....	....	2	·7155	....	....	....
2	50·9443	....	....	....					

Weighted mean.................. +50·03
V_a.................. −16·73
V_d.................. − ·21
Curvature.......... − ·28

Radial velocity.................. +32·8

ϕ PERSEI 3054.

1909. Dec. 27.
G. M. T. 12h 05m

Observed by } J. B. Cannon.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9652	....	....	....	1	34·9460	34·8873	·0652	+62·81
½	·8770	75·8671	·0405	+65·04	2	·7325	....	....	....
2	·4567	....	....	....	½	24·2365	24·1633	·0911	+78·37
2	50·9574	....	....	....	2	·0782	....	....	....
2	·9794	50·9429	·0544	+62·96					

Weighted mean................		+65·11
V_a..................	−19·20	
V_d..........................		+ ·02
Curvature..........	− ·28	
Radial velocity................		+45·6

ϕ PERSEI 3055.

1909. Dec. 27.
G. M. T. 12h 40m

Observed by } J. B. Cannon.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9712	....	....	....	1½	34·9369	34·8853	·0632	+60·89
½	·8772	75·8614	·0348	+55·89	2	·7254	....	....	....
2	·4624	....	....	....	½	24·1941	24·1312	·0690	+59·57
2	50·9512	....	....	....	2	·0679	....	....	....
2	·9796	50·9493	·0608	+70·37					

Weighted mean................		+64·40
V_a..................	−19·20	
V_d..................	− ·05	
Curvature..........	− ·28	
Radial velocity................		+44·9

φ PERSEI 3062.

1909. Dec. 29.
G. M. T. 13h.21m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9696	....	....	....	1	34·9468	34·8863	·0642	+61·85
½	·8696	75·8560	·0294	+47·22	2	·7343	....	....	....
2	·4584	....	....	....	1	24·2216	24·1510	·0788	+67·79
2	50·9591	....	....	....	2	·0756	....	....	....
1½	·9846	50·9464	·0579	+67·01					

Weighted mean................		+63·44
V_a..................	−19·73	
V_d..................	− ·05	
Curvature..........	− ·28	
Radial velocity................		+43·4

φ PERSEI 3078.

1909. Dec. 31.
G. M. T. 12h 27m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9535	....	....	....	1	34·9068	34·8694	·0473	+45·57
½	·8587	75·8615	·0349	+56·05	2	·7112	....	....	....
2	·4412	....	....	....	½	24·2112	24·1600	·0878	+75·53
2	50·9377	....	....	....	2	·0562	....	....	....
2	·9588	50·9420	·0535	+61·92					

Weighted mean................		+58·80
V_a..................	−20·19	
V_d..................	− ·03	
Curvature..........	− ·28	
Radial velocity................		+ 38·3

ϕ PERSEI 3079.

1909. Dec. 31.
G. M. T. 13h 05m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9815	....	....	....	1½	34·9415	34·8731	·0510	+49·13
½	·8940	75·8683	·0417	+66·97	2	·7422	....	....	....
2	·4710	....	....	....	1	24·2240	24·1420	·0698	+60·05
2	50·9748	....	....	....	2	·0870	....	....	....
2	·9875	50·9336	·0451	+52·18					

Weighted mean.................		+54·32
V_a..................	−20·19	
V_d..................	− ·05	
Curvature..........	− ·28	
Radial velocity.................		+ 33·8

ϕ PERSEI 3082.

1910. Jan. 4.
G. M. T. 12h 09m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9631	....	....	....	1	·9771	50·9474	·0589	+68·17
½	·8718	75·8643	·0377	+60·55	½	34·9306	34·8908	·0687	+66·18
2	·4536	....	....	....	2	·7136	....	....	....
2	50·9506	....	....	....					

Weighted mean.................		+65·77
V_a..................	−21·08	
V_d..................	− ·03	
Curvature..........	− ·28	
Radial velocity.................		+ 44·4

ϕ PERSEI 3083.

1910. Jan. 4.
G. M. T. 12h 50m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9620	....	....	....	1½	·9768	50·9442	·0557	+64·47
½	·8725	75·8659	·0393	+63·12	1	34·9302	34·8840	·0619	+59·63
2	·4530	....	....	....	2	·7200	....	....	....
2	50·9535	....	....	....					

Weighted mean.................		+62·63
V_a..................	−21·08	
V_d..................	− ·03	
Curvature..........	− ·28	
Radial velocity.................		+ 41·2

ϕ PERSEI 3088.

1910. Jan. 10.
G. M. T. 11^h 45^m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9802	....	....	....	1	·9770	50·9446	·0561	+64·93
½	·8872	75·8622	·0356	+57·18	½	34·8982	34·8508	·0287	+27·65
2	·4722	....	....	....	2	·7212	......	....	....
2	50·9540	....	....	....					

Weighted mean.................. +53·6
V_a.................. −22·21
V_d.................. − ·05
Curvature.......... − ·28

Radial velocity................. + 31·1

ϕ PERSEI 3089.

1910. Jan. 10.
G. M. T. 12^h 17^m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9584	....	....	....	1	·9267	50·9224	·0339	+39·23
½	·8407	75·8380	·0114	+18·31	1	34·8587	34·8403	·0182	+21·06
2	50·9252	....	....	....	2	·6922	....	....	....

Weighted mean.................. +27·78
V_a.................. −22·21
V_d.................. − ·05
Curvature.......... − ·28

Radial velocity................. + 5·3

ϕ PERSEI 3095.

1910. Jan. 12.
G. M. T. 11^h 36^m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9726	....	....	....	1	·9646	50·9403	·0518	+59·95
½	·8461	75·8295	·0029	+ 4·66	1½	34·8676	34·8385	·0164	+15·80
2	·4614	....	....	....	2	·7029	....	....	....
2	50·9452	....	....	....					

Weighted mean.................. +28·66
V_a.................. −22·53
V_d.................. − ·02
Curvature.......... − ·28

Radial velocity................. + 5 8

ϕ PERSEI 3096.

1910. Jan. 12.
G. M. T. 12h 15m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	50·9286	....	....	....	1½	·9154	50·9077	·0192	+22·22

Weighted mean		+22·22
V_a	−22·53	
V_d	− ·02	
Curvature	− ·28	
Radial velocity	− 0·6	

ϕ PERSEI 3097.

1910. Jan. 12.
G. M. T. 12h 45m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9664	....	....	....	1½	·9529	50·9309	·0424	+49·07
½	·8674	75·8560	·0294	+47·22	1	34·8559	34·8383	·0162	+15·61
2	·4592	....	....	....	2	·7046	....	....	....
2	50·9429	....	....	....					

Weighted mean		+ 37·61
V_a	−22·53	
V_d	− ·02	
Curvature	− ·28	
Radial velocity		+ 14·8

ϕ PERSEI 3109.

1910. Jan. 14.
G. M. T. 17h 05m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9605	....	....	....	1½	·9761	50·9372	·0487	+43·63
½	·8534	75·8480	·0214	+34·37	1	34·9116	34·8461	·0240	+23·12
2	·4529	....	....	....	2	·7393	....	....	....
2	50·9598	....	....	....					

Weighted mean		+ 35·25
V_a	−22·86	
V_d	− ·21	
Curvature	− ·28	
Radial velocity		+ 11·9

ϕ PERSEI 3110.

1910. Jan. 14.
G. M. T. 17h 45m

Observed by W. E. Harper.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9737	....	....	....	1½	·9728	50·9245	·0360	+41·67
½	·8545	75·8358	·0092	+14·78	1½	34·9248	34·8559	·0338	+32·56
2	·4665	....	....	....	2	·7428	....	....	....
2	50·9692	....	....	....					

Weighted mean................. +33·93
V_a.................. −22·86
V_d.................. − ·21
Curvature.......... − ·28

Radial velocity................. + 10·6

ϕ PERSEI 3124.

1910. Jan. 15.
G. M. T. 18h 15m

Observed by J. S. Plaskett.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9568	....	....	....	1½	·9616	50·9222	·0337	+39·00
½	·8548	75·8534	·0268	+43·04	1	34·9060	34·8290	·0069	+ 6·65
2	·4480	....	....	....	2	·7508	....	....	....
2	50·9603	....	....	....					

Weighted mean................. + 28·89
V_a.................. −23·00
V_d.................. − ·19
Curvature.......... − ·28

Radial velocity................. + 5·4

ϕ PERSEI 3152.

1910. Jan. 25.
G. M. T. 12h 40m

Observed by } J. B. Cannon.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9632	....	....	....	1	34·8450	34·8466	·0245	+23·60
½	·8405	75·8328	·0062	+ 9·96	2	·6712	....	....	....
2	·4538	....	....	....	1	24·1010	24·1075	·0353	+30·37
2	50·9232	....	....	....	2	23·9985	....	....	....
1½	·9072	50·9049	·0164	+18·98					

Weighted mean................. + 21·85
V_a.................. −24·08
V_d.................. − ·12
Curvature.......... − ·28

Radial velocity......... − 2·6

ϕ PERSEI 3153.

1910. Jan. 25.
G. M. T. 13h 20m

Observed by} J. B. Cannon.
Measured by}

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9660	....	....	....	1	34·8467	34·8470	·0249	+23·99
½	·8480	75·8369	·0103	+16·54	2	·6735	....	....	....
2	·4592	....	....	....	1	24·1037	24·1035	·0313	+26·93
2	50·9247	....	....	....	2	·0052	....	....	....
1½	·9130	50·9092	·0207	+23·96					

Weighted mean.................		+ 23·78
V_a..................	−24·08	
V_d..................	− ·12	
Curvature..........	− ·28	
Radial velocity.........	− 0·7	

OBSERVING RECORD AND DETAILED MEASURES OF τ TAURI.

P.—Plaskett.
H.—Harper.
P¹.—Parker.
C.—Cannon.

RECORD OF SPECTROGRAMS.

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure. G. M. T.	Duration.	Hour Angle at end.	Comparison Spectrum. Exposure in seconds.	Comparison Spectrum. Kind.	Temperature Centigrade. Room. Beginning.	Room. End.	Prism Box. Beginning.	Prism Box. End.	Slit Width in inches.	Focal Position. Star Focus.	Collimator.	Camera.	Seeing.	Observer.	Remarks.
				1907.	h. m.	m.	h. m.		m.											
τ Tauri...	1153	1L	Seed 27	Nov. 18	16 17	65	2 05 E	5- 6- 6- 5	FeVSpark	3·3	3·3	5·0	5·0	·0013	74·0	10·8	18·18	Hazy.....	P	
" ..	1180	"	"	Dec. 4	6 12	45	1 45 W	4- 4- 4- 4	" ..	−13·0	−12·5	1·1	1·1	·0015	72·0	10·8	18·1	Good.....	H-P	
" ..	1181	"	"	"	6 57	40	2 25 W	"	" ..	−12·5	−12·4	"	"	"	"	"	"	"	P	
				1908.																
" ..	1225	"	"	Jan. 14	11 56	36	1 57 E	1½½	" ..	−8·5	−10·5	−4·9	−5·1	·0013	72·5	10·8	18·05	"	H	
" ..	1226	"	"	"	12 35	40	1 14 E	1- 1- 1- 1	" ..	−10·5	−11·5	−5·1	−5·1	"	"	"	"	"	H	
" ..	1232	"	"	Jan. 16	11 12	35	2 30 E	1¼-1¼-1¼-1¼	" ..	−12·0	−12·0	−6·0	−6·0	"	72·0	"	"	Fair	P	
" .	1256	"	"	Jan. 22	11 50	40	1 18 W	3- 3- 3	" ..	−7·0	−8·0	0·0	−0·1	"	72·5	"	18·09	Good.....	H	
" ..	1270	"	"	Jan. 24	12 14	32	1 00 E	1¼-1¼-1¼-1¼	" ..	−14·3	−14·6	−9·0	−9·0	"	72·0	"	18·0	....	P	
" ..	1297	"	"	Jan. 29	12 01	32	1 08 E	1½-1½-1½-1½	" ..	−18·5	−18·5	−8·5	−8·4	"	72·4	"	18·08	Unsteady.	H	
" ..	1298	"	"	"	12 34	32	0 35 E	"	" ..	−18·5	−19·5	−8·5	−8·4	"	"	"	"	Good....	H	
" ..	1310	"	"	Feb. 3	12 13	32	0 20 E	2- 2- 2- 2	" ..	−14·0	−16·0	−7·5	−7·6	"	"	"	"	"	H	
" .	1311	"	"	"	12 45	30	0 10 W	"	" ..	−16·0	−16·5	−7·6	−7·7	"	"	"	"	"	H	
" ..	1323	"	"	Feb. 17	14 22	36	2 45 W	1- 2- 1	" ..	−12·5	−13·0	−2·3	−2·3	"	"	"	18·1	Fair......	H	
" ..	1324	"	"	"	14 58	34	3 20 W	1- 1- 1- 1	" ..	−13·0	−14·0	"	"	"	"	"	"	"	H	
" ..	1345	"	"	Feb. 22	12 31	27	1 10 W	2- 2- 2- 2	" ..	−10·8	−11·0	−1·8	−1·8	"	72·5	"	"	Good.....	P	
" ..	1350	"	"	Feb. 24	13 24	28	2 10 W	"	" ..	−10·0	−10·2	−2·0	−2·1	"	"	"	18·24	"	P	
" .	1374	"	"	Mar. 4	13 38	40	3 05 W	"	" ..	−5·0	−6·0	+0·8	+0·8	"	72·4	"	18·25	Unsteady	H	
" ..	1383	"	"	Mar. 9	12 51	58	2 50 W	1- 1- 1- 1	" ..	−5·5	−7·0	1·4	1·3	"	"	"	18·3	,	P	
" .	1394	"	"	Mar. 11	13 06	52	3 10 W	¾- ¾- ¾- ¾	" ..	−4·5	−4·5	6·2	6·2	"	72·5	"	18·35	Hazy.....	H	
" ..	1889	"	"	Sept. 14	19 47	95	0 35 E	3- 3- 3- 3	" ..	11·0	10·5	21·2	21·2	·0015	73·0	"	19·0	Poor.....	P¹	
" ..	1913	"	"	Oct. 2	20 02	45	0 30 E	"	" ..	3·5	2·8	12·8	12·8	"	"	"	18·62	Good.....	C	
" ..	1923	"	"	Oct. 9	19 45	50	0 15 E	3- 2- 2- 3	" ..	5·1	4·6	14·9	14·8	"	"	"	18·80	"	P¹	
" ..	1929	"	"	Oct. 12	18 32	75	1 04 E	3- 3- 3- 3	" .	4·0	4·0	7·3	7·6	·0016	"	"	"	Faint....	P¹-H	
" ..	1940	"	"	Oct. 19	18 00	70	0 55 E	"	" ..	7·5	7·0	16·2	16·2	·0015	"	"	18·89	Good.....	P¹	
" ..	1945	"	"	Oct. 30	17 10	44	1 00 E	"	" ..	2·5	3·0	9·8	10·0	"	"	"	18·7	Fair......	C	
" ..	1973	"	"	Nov. 20	18 47	58	1 40 W	"	" ..	−3·5	−4·7	3·6	3·6	"	"	"	18·4	"	P¹	

OBSERVING RECORD AND DETAILED MEASURES OF τ TAURI.

P.—Plaskett.
H.—Harper.
P¹.—Parker.
C.—Cannon.

RECORD OF SPECTROGRAMS.—*Continued.*

Star.	No. of Negative.	Camera.	Plate.	Date.	Middle of Exposure. G. M. T.	Duration.	Hour Angle at end.	Comparison Spectrum. Exposure in seconds.	Comparison Spectrum. Kind.	Temperature Centigrade. Room. Beginning.	Temperature Centigrade. Room. End.	Temperature Centigrade. Prism Box. Beginning.	Temperature Centigrade. Prism Box. End.	Slit Width in inches.	Focal Position. Star Focus.	Focal Position. Collimator.	Focal Position. Camera.	Seeing.	Observer.	Remarks.
				1908.	h. m.	m.	h. m.	m.												
τ Tauri. .	2000	IL	Seed 27	Dec. 4	18 02	40	1 35 W	3- 3- 3- 3	FeVSpark	− 7·4	− 8·0	−1·4	−1·5	·0016	73·0	10·8	18·2	Clear.....	C	
" . .	2008	"	"	Dec. 7	19 30	60	3 27 W	"	" . .	− 7·0	− 9·5	−0·8	−0·8	"	"	"	18·45	Fair.... .	H	
" . .	2031	"	"	Dec. 16	16 09	60	0 42 W	2- 4- 4- 3	" . .	− 9·0	−10·0	3·0	3·0	·0015	"	"	18·5	"	H	
" . .	2032	"	"	"	17 10	60	1 40 W	2- 2- 2- 2	" . .	−10·0	−10 5	"	"	"	"	"	"	Good.....	H	
" . .	2046	"	"	Dec. 18	16 37	75	1 32 W	3- 3- 4- 4	" . .	− 8.0	− 9·7	−4·6	−4·7	"	"	"	18·45	"	C	
" . .	2049	"	"	"	18 07	75	2 55 W	3- 3- 4- 4	" . .	−10·5	−11·2	−4·9	−5·1	"	"	"	"	Fair......	P¹	
" . .	2056	"	"	Dec. 21	16 10	70	1 05 W	3- 2- 2- 3	" . .	−11·3	−12·4	−1·7	−1·9	"	"	"	"	Good.....	P¹	
" . .	2059	"	"	"	17 55	90	3 00 W	3- 3- 4- 3	" . .	−12 4	−12·4	−1·9	−1·9	"	"	"	"	"	P¹–C	
" . .	2081	"	"	Dec. 31	14 30	91	0 20 W	3- 3- 3- 3	" . .	−10·0	−13·5	−3·3	−3·3	"	"	"	18·6	Poor	H	Haze.
				1909.																
" . .	2086	"	"	Jan. 2	12 46	47	1 50 E	2- 2- 2- 2	" . .	− 8·4	− 9·5	−6·7	−6·7	"	73·1	"	18·48	....	P	
" . .	2090	"	"	Jan. 6	13 30	69	0 30 E	2- 4- 3	" . .	−12·0	−14·0	−2·5	−2·5	"	"	"	18·56	Good.....	H	
" . .	2097	"	"	"	19 12	65	5 15 W	3- 3- 3- 3	" . .	−17·0	−18·5	−3·4	−3·6	"	"	"	"	"	C	
" . .	2104	"	"	Jan. 7	12 11	57	1 55 E	"	" . .	−14·5	−16·0	−9·1	−9·1	"	"	"	18·65	Poor	P	
" . .	2119	"	"	Jan. 11	12 05	85	1 20 E	2- 2- 2- 2	" . .	− 6·1	− 6·6	+1·0	+1·0	"	"	"	18·7	good ½time	P¹	
" . .	2131	"	"	Jan. 13	16 24	60	2 45 W	"	" . .	−15·0	−15·0	−12·0	−12·0	·0016	"	"	18·65	....	H	Good&bad
" . .	2138	"	"	Jan. 15	14 08	63	0 40 W	3- 3- 3- 3	" . .	−12·5	−14·8	−4·4	−4·7	"	"	"	18·5	Good	C	
" . .	2145	"	"	"	16 10	80	2 50 W	4- 4- 4- 4	" . .	−15·6	−16·4	−5·2	−5·3	"	"	"	"	"	C	
" . .	2159	"	"	Jan. 18	10 56	58	2 20 E	3- 3- 3- 3	" . .	−14·5	−15·6	−13·7	−13·8	·0015	"	"	18·7	"	P¹	
" . .	2160	"	"	"	11 55	60	1 20 E	2- 2- 2- 2	" . .	−15·6	−17·4	−13·8	−13·9	"	"	"	"	" . . .	P¹	
" . .	2169	"	"	"	14 52	45	1 30 W	"	" . .	−19·8	−19·8	−13·8	−13·8	"	"	"	"	"	P¹	
" . .	2170	"	"	"	15 45	60	2 30 W	"	" . .	−19·8	−19·8	−13·8	−13·8	"	"	"	"	"	P¹	
" . .	2173	"	"	Jan. 20	11 08	73	1 55 E	3- 3- 3- 3	" .	− 2·5	− 3·5	−1·0	−1·0	·0016	"	"	18·68	Fair......	H	
" . .	2190	"	"	Jan. 28	12 30	60	0 10 E	2- 2- 2- 2	" . .	− 8·0	− 9·6	−7·0	−7·1	"	"	"	"	Good	P¹	
" . .	2191	"	"	"	13 30	60	0 50 W	"	" . .	− 9·6	− 9·5	−7·1	−7·6	"	"	"	"	"	P¹	
" . .	2193	"	"	"	16 28	57	3 40 W	"	" . .	− 9·6	− 9·7	−7·6	−7·7	"	"	"	"	"	P¹	
" . .	2194	"	"	"	17 11	48	4 30 W	"	" . .	− 9·7	− 9 8	−7·7	−7·7	"	"	"	"	"	P¹	
" . .	2223	"	"	Feb. 3	12 37	60	0 20 W	"	" .	− 6·5	− 8·5	−3·2	−3·3	"	"	"	"	"	H	
" . .	2247	"	"	Feb. 8	11 53	73	0 02 E	"	" . .	− 9·8	−10·5	−5·0	−5·1	"	"	"	18·3	"	P¹	
" . .	2255	"	"	"	14 49	62	3 00 W	"	" . .	−13·8	−14·5	−5·3	−5·4	"	"	"	"	"	P¹	

" ..	2256	"	"	"	16	00	70	4 10 W	"	" ..	−14·5	−16·6	−5·4	−5·6	"	"	"	"	" .. .	P1	
" ..	2271	"	"	Feb. 10	14	45	55	3 00 W	"	" ..	− 4·0	− 4·0	−1·8	−1·8	"	"	"	18·35	Poor.. ...	H	Clouds.
" ..	2296	"	"	Feb. 22	14	05	60	3 05 W	"	" ..	− 2·0	− 2·0	+1·1	+1·1	"	"	"	18·85	Good	P1	
" ..	2297	"	"	"	15	06	58	4 00 W	"	" ..	− 2·0	− 2·6	+1·1	+1·1	"	"	"	"	Fair......	P1	
" ..	2307	"	"	Feb. 25	15	25	60	4 35 W	"	" ..	−10·5	−12·0	−1·1	−2·0	·0015	"	"	"	Clear	P1	Windy.
" ..	2308	"	"	"	16	23	53	5 30 W	"	" ..	−12·0	−13·5	−2·0	−2·0	"	"	"	"	"	P1	Unsteady.
" ..	2336	I	"	Mar. 8	13	49	52	3 40 W	1- 1- 1- 2	New Fe V Spark.	− 2·6	− 3·9	3·1	2·5	"	38·5	"	27·70	Good	P1	
" .	2337	"	"	"	14	44	52	4 35 W	2- 1- 1- 2	" ..	− 3·9	− 3·9	2·5	2·6	"	"	"	"	"	P1	
" ..	2353	"	"	Mar. 11	12	53	53	2 58 W	1- 1- 1- 1	" ..	− 3·0	− 2·0	4·8	4·0	·002	"	....	"	"	H	
" ..	2378	"	"	Mar. 15	13	57	46	4 15 W	1½- ½	" ..	− 1·2	− 2·5	1·9	1·9	"	"	....	"	"	P1	
" ..	2407	"	"	Mar. 22	13	42	45	4 27 W	1- 1- 1- 1	" ..	1·3	1·5	5·5	5·5	"	39·0	...	"	"	P1	
" ..	2408	"	"	"	14	31	48	5 15 W	"	" ..	1·5	1·0	5·1	5·7	"	"	...	"	Windy....	P1	
" ..	2427	"	"	Mar. 23	14	52	45	5 37 W	"	" ..	1·0	0·5	7·8	7·6	"	"	....	"	Good	C	
" ..	2775	"	"	Aug. 27	18	25	40	4 30 E	"	" ..	17·0	16·2	22·3	22·2	"	41·5	....	27·69	5	P1	
" ..	2779	"	"	Sept. 7	19	59	36	2 10 E	"	" ..	9·1	8·7	11·5	11·5	"	"	....	27·55	5	P1	
" ..	2780	"	"	"	20	39	46	1 30 E	"	" .	8·7	8·5	11·5	11·6	"	"	....	"	5	P1	
" ..	2798	"	"	Sept. 17	20	30	49	0 50 E	3- 3- 3- 3	" ..	9·8	9·5	21·8	21·7	"	42·2	...	"	5	P1	
" ..	2799	"	"	"	21	40	43	0 40 W	"	" ..	9·5	9·0	21·7	21·7	"	"	....	"	4	P1	Getting hazy.
" ..	2806	"	"	Sept. 20	19	35	42	1 45 E	1- 1- 1- 1	" ..	11·7	11·7	20·2	20·1	"	"	....	"	5	C	
" ..	2807	"	"	"	20	19	40	1 00 E	"	" ..	11·7	11·6	20·1	20·1	"	"	....	"	5	C	
" ..	2821	"	"	Sept. 24	18	37	43	2 35 E	"	" ..	9·4	9·6	12·8	12·6	"	"	....	"	4	P1	
" ..	2829	"	"	Sept. 28	19	41	47	1 10 E	"	" ..	8·5	7·2	10·8	10·8	"	"	....	"	4-5	C	
" ..	2830	"	"	"	20	28	43	0 20 E	"	" ..	7·2	7·5	10·8	10·8	"	"	....	"	4-5	C	
" ..	2846	"	"	Oct. 4	21	25	44	1 00 W	"	" ..	10·0	9·5	22·7	22·6	"	"	....	"	5	H	
" ..	2848	"	"	Oct. 5	18	51	48	1 23 E	"	" ..	11·9	11·5	13·1	13·0	"	"	....	"	5	P1	
" ..	2857	"	"	Oct. 6	18	05	50	2 30 E	"	" ..	14·3	14·0	20·4	20·4	"	"	....	"	5	C	
" ..	2873	"	"	Oct. 8	18	00	45	2 10 E	"	" ..	14·5	14·1	22·7	22·6	"	"	..	"	5	P1	
" ..	2882	"	"	Oct. 12	19	51	43	0 03 E	"	" ..	4·5	4·5	6·6	6·6	"	"	....	"	3-4	H	
" ..	2887	"	"	Oct. 15	21	10	86	1 40 W	"	" ..	4·5	4·4	10·6	10·8	"	"	....	"	4-3-0	P1	Hazy after 15m
" ..	2895	"	"	Oct. 19	20	07	40	0 39 W	"	" .	2·8	2·6	7·9	7·85	"	"	....	"	5	C	
" ..	2896	"	"	"	20	48	40	1 20 W	"	" ..	2·6	2·3	7·85	7·85	"	"	....	"	5	C	
" ..	2905	"	"	Oct. 20	18	44	40	0 40 E	"	" ..	1·8	− 0·2	6·8	6·8	"	"	....	"	5	C	
" ..	2906	"	"	"	19	25	40	....	"	" ..	− 0·2	− 0·1	6·8	6·8	"	"	...	"	4	C	
" ..	2923	"	"	Oct. 29	18	00	50	0 45 E	2- 1- 1	" ..	0·2	0·0	5·9	5·8	·0017	"	....	"	5	H-P1	
" ..	2924	"	"	"	18	44	37	0 10 E	1- 1- 1- 1	" ..	0·0	− 0·8	5·8	5·6	"	"	....	"	5	P1	
" ..	2938	"	"	Nov. 8	22	00	42	3 50 W	"	" ..	1·5	1·5	5·7	5·7	·002	"	....	"	4	H	
" ..	2940	"	"	Nov. 9	19	20	40	1 13 W	"	" ..	− 1·0	− 1·1	0·6	0·8	"	"	....	"	5	C	
" ..	2941	"	"	"	20	03	55	2 10 W	"	" ..	− 1·1	− 0·5	0·8	0·6	"	"	....	"	4-3-2-1	C	
" ..	2946	"	"	Nov. 12	16	54	42	1 00 E	"	" ..	8·5	8·0	15·5	15·5	"	"	....	"	5	H	
" ..	2947	"	"	"	17	38	44	0 15 E	"	" ..	8·0	7·5	15·5	15·5	"	"	....	"	5	H-P1	
" ..	2955	"	"	Nov. 15	18	02	43	0 20 W	4- 4- 5- 4	" ..	2·8	2·0	15·6	15·6	"	"	....	"	5	C	
" ..	2956	"	"	"	19	04	48	1 05 W	4- 4- 4- 4	" ..	2·0	2·0	15·6	15·6	"	"	....	"	5	C	
" ..	2965	"	"	Nov. 18	13	50	43	3 37 E	3- 3- 3- 3	" ..	− 3·0	− 3·0	1·1	1·0	"	"	....	"	3-4-5	H	
" ..	2984	"	"	Nov. 30	19	36	40	2 55 W	3- 3- 2- 2	" ..	− 4·0	− 3·5	4·2	4·2	"	"	....	"	5	C	
" ..	2985	"	"	"	20	17	40	3 36 W	3- 3- 2- 2	" ..	− 3·5	− 3·8	4·2	4·2	"	"	....	"	5	C	
" ..	3001	"	"	Dec. 1	18	32	35	1 50 W	1½-1½-1½-1½	" ..	− 1·2	− 1·4	6·6	6·45	"	"	....	"	5	C	
" ..	3002	"	"	"	19	08	35	2 26 W	"	" ..	− 1·4	− 1·6	6·45	6·45	"	"	....	"	5	C	
" ..	3018	"	"	Dec. 4	18	24	23	1 45 W	1- 1- 1- 1	" ..	0·6	0·5	1·4	1·4	"	"	...	"	4	P	
" ..	3019	"	"	"	18	48	24	2 10 W	"	" ..	0·5	0·4	1·4	1·4	"	"	....	"	4	P	

τ TAURI 1153.

1907. Nov. 18.
G. M. T. 16ʰ 17ᵐ

Observed by J. S. Plaskett.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	54·7052	....	....	....	½	45·2453	·2678	·0291	+30·38
½	53·4135	·4426	·0403	+46·06	2	45·2511	....	....	....
2	53·0848	....	....	....					

Weighted mean.................		+ 38·22
V_a.........................		+ 7·54
V_d.........................		+ ·19
Curvature..........	− ·28	
Radial velocity.................		+ 45·7

τ TAURI 1180.

1907. Dec. 4.
G. M. T. 18ʰ 12ᵐ

Observed by J. S. Plaskett.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	45·2882	....	....	....	2	27·2432	....	....	....
½	45·2452	·2306	·0081	− 8·45	½	15·4313	·4490	·0243	−17·35
¼	27·3502	·3535	·0684	−59·36	2	15·3809	....	....	....

Weighted mean.................	− 22·18
V_a.........................	− 5·99
V_d.........................	− ·11
Curvature..................	− ·28
Radial velocity.................	−28·6

τ TAURI 1181.

1907. Dec. 4.
G. M. T. 18ʰ 57ᵐ

Observed by J. S. Plaskett.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	54 7475	....	....	....	2	27 2258	....	....	....
½	53·3462	·3432	·0591	−67·55	1	20·7068	·7350	·0456	−37·12
2	53·1146	....	....	....	2	20·4916	....	....	....
2	45·2640	....	....	....	⅛	15·3515	·3913	·0820	−63·46
½	45·2234	·2330	·0057	− 5·95	2	15·3588	....	....	....
½	27·3650	·3857	·0362	−31·42					

Weighted mean.................	− 8·91
V_a.........................	− 5·99
V_d.........................	− ·16
Curvature..................	− ·28
Radial velocity.................	−44·8

τ TAURI 1181.*

1907. Dec. 4.
G. M. T. 18ʰ 57ᵐ

Observed by J. S. Plaskett.
Measured by T.H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	73·0669	......	......	......	2	27·2626	......	......	......
½	72·9048	·8464	·0184	−26·70	½	20·7725	·7580	·0226	18·30
2	72·5046	......	......	......	2	20·5345	......	......	......
2	45·3059	......	......	......	½	15·4542	·4538	·0195	−15·09
½	45·2623	·2300	·0087	9·08	2	15·3990	......	......	......
½	27·4236	·4073	·0053	4·60					

Weighted mean.................... −14·36
V_a.............................. − 5·99
V_d.............................. − ·16
Curvature.......................... − ·28

Radial velocity.................... −20·8

*Check measurement.

τ TAURI 1225.

1908. Jan. 14.
G. M. T. 11ʰ 56ᵐ

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	53·4397	·3947	·0076	− 8·69	½	27·4915	·4410	·0200	+17·36
2	53·1565	......	......	......	2	27·2970	......	......	......
2	45·3150	......	......	......	½	20·8635	·8095	·0290	+23·61
1½	45·3003	·2590	·0203	+21·19	2	20·5742	......	......	......

Weighted mean.................. + 7·75
V_a.................... −20·39
V_d.......................... + ·17
Curvature.......... − ·28

Radial velocity,........ − 12·7

τ TAURI 1226.

1908. Jan. 14.
G. M. T. 12h 35m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	73·0420	....	....	....	2	45·2701	....	....	....
1	72·9274	·8951	·0303	+43·96	½	30·8825	·8877	·0121	+10·86
2	72·4746	....	....	....	2	30·8652	....	....	....
2	54·0365	....	....	....	1	27·4230	·4320	·0100	+ 8·68
1	54·0100	·0023	·0325	+37·41	2	27·2377	....	....	....
1	53·4042	·3992	·0030	− 3·43	1	20·7740	·7853	·0047	+ 3·83
2	53·1157	....	....	....	2	20·5086	....	....	....
2	48·7667	....	....	....	½	15·4580	·4684	·0049	− 3·79
½	48·3168	·3193	·0086	+ 9·29	2	15·3882	....	....	....
1½	45·2761	·2796	·0409	+42·70					

Weighted mean.................		+20·33
V_a.................	−20·39	
V_d.........................		+ ·12
Curvature..........	− ·28	
Radial velocity.........	− 0·2	

τ TAURI 1232.

1908. Jan. 16.
G. M. T. 11h 12m

Observed by J. S. Plaskett.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	73·0535	....	....	....	2	45·3530	·3357	·0970	80·39
1	72·9628	·9190	·0542	+78·64	2	45·2909	....	....	....
2	72·4889	....	....	....	1	27·5473	·5350	·1131	98·17
1½	54·0620	....	....	....	2	27·2590	....	....	....
1	53·5091	·4814	·0791	90·41	1	20·8867	·8757	·0951	+77·13
2	53·1377	....	....	....	2	20·5307	....	....	....

Weighted mean.................		+84·59
V_a.................	−21·14	
V_d.........................		+ ·20
Curvature..........	− ·28	
Radial velocity.................		+63·4

τ TAURI 1256.

1908. Jan. 22.
G. M. T. 14h 50m

Observed by } W. E. Harper.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	73·0469	....	....	....	1	45·3242	·3268	·0881	91·98
½	72·9487	·9135	·0487	+70·66	2	45·2710	....	....	....
2	72·4756	....	....	....	½	27·4822	·5014	·0795	69·00
2	54·0379	....	....	....	2	27·2272	....	....	....
1	53·4620	·4548	·0525	60·00	1	20·8343	·8623	·0817	66·50
2	53·1182	....	....	....	2	20·4917	....	....	....
2	48·7683	....	....	....	½	15·5062	·5413	·0680	+52·63
½	48·4032	·4013	·0906	97·85	2	15·3636	....	....	....

Weighted mean..................		+72·71
V_a..................	−23·81	
V_d..................	− ·09	
Curvature..........	− ·28	
Radial velocity..................		+48·5

τ TAURI 1270.

1908. Jan. 24.
G. M. T. 12h 14m

Observed by J. S. Plaskett.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9880	....	....	....	1	45·2404	·2562	·0175	18·27
1	72·8501	·8706	·0058	+ 8·42	2	45·2578	....	....	....
2	72·4282	....	....	....	¼	27·4372	·4366	·0147	12·76
2	54·7254	....	....	....	2	27·2474	....	....	....
½	53·4032	·4188	·0165	18·86	½	20·8092	·8045	·0239	+19·45
2	53·0967	....	....	....	2	20·5249	....	....	....

Weighted mean..................		+15·08
V_a..................	−24·14	
V_d..................		+ ·11
Curvature..........	− ·28	
Radial velocity.........	− 9·2	

τ TAURI 1270.*

1908. Jan. 24.
G. M. T. 12h 14m

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·0001	....	....	....	1	45·2589	·2518	·0131	13·67
½	72·8711	·8779	·0131	+19·01	½	27·4428	·4173	·0047	4·08
2	72·4468	....	....	....	2	27·2721	....	....	....
2	54·7451	....	....	....	½	20·8347	·8062	·0256	20·84
1	53·4108	·4055	·0032	3·68	2	20·5485	....	....	....
2	53·1178	....	....	....	½	15·5395	·5078	·0345	+26·70
2	45·2807	....	....	....	2	15·4303	....	....	....

Weighted mean.................		+ 8·78
V_a..................	−24·14	
V_d..........................		+ ·11
Curvature..........	− ·28	
Radial velocity.........	− 15·5	

*Check measurement.

τ TAURI 1297.

1908. Jan. 29.
G. M. T. 12h 01m

Observed by W. E. Harper.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	73·0013	....	....	....	½	45·2154	·2463	·0076	7·94
¼	72·8609	·8688	·0040	+5·80	2	45·2427	....	....	
2	72·4386	....	....	....	¼	27·4162	·4438	·0219	19·00
2	54·7155	....	....	....	2	27·2190	....	....	
1	53·3767	·4049	·0026	2·97	¼	20·7476	·7736	·0070	+5·70
2	53·0834	....	....	....	2	20·4941	....	....	

Weighted mean.................		+6·47
V_a..................	−25·45	
V_d..........................		+ ·13
Curvature..........	— ·28	
Radial velocity.........	− 19·1	

τ TAURI 1297.*

1908. Jan. 29.
G. M. T. 12h 01m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	54·7565	....	....	....	½	45·2475	·2372	·0015	− 1·56
¼	54·0162	·0024	·0326	+37·52	½	27·4463	·4317	·0191	+16·58
½	53·4152	·4019	·0004	+ 0·46	2	27·2612	....	....	....
2	53·1250	....	....	....	½	20·7805	·7767	·0139	−11·31
2	48·7814	....	....	....	2	20·5338	....	....	....
½	48·3269	·3155	·0048	+ 5·18	½	30·8451	·8513	·0243	−20·82
2	45·2839	....	....	....	2	30·8642	....	....	....

Weighted mean..................		+1·12
V_a..................	−25·45	
V_d..........................		+ ·13
Curvature..........	− ·28	
Radial velocity.........	−24·5	

* Check measurement.

τ TAURI 1298.

1908. Jan. 29.
G. M. T. 12h 34m

Observed by W. E. Harper.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9941	....	....	....	1	45·1673	·1952	·0435	−45·41
1	72·8168	·8320	·0328	−47·59	2	45·2457	....	....	....
2	72·4307	....	....	....	½	27·4037	·4284	·0065	+ 5·64
2	54·7199	....	....	....	2	27·2219	....	....	....
1	53·3581	·3803	·0220	−25·15	½	20·7569	·7795	·0011	−0·90
2	53·0898	....	....	....	2	20·4975	....	....	....

Weighted mean.........	−28·95	
V_a..................	−25·45	
V_d..........................		+·08
Curvature..........	− ·28	
Radial velocity.........	− 54·6	

τ TAURI 1298.*

1908. Jan. 29.
G. M. T. 12h 34m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	73·0046	....	....	....	2	45·2568	....	....	....
½	72·8550	·8596	·0052	− 7·54	1	45·2359	·2527	·0140	+14·61
2	72·4410	....	....	....	½	27·4083	·4206	·0080	+ 6·94
2	54·7297	....	....	....	2	27·2345	....	....	....
¼	53·9745	·9882	·0184	+21·18	½	20·7631	·7729	·0077	− 5·27
2	53·0970	....	....	....	2	20·5102	....	....	....
2	48·7523	....	....	....	½	15·4709	·4797	·0064	+ 4·79
½	48·3208	·3385	·0278	+30·02	2	15·3898	....	....	....

Weighted mean.................		+ 9·18
V_a..................	−25·45	
V_d..........................		+ ·08
Curvature..........	− ·28	
Radial velocity.........	− 16·5	

*Check measurement.

τ TAURI 1310.

1908. Feb. 3.
G. M. T. 12h 13m

Observed by W. E. Harper.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	54·7015	....	....	....	⅛	27·4312	·4514	·0295	25·60
½	53·4573	·5006	·0983	+112·36	2	27·2267	....	....	....
2	53·0678	....	....	....	¼	20·8510	·8632	·0826	+67·24
½	45·2619	·2999	·0612	63·90	2	20·5082	....	....	....
2	45·2356	....	....	....					

Weighted mean.................		+78·65
V_a..................	−26·74	
V_d..........................		+ ·05
Curvature..........	− ·28	
Radial velocity.................		+ 51·7

τ TAURI 1310.*

1908. Feb. 3.
G. M. T. 12h 13m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	54·7415	....	....	....	2	45·2832	....	....	....
½	53·4615	·4582	·0559	+63·95	¼	27·5075	·4782	·0656	56·94
2	53·1167	....	....	....	2	27·2759	....	....	....
1	48·7764	....	....	....	¼	20·9350	·9027	·1221	+99·39
¼	48·3984	·3920	·0813	87·80	2	20·5523	....	....	....
1	45·3174	·3078	·0691	72·14					

Weighted mean.................		+73·42
V_a.................	−26·74	
V_d........................		+ ·05
Curvature..........	− ·28	
Radial velocity.................		+ 46·4

*Check measurement.

τ TAURI 1311.

1908. Feb. 3.
G. M. T. 12h 45m

Observed by W. E. Harper.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	73·0001	....	....	....	1	45·3090	·3072	·0685	71·51
½	72·9465	·9557	·0909	+131·90	2	45·2754	....	....	....
2	72·4398	....	....	....	½	27·4826	·4905	·0686	59·54
2	54·7247	....	....	....	2	27·2386	....	....	....
½	53·4597	·4758	·0735	84·01	½	20·8986	·9046	·1240	+100·94
2	53·0962	....	....	....	2	20·5141	....	....	....

Weighted mean.................		+89·58
V_a.................	−26·74	
V_d.................	·00	
Curvature..........	− ·28	
Radial velocity.................		+ 62·6

τ TAURI 1323.

1908. Feb. 17.
G. M. T. 14h 22m

Observed by W. E. Harper.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
1	73·0562	....	....	....	2	45·3101	....	....	....
½	72·9671	·9208	·0560	+81·26	1	40·3405	·3040	·0942	93·16
1	54·7818	....	....	....	1	27·5530	·5149	·0930	80·72
1½	53·4745	·4341	·0318	36·35	2	27·2849	....	....	....
2	53·1525	....	....	....	1½	20·8760	·8364	·0558	45·42
2	48·8111	....	....	....	2	20·5596	....	....	....
1½	48·4372	·3967	·0860	92·88	½	15·6175	·5779	·1046	+80·96
2	45·3346	·2981	·0593	61·91	2	15·4382	....	....	....

Weighted mean................		+67·45
V_a..................	−29·27	
V_d..................	− ·19	
Curvature..........	− ·28	
Radial velocity................		+ 37·7

τ TAURI 1323.*

1908. Feb. 17.
G. M. T. 14h 22m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	73·0134	....	....	....	1	45·2865	·2957	·0570	59·51
¼	72·9139	·9088	·0440	+63·40	2	45·2644	....	....	....
1	72·4565	....	....	....	1	27·4904	·4995	·0869	75·43
2	54·7388	....	....	....	2	27·2375	....	....	....
½	54·0446	·0478	·0780	89·78	1	20·8365	·8440	·0634	51·61
½	53·4270	·4305	·0282	32·26	2	20·5125	....	....	....
2	53·1083	....	....	....	¼	15·5277	·5364	·0631	+48·84
2	48·7690	....	....	....	2	15·3899	....	....	....
½	48·3844	·3855	·0748	80·78					

Weighted mean.............		+63·20
V_a..................	−29·27	
V_d..................	− ·19	
Curvature..........	− ·28	
Radial velocity................		+33·5

*Check measurement.

τ TAURI 1324.

1908. Feb. 17.
G. M. T. $14^h\ 58^m$

Observed by W. E. Harper.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	54·7023	....	....	....	½	27·4415	·4716	·0497	43·13
1	53·4503	·4870	·0847	+96·81	2	27·2165	....	....	....
2	53·0761	....	....	....	½	20·8301	·8571	·0765	+62·27
2	45·2379	....	....	....	2	20·4931	....	....	....
1	45·2187	·2544	·0157	16·39					

Weighted mean.................		+55·30
V_a..................	−29·27	
V_d..................	− ·22	
Curvature..........	− ·28	
Radial velocity.................		+25·5

τ TAURI 1345.

1908. Feb. 22.
G. M. T. $12^h\ 31^m$

Observed by J. S. Plaskett.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	73·0030	....	....	....	2	45·2531	....	....	....
½	72·8533	·8582	·0066	− 9·58	1	45·2166	·2371	·0016	− 1·67
2	72·4452	....	....	....	2	30·8542	....	....	....
2	54·7252	....	....	....	½	30·8427	·8589	·0167	−15·00
1	53·3779	·3922	·0101	−11·54	¼	27·3507	·3737	·0482	−41·84
2	53·0982	....	....	....	2	27·2234	....	....	....
2	48·7528	....	....	....	½	20·7640	·7862	·0016	+ 4·59
1	48·3166	·3146	·0039	+ 4·17	2	20·4978	....	....	....

Weighted mean..................	− 6·21
V_a..........................	−29·70
V_d..........................	− ·09
Curvature....................	− ·28
Radial velocity..................	− 36·3

τ TAURI 1350.

1908. Feb. 24. G. M. T. 13ʰ 24ᵐ

Observed by J. S. Plaskett.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9941	....	....	....	1	45·3560	·3152	·0765	79·87
1	72·8814	·8952	·0304	+44·11	¼	30·9822	·9025	·0269	24·16
2	72·4387	....	....	....	2	30·9501	....	....	....
2	54·7600	....	....	....	½	27·5649	·4772	·0553	48·00
2	53·4946	·4743	·0720	82·30	2	27·3348	....	....	....
2	53·1329	....	....	....	1	20·9536	·8491	·0685	+55·76
2	45·3144	....	....	....	2	20·6253	....	....	....

Weighted mean................. +65·11
V_a.................. −29·86
V_d.................. − ·16
Curvature.......... − ·28

Radial velocity................. +34·8

τ TAURI 1374.

1908. Mar. 4. G. M. T. 13ʰ 38ᵐ

Observed by W. E. Harper.
Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	73·0031	....	....	....	1½	48·3030	·3623	·0516	55·73
1	72·8846	·8908	·0260	+37·73	½	45·2370	·3015	·0628	65·56
2	72·4406	....	....	....	2	45·2091	....	....	....
2	54·6915	....	....	....	½	27·3421	·4335	·0116	10·07
1½	53·3889	·4353	·0330	37·72	2	27·1549	....	....	....
2	53·0666	....	....	....	½	20·7382	·8378	·0572	+46·56
2	48·7114	....	....	....	2	20·4201	....	....	....

Weighted mean................. +43·45
V_a.................. −29·97
V_d.................. − ·20
Curvature.......... − ·28

Radial velocity................. +13·0

τ TAURI 1374.*

1908. Mar. 4. Observed by W. E. Harper.
G. M. T. $13^h\ 38^m$ Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	73·0838	....	....	....	1	45·2987	·2804	·0417	43·53
¼	72·9648	·8894	·0246	+35·69	2	45·2919	....	....	....
2	72·5257	....	....	....	1	27·4495	·4596	·0470	40·80
2	54·7799	....	....	....	2	27·2365	....	....	....
1	54·0353	·9993	·0295	33·95	½	20·8292	·8490	·0684	55·68
½	53·4525	·4175	·0152	17·39	2	20·5002	....	....	....
2	53·1464	....	....	....	½	15·5013	·5266	·0533	+41·25
2	48·7997	....	....	....	2	15·3733	....	....	....
½	48·3861	·3564	·0457	49·36					

Weighted mean.................		+39·85
V_a.................	−29·97	
V_d.................	− ·20	
Curvature..........	− ·28	
Radial velocity.................		+ 9·4

*Check measurement.

τ TAURI 1383.

1908. Mar. 9. Observed by J. S. Plaskett.
G. M. T. $12^h\ 51^m$ Measured by C. R. Westland.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	73·0302	....	....	....	2	45·2686	·3081	·0694	72·45
¼	72·9096	·8899	·0251	+36·42	2	45·2341	....	....	....
2	72·4623	....	....	....	¼	30·9162	·9783	·1027	92·22
2	54·7178	....	....	....	2	30·8081	....	....	....
1	53·4216	·4464	·0441	50·40	¼	27·4040	·4692	·0473	41·06
2	53·0871	....	....	....	2	27·1812	....	....	....
2	48·7342	....	....	....	1	20·7668	·8398	·0592	+48·19
1	48·3826	·4188	·1081	116·75	2	20·4466	....	....	....

Weighted mean.................		+70·03
V_a.................	−30·98	
V_d.................	− ·18	
Curvature..........	− ·28	
Radial velocity.................		+38·6

τ TAURI 1394.

1908. Mar. 11.
G. M. T. 13ʰ 06ᵐ

Observed by W. E. HARPER.
Measured by C. R. WESTLAND.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	54·7212	....	....	....	¼	27·4568	·4370	·0151	+13·10
1½	53·3653	·3830	·0193	−22·06	2	27·2667	....	....	....
2	53·0949	....	....	....	1	20·7872	·7558	·0248	−20·19
2	48·7572	....	....	....	2	20·5517	....	....	....
1	48·2433	·2553	·0554	−59·83	½	15·4759	·4400	·0333	−25·77
1	45·2677	·2752	·0365	+38·10	2	15·4347	....	....	....
2	45·2661	....	....	....					

Weighted mean..................	−16·12
V_a..........................	−31·14
V_d..........................	− ·21
Curvature......................	− ·28
Radial velocity................	− 47·7

τ TAURI 1889.

1908. Sept. 14.
G. M. T. 19ʰ 47ᵐ

Observed by / Measured by } T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	54·7230	....	....	....	½	45·2599	·2688	·0301	+31·42
½	53·4032	·4262	·0239	+27·45	2	45·2657	....	....	....
2	53·0880	....	....	....					

Weighted mean..................	+29·44
V_a..........................	+29·08
V_d..........................	+ ·12
Curvature.......... — ·28	
Radial velocity................	+ 58·4

τ TAURI 1913.

1908. Oct. 2.
G. M. T. 20ʰ 02ᵐ

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	54·7358	....	....	....	2	45·2902	....	....	....
½	53·4288	·4300	·0277	+31·66	½	45·2597	·2431	·0044	4·59
2	53·1121	....	....	....	2	43·5533	....	....	....
2	48·7811	....	....	....	½	30·9679	·9034	·0278	+24·13
½	48·3657	·3546	·0439	47·41	2	30·9349	....	....	....

Weighted mean.................. +26·95
V_a......................... +25·82
V_d......................... + ·09
Curvature.......... — ·28

Radial velocity.............. + 52·6

τ TAURI 1923.

1908. Oct. 9.
G. M. T. 19ʰ 45ᵐ

Observed by / Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	54·7399	....	....	....	½	45·1963	·1798	·0589	61·49
½	53·3639	·3630	·0393	−44·92	½	27·4183	·3521	·0605	52·51
2	53·1150	....	....	....	2	27·3128	....	....	....
2	48·7800	....	....	....	½	20·8522	·7385	·0421	−34·27
½	48·2812	·2702	·0405	43·74	2	20·6337	....	....	....
2	45·2901	....	....	....					

Weighted mean......... −50·66
V_a......................... +23·91
V_d......................... + ·05
Curvature.......... — ·28

Radial velocity. . . . — 28·0

τ TAURI 1929.

1908. Oct. 12.
G. M. T. $18^h\ 32^m$

Observed by} Measured by} T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9717	....	....	....	½	48·2380	·2370	·0737	79·45
½	72·8006	·8387	·0261	−37·87	2	45·2822	....	....	....
2	72·4067	....	....	....	1	45·2137	·2051	·0336	35·08
2	54·7314	....	....	....	½	27·4424	·3863	·0263	22·83
1	53·9448	·9532	·0166	19·11	2	27·3027	....	....	....
½	53·3451	·3514	·0509	58·30	½	20·7752	·6937	·0869	−70·74
2	53·1057	....	....	....	2	20·6015	....	....	....
2	48·7710	....	....	....					

Weighted mean.........	−41·95	
V_a........................		+22·98
V_d........................		+ ·12
Curvature..........	− ·28	
Radial velocity.........	− 19·1	

τ TAURI 1940.

1908. Oct. 19.
G. M. T. $18^h\ 00^m$

Observed by} Measured by} T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	54·7245	....	....	....	2	45·2687	....	....	....
½	53·9620	·9794	·0096	+11·05	½	45·2427	·2476	·0089	+ 9·29

Weighted mean.................		+10·17
V_a........................		+20·59
V_d........................		+ ·09
Curvature..........	− ·28	
Radial velocity.................		+30·6

τ TAURI 1945.

1908. Oct. 30.
G. M. T. 17^h 10^m

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9638	....	....	....	1	48·2660	·2693	·0414	−44·71
½	72·7680	·8125	·0523	−75·88	2	45·2702	....	....	....
2	72·4052	....	....	....	1	45·2058	·2092	·0295	−30·80
2	54·7385	....	....	....	2	30·9134	....	....	....
½	53·9079	·9083	·0615	−70·78	1	30·8788	·8358	·0398	−35·53
1	53·3570	·3662	·0361	−41·19	½	27·3904	·3399	·0724	−62·84
2	53·1028	....	....	....	2	27·2971	....	....	....
2	48·7667	....	....	....					

Weighted mean.........	−46·72	
V_a.........................		+16·16
V_d.........................		+ ·09
Curvature..........	− ·28	
Radial velocity.........	− 30·7	

τ TAURI 1973.

1908. Nov. 20.
G. M. T. 18^h 47^m

Observed by, Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9961	....	....	....	2	48·8160	....	....	....
½	72·8537	·8669	·0021	+ 3·04	¼	48·3253	·2771	·0326	−36·48
2	72·4330	....	....	....	2	45·3347	....	....	....
2	54·7687	....	....	....	½	45·2923	·2312	·0075	− 7·83
1	53·9891	·9607	·0041	− 4·72	½	27·5186	·3866	·0260	−22·47
½	53·3895	·3594	·0429	−49·08	2	27·3786	....	....	....
2	53·1421	....	....	....					

Weighted mean.........	−16·02	
V_a.........................		+ 6·04
V_d.........................	− ·09	
Curvature..........	− ·28	
Radial velocity.........	− 10·3	

τ TAURI 1973.*

1908. Nov. 20.
G. M. T. 18h 47m

Observed by} Measured by} T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9873	....	....	....	2	45·3257	....	....	....
½	72·8548	·8760	·0112	+16·25	1	45·2805	·2284	·0103	−10·75
2	72·4275	....	....	....	½	27·5171	·3918	·0208	−18·05
2	54·7567	....	....	....	2	27·3719	....	....	....
1	53·3835	·3667	·0356	−40·73	1	20·8779	·7217	·0589	−47·84
2	53·1307	....	....	....	2	20·6762	....	....	....

Weighted mean.........	−25·05	
V_a........................		+6·04
V_d..................	− ·09	
Curvature..........	− ·28	
Radial velocity.........	− 19·4	

*Check measurement.

τ TAURI 2000.

1908. Dec. 4.
G. M. T. 18h 02m

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·8657	....	....	....	2	30·9562	....	....	....
½	72·7337	·8808	·0160	+23·22	1	30·9462	·8604	·0152	13·65
2	72·2890	....	....	....	½	27·5170	·4148	·0022	+ 1·91
2	45·2620	....	....	....	2	27·3489	....	....	....
1	45·2433	·2549	·0162	16·91					

Weighted mean................		+ 14·71
V_a..................	− 1·23	
V_d..................	− ·11	
Curvature..........	− ·28	
Radial velocity................		+ 13·0

τ TAURI 2008.

1908. Dec. 7
G. M. T. 19ʰ 30ᵐ

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9295				2	45·2943			
½	72·9924	·8725	·0077	+11·07	1	45·2534	·2327	·0060	− 6·26
2	72·3653				1	31·9955	·8967	·0052	+ 4·67
2	54·7202				2	30·9692			
½	66·1165	·1768	·0111	−14·78	½	27·5246	·4105	·0021	− 1·82
1	53·3750	·3922	·0101	−11·55	2	27·3607			
2	53·0949								

Weighted mean......... − 3·38
V_a................. − ·98
V_d................. − ·21
Curvature.......... − ·28

Radial velocity......... − 4·8

τ TAURI 2031.

1908. Dec. 16.
G. M. T. 16ʰ 09ᵐ

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	54·7272				2	45·2812			
½	53·4074	·4206	·0183	+20·94	¼	45·2674	·2598	·0211	+22·03
2	53·1002								

Weighted mean................. + 21·29
V_a................. − 7·44
V_d................. ·00
Curvature.......... − ·28

Radial velocity................. + 13·6

τ TAURI 2031. *

1908. Dec. 16.
G. M. T. 16ʰ 09ᵐ

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	54·6646				2	45·2364			
½	53·3393	·4054	·0031	+ 3·55	½	45·2072	·2444	·0057	+ 5·95
2	53·0398								

Weighted mean................. + 4·75
V_a................. − 7·44
V_d................. ·00
Curvature.......... − ·28

Radial velocity......... − 3·0

* Check measurement.

τ TAURI 2032.

1908. Dec. 16.
G. M. T. 17h 10m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	54·7235	....	....	....	2	45·2939	....	....	....
½	53·3929	·4121	·0098	+11·21	½	45·2589	·2386	·0001	− 0·10
2	53·0926	....	....	....					

Weighted mean.................		+11·11
V_a..................	− 7·47	
V_d..................	− ·09	
Curvature..........	− ·28	
Radial velocity.................		+3·3

τ TAURI 2046.

1908. Dec. 18.
G. M. T. 16h 37m

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·8840	....	....	....	2	45·2752	....	....	....
½	72·7756	·8144	·0423	+61·50	1	45·3155	·3339	·0750	78·75
2	72·2964	....	....	....	1	27·6342	·6703	·0993	79·01
2	54·6929	....	....	....	2	27·3610	....	....	....
½	53·9820	·0016	·0584	67·51	½	20·9875	·0421	·0533	43·76
1	53·3766	·3972	·0190	21·83	2	20·6760	....	....	....
2	53·0682	....	....	....	½	15·7635	·8349	·1018	+79·60
2	48·7520	....	....	....	2	15·5877	....	....	....
½	48·3897	·4077	·0945	102·53					

Weighted mean..................		+ 64·95
V_a..................	− 8·48	
V_d..................	− ·09	
Curvature..........	− ·28	
Radial velocity.................		+ 56·1

τ TAURI 2049.

1908. Dec. 18.
G. M. T. 18^h 07^m

Observed by / Measured by } T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Rev^{ns}.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·8856				1	45·3137	·3331	·0742	77·91
½	72·7923	·8233	·0512	+74·44	1	31·0548	·0836	·0873	79·00
2	72·3229				2	30·9622			
2	54·6889				1	27·5912	·6277	·0567	49·61
1	53·4311	·4530	·0748	85·94	2	27·3606			
2	53·0675				1	20·0236	·0730	·0842	69·13
2	48·7510				2	20·6812			
1	48·3807	·3997	·0865	93·85	½	15·7108	·7808	·0477	+37·30
2	45·2742				2	15·5891			

Weighted mean		+ 73·04
V_a	− 8·48	
V_d	− ·14	
Curvature	− ·28	
Radial velocity		+ 64·0

τ TAURI 2056.

1908. Dec. 21.
G. M. T. 16^h 10^m

Observed by / Measured by } T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9024				2	45·2693			
½	72·7854	·7988	·0267	+38·82	½	45·2902	·3145	·0556	58·38
2	72·3408				½	27·5377	·5945	·0327	28·64
2	54·7012				2	27·3403			
½	54·0043	·0164	·0732	84·62	½	20·9772	·0590	·0702	+57·70
½	53·4106	·4236	·0454	52·16	2	20·6488			
2	53·0753								

Weighted mean		+ 53·38
V_a	−10·02	
V_d	− ·11	
Curvature	− ·28	
Radial velocity		+ 43·0

τ TAURI 2056*

1908. Dec. 21.
G. M. T. 16h 10m

Observed by / Measured by } T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·8513	....	....	....	2	45·2173	....	....	....
½	72·7510	·8160	·0439	+63·83	½	45·2737	·3500	·0911	95·65
2	72·2884	....	....	....	½	27·5207	·6279	·0661	57·90
2	54·6503	....	....	....	2	27·2899	....	....	....
½	53·9388	·0023	·0591	68·32	½	20·9226	·0550	·0662	+54·42
½	53·3810	·4468	·0686	78·82	2	20·5982	....	....	....
2	53·0225	....	....	....					

Weighted mean................ +69·83
V_a..................−10·02
V_d..................− ·11
Curvature..........− ·28

Radial velocity................ +59·5

*Check measurement.

τ TAURI 2059.

1908. Dec. 21.
G. M. T. 17h 55m

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·8948	....	....	....	2	48·7704	....	....	....
½	72·7929	·9065	·0417	+60·51	½	48·3427	·3423	·0316	34·13
2	72·3382	....	....	....	2	45·2900	....	....	....
2	54·7124	....	....	....	½	45·3155	·2991	·0604	63·06
½	54·0045	·0300	·0602	69·29	½	27·6072	·4861	·0735	+63·70
1	53·4057	·4287	·0264	30·22	2	27·3677	....	....	....
2	53·0902	....	....	....					

Weighted mean................ +47·52
V_a..................−10·02
V_d..................− ·14
Curvature..........− ·28

Radial velocity................ +37·1

τ TAURI 2059*

1908. Dec. 21.
G. M. T. $17^h\ 55^m$

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	54·7040	....	....	....	2	45·2830	....	....	....
½	53·4275	·4345	·0560	+64·34	½	27·5955	·6362	·0744	+65·13
2	53·0827	....	....	....	2	27·3564	....	....	....
½	45·3124	·3230	·0641	67·31					

Weighted mean................ +63·65
V_a..................−10·02
V_d..................− ·14
Curvature..........− ·28

Radial velocity................ +53·2

*Check measurement.

τ TAURI 2081.

1908. Dec. 31.
G. M. T. $14^h\ 30^m$

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9200	....	....	....	2	45·2688	....	....	....
½	72·7770	·8198	·0011	− 1·59	½	45·2415	·2563	·0076	+ 7·96
2	72·3572	....	....	....	½	30·9369	·9322	·0036	− 3·33
2	54·7030	....	....	....	2	30·9354	....	....	....
¼	53·3586	·3808	·0094	−10·77	¼	27·4959	·4902	·0030	+ 2·62
2	53·0789	....	....	....	2	27·3276	....	....	....
2	48·7562	....	....	....	¼	20·8592	·8462	....	....
½	48·2930	·3068	·0051	− 5·52	2	20·6385	....	....	....

Weighted mean..........− 0·84
V_a..................−14·77
V_d.......................... + ·04
Curvature..........− ·28

Radial velocity..........− 15·8

τ TAURI 2086.

1909. Jan. 2.
G. M. T. 12h 46m

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9349	....	....	....	½	48·4172	·3998	·0866	93·96
½	72·8420	·8243	·0522	+75·90	1	45·3524	·2589	·0807	84·74
2	72·3695	....	....	....	2	45·3064	....	....	....
2	54·7303	....	....	....	½	27·6126	·6231	·0613	53·64
1	53·4474	·4281	·0500	57·45	2	27·3866	....	....	....
2	53·1097	....	....	....	½	21·0446	·0726	·0838	+68·88
2	48·7874	....	....	....	2	20·7026	....	....	....

Weighted mean.................		+72·09
V_a.................	−15·65	
V_d.................		+ ·14
Curvature...........	− ·28	
Radial velocity.................		+56·3

τ TAURI 2086.*

1909. Jan. 2.
G. M. T. 12h 46m

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·8922	....	....	....	1	45·3138	·3219	·0832	86·86
½	72·7980	·9143	·0495	+71·82	2	45·2655	....	....	....
2	72·3325	....	....	....	½	27·5869	·4923	·0797	69·18
2	54·6902	....	....	....	2	27·3412	....	....	....
1	53·4154	·4631	·0608	69·55	1	21·0334	·8927	·1121	+91·25
2	53·0653	....	....	....	2	20·6607	....	....	....

Weighted mean.................		+79·54
V_a.................	−15·65	
V_d.................		+ ·14
Curvature...........	− ·28	
Radial velocity.................		+63·7

*Check measurement.

τ TAURI 2086*

1909. Jan. 2.
G. M. T. 12ʰ 46ᵐ

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·8987	....	....	....	¼	48·3827	·4021	·0889	96·46
¼	72·7728	·7912	·0191	+27·77	1	45·3133	·3392	·0803	84·31
2	72·3337	....	....	....	2	45·2677	....	....	....
2	54·6962	....	....	....	½	27·5623	·6127	·0509	44·54
½	53·4087	·4256	·0474	54·46	2	27·3467	....	....	....
2	53·0716	....	....	....	½	21·0002	·0682	·0794	+65·19
2*	48·7506	....	....	....	2	20·6626	....	....	....

Weighted mean.................. +65·82
V_a....................−15·65
V_d.......................... + ·14
Curvature............− ·28

Radial velocity.................. +50·0

*Check measurement.

τ TAURI 2090.

1909. Jan. 6.
G. M. T. 13ʰ 30ᵐ

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9267	....	....	....	1	45·2665	·2595	·0007	+ 0·73
½	72·7850	·7750	·0029	+ 4·22	½	27·5058	·5378	·0332	−29·05
2	72·3633	....	....	....	2	27·3651	....	....	....
2	54·7219	....	....	....	1	20·9009	·9515	·0373	−30·62
½	53·9773	·9648	·0216	+24·97	2	20·6800	....	....	....
1	53·3932	·3795	·0013	+ 1·49	½	15·6442	·7157	·0174	−12·61
2	53·1037	....	....	....	2	15·5876	....	....	....
2	45·3006	....	....	....					

Weighted mean..........− 4·93
V_a....................−17·44
V_d.......................... + 0·09
Curvature...........− ·28

Radial velocity ....− 22·6

τ TAURI 2097.

1909. Jan. 6.
G. M. T. 19^h 12^m

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9025	…	…	…	2	45·2942	…	…	…
½	72·7427	·7567	·0154	−22·39	1	45·2540	·2524	·0065	− 6·82
2	72·3394	…	…	…	½	27·5469	·5754	·0044	+ 3·85
2	54·7157	…	…	…	2	27·3686	…	…	…
½	53·9524	·9500	·0068	+ 7·86	½	20·8885	·9341	·0547	−46·79
1	53·3533	·3520	·0262	−30·10	2	20·6850	…	…	…
2	53·0898	…	…	…					

Weighted mean	−16·42
V_a	−17·44
V_d	− ·29
Curvature	− ·25
Radial velocity	−34·4

τ TAURI 2104.

1909. Jan. 7.
G. M. T. 11^h 10^m

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9032	…	…	…	1	45·2723	·2930	·0341	35·80
½	72·7707	·7822	·0101	+14·68	½	31·0053	·0410	·0447	40·50
2	72·3438	…	…	…	2	30·9553	…	…	…
2	54·7025	…	…	…	½	27·5302	·5824	·0114	+ 9·98
½	53·9693	·9791	·0359	41·50	2	27·3449	…	…	…
½	53·3900	·4003	·0221	25·39	1	20·8720	·9448	…	…
1	53·0786	…	…	…	2	20·6578	…	…	…
2	45·2729	…	…	…					

Weighted mean		+29·09
V_a	−17·83	
V_d	− ·27	
Curvature	− ·28	
Radial velocity		+10·7

τ TAURI 2104.*

1909. Jan. 7.
G. M. T. 12ʰ.11ᵐ

Observed by J. S. Plaskett.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	72·9342	....	....	....	½	31·0450	·0565	·0602	54·50
½	72·8677	·8488	·0767	+111·52	2	30·9795	....	....	....
2	72·3736	....	....	....	½	27·5773	·6015	·0397	34·78
2	54·7297	....	....	....	2	27·3729	....	....	....
½	54·0167	·9983	·0551	63·70	½	20·0367	·0786	·0898	73·81
1	53·4152	·3968	·0186	21·37	2	20·6887	....	....	....
2	53·1077	....	....	....	½	15·7372	·8041	·0710	+55·24
1	45·3197	·3078	·0489	51·34	2	15·5922	....	....	....
2	45·3055	....	....	....					

Weighted mean..................		+53·89
V_a..................	−17·83	
V_d..................	− ·27	
Curvature..........	− ·28	
Radial velocity..................		+35·5

*Check measurement.

τ TAURI 2119.

1909. Jan. 11.
G. M. T. 12ʰ 05ᵐ

Observed by / Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	72·8943	....	....	....	2	54·6977	....	....	....
½	72·7919	·9069	·0421	+61·09	½	53·4143	·4571	·0448	+51·15
2	72·3305	....	....	....	2	53·0706	....	....	....

Weighted mean..................		+56·12
V_a..................	−19·51	
V_d..........................		+ ·14
Curvature..........	− ·28	
Radial velocity................		+36·5

τ TAURI 2131.

1909. Jan. 13.
G. M. T. 16h 24m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·8616	....	....	....	2	45·2948	....	....	....
½	72·7735	·8287	·0566	+82·29	½	31·0662	·0515	·0552	49·91
2	72·2980	....	....	....	2	30·0057	....	....	....
2	54·6989	....	....	....	1	27·6183	·6061	·0443	36·81
½	53·9622	·9724	·0292	33·75	2	27·4093	....	....	....
½	53·4226	·4313	·0531	61·01	½	20·0207	·0068	·0180	15·90
2	53·0814	....	....	....	2	20·7445	....	....	....
2	48·7669	....	....	....	½	15·7535	·7536	·0205	+16·03
½	48·3812	·3843	·0711	76·14	2	15·6590	....	....	....
1	45·2985	·2973	·0384	40·42					

Weighted mean..................		+44·60
V_a..................	−20·37	
V_d..................	− ·14	
Curvature..........	− ·28	
Radial velocity..................		+23·8

τ TAURI 2131.*

1909. Jan. 13.
G. M. T. 16h 24m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·8650	....	....	....	2	48·7773	....	....	....
½	72·7801	·8308	·0587	+85·15	½	48·3866	·3793	·0661	71·78
2	72·3058	....	....	....	1	45·3123	·3035	·0446	46·83
2	54·7068	....	....	....	2	45·3024	....	....	....
½	53·9778	·9818	·0386	44·62	½	27·6086	·5904	·0286	+25·02
½	53·4288	·4324	·0542	62·26	2	27·4153	....	....	....
2	53·0857	....	....	....					

Weighted mean..................		+54·57
V_a..................	−20·37	
V_d..................	− ·14	
Curvature..........	− ·28	
Radial velocity..................		+33·7

*Check measurement.

τ TAURI 2138.

1909. Jan. 15.
G. M. T. 14h 08m

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·8577	...	...	...	1	45·2283	·2272	·0317	−33·28
½	72·6732	·7323	·0398	−57·87	½	27·5337	·5677	·0059	+ 5·17
2	54·6866	...	...	...	2	27·3631	...	...	...
½	53·3008	·3202	·0580	−66·64	½	20·8536	·9012	·0876	−71·91
2	53·0713	...	...	...	2	20·6830	...	...	...
2	45·2747	...	...	...					

Weighted mean	−42·96
V_a	−21·10
V_d	·00
Curvature	− ·28
Radial velocity	−64·3

τ TAURI 2145.

1909. Jan. 15.
G. M. T. 16h 10m

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9024	...	...	...	1	45·2566	·2435	·0154	16·17
½	72·7315	·7481	·0240	−34·89	½	27·5301	·5244	·0374	32·75
2	72·3347	...	...	...	2	27·4028	...	...	...
2	54·7175	...	...	...	½	20·9573	·9450	·0438	35·96
½	53·9476	·9412	...	...	2	20·7229	...	...	...
1	53·3639	·3563	·0219	25·16	½	15·6825	·6980	·0350	—27·37
2	53·0969	...	...	...	2	15·6436	...	...	...
2	45·3067	...	...	...					

Weighted mean	−24·68
V_a	−21·10
V_d	− ·14
Curvature	− ·28
Radial velocity	—46·2

τ TAURI 2159.

1909. Jan. 18.
G. M. T. $10^h\ 56^m$

Observed by } T. H. Parker
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·8983	....	....	....	½	48·3067	·2891	·0240	−26·06
½	72·7616	·7769	·0049	+ 7·12	2	45·3124	....	....	....
2	72·3410	....	....	....	½	45·2689	·2501	·0088	− 9·24
2	54·7295	....	....	....	½	27·6154	·6030	·0412	+36·04
½	53·3948	·3793	·0011	+ 1·26	2	27·4095	....	....	....
2	53·1039	....	....	....	½	20·9934	·9877	·0011	− 0·90
2	48·7876	....	....	....	2	20·7363	....	....	....

Weighted mean..................		+1·52
V_a..................	−22·50	
V_d..........................		+ ·21
Curvature..........	− ·28	
Radial velocity.........	− 21·1	

τ TAURI 2160.

1909. Jan. 18.
G. M. T. $11^h\ 55^m$

Observed by } T. H. Parker.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·8947	....	....	....	½	45·2303	·2473	·0116	−12·18
½	72·7607	·7848	·0117	−17·01	½	27·5237	·5532	·0086	− 7·43
2	72·3270	....	....	....	2	27·2676	....	....	....
2	54·7096	....	....	....	½	20·9141	·9469	·0419	−34·44
½	53·3583	·3679	·0103	−12·98	2	20·6978	....	....	....
2	53·0777	....	....	....	½	15·6707	·7140	·0191	−14·94
2	45·2766	....	....	....	2	15·6158	....	....	....

Weighted mean.........	−16·50	
V_a................	−22·50	
V_d.........................		+0·14
Curvature..........	− ·28	
Radial velocity.........	− 39·0	

τ TAURI 2169.

1909. Jan. 18.
G. M. T. 14^h 52^m

Observed by / Measured by } T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9030	....	....	....	1	45·2878	·2698	·0109	+11·44
½	72·7425	·7548	·0173	−25·50	½	39·9820	9690	·0233	+20·39
2	72·3418	....	....	....	2	30·0040	....	....	....
2	54·7267	....	....	....	½	27·5878	·5851	·0273	−46·36
½	53·9609	·9435	·0003	+ 0·34	2	27·3998	....	....	....
½	53·3683	·3495	·0287	−32·98	1	20·9252	·9324	·0564	−24·71
2	53·1089	....	....	....	2	20·7234	....	....	....
2	45·3116	....	....	....					

Weighted mean	−14·71
V_a	−22·50
V_d	− ·09
Curvature	− ·28
Radial velocity	− 37·5

τ TAURI 2170.

1909. Jan. 18
G. M. T. 15^h 45^m

Observed by / Measured by } T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·8853	....	....	....	2	45·3083	....	....	....
½	72·7168	·7475	·0246	−35·77	½	45·2711	....	....	....
2	72·3232	....	....	....	½	27·6086	·5892	·0274	+24·00
2	54·7137	....	....	....	2	27·4165	....	....	....
½	53·9146	·9072	·0360	−41·60	½	21·0265	·0213	·0325	+26·68
½	53·3801	·3687	·0095	−10·91	2	20·7358	....	....	....
2	53·1027	....	....	....					

Weighted mean	− 6·70
V_a	−22·50
V_d	− ·14
Curvature	− ·28
Radial velocity	− 29·6

τ TAURI 2173.

1909. Jan. 20.
G. M. T. 11ʰ 08ᵐ

Observed by W. E. HARPER.
Measured by T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	72·9315	...	...	...	2	45·2973	...	...	...
½	72·8332	·8158	·0437	+63·54	½	45·3060	·3023	·0434	45·57
2	72·3733	...	...	...	½	27·5907	·6287	·0671	58·71
2	54·7277	...	...	...	2	27·3591	...	...	...
½	54·0375	·0205	·0773	89·36	¼	20·0194	·0762	·0874	+71·75
½	53·4510	·4326	·0544	62·51	2	20·6738	...	...	...
2	53·1080	...	...	...					

Weighted mean		+64·61
V_a	−22·86	
V_d		+ ·09
Curvature	− ·28	
Radial velocity		+41·5

τ TAURI 2173.*

1909. Jan. 20.
G. M. T. 11ʰ 08ᵐ

Observed by W. E. HARPER.
Measured by T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	72·9215	...	...	...	½	45·2986	·3045	·0456	47·88
½	72·8228	·8181	·0460	+66·88	2	45·2877	...	...	...
2	72·3579	...	...	...	½	27·5810	·6273	·0655	57·31
2	54·7162	...	...	...	2	27·3488	...	...	...
½	54·0089	·0020	·0588	67·97	½	21·0174	·0911	·1023	+83·99
1	53·4409	·4328	·0546	62·73	2	20·6569	...	...	...
2	53·0983	...	...	...					

Weighted mean		+64·40
V_a	−22·86	
V_d		+ ·09
Curvature	− ·28	
Radial velocity		+41·3

*Check measurement.

τ TAURI 2173.*

1909. Jan. 20.
G. M. T. 11h 08m

Observed by W. E. Harper
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	73·3783	....	....	....	2	45·7423	....	....	....
¼	73·3083	·8473	·0752	+109·37	½	45·7475	·2988	·0400	42·00
2	72·8128	....	....	....	½	28·0450	·6398	·0698	60·63
2	54·4613	....	....	....	2	27·8023	....	....	....
1	54·4830	·0235	·0803	92·87	¼	23·0943	·7065	....	....
½	53·9105	·4515	·0733	84·23	½	21·4700	·0882	·0994	+81·66
2	49·2240	....	....	....	2	16·0205	....	....	....
¼	49·8271	·3731	·0600	65·14					

Weighted mean..................		+77·35
V_a..................	−22·86	
V_d..........................		+ ·09
Curvature...........	− ·28	
Radial velocity.................		+54·4

*Check measurement.

τ TAURI 2190.

1909. Jan. 28.
G. M. T. 12h 30m

Observed by / Measured by } T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·8836	....	....	....	2	45·2845	....	....	....
½	72·7694	·8038	·0317	+46·09	½	45·3015	·3106	·0517	54·29
2	72·3176	....	....	....	½	27·6570	·6792	·1174	102·84
2	54·6973	....	....	....	2	27·3749	....	....	....
½	53·4349	·4460	·0678	77·90	½	20·0549	·0836	·0948	+77·93
2	53·0782	....	....	....	2	20·7019	....	....	....

Weighted mean..................		+71·80
V_a..................	−24·89	
V_d..........................		+ ·04
Curvature...........	− ·28	
Radial velocity.................		+46·7

τ TAURI 2191.

1909. Jan. 28.
G. M. T. 13ʰ 30ᵐ

Observed by } T. H. Parker.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	72·9228	....	....	....	1	45·3473	·3226	·0637	66·89
½	72·8421	·8364	·0643	+93·49	2	45·3183	....	....	....
2	72·3585	....	....	....	½	27·6448	·6391	·0773	67·71
2	54·7303	....	....	....	2	27·4028	....	....	....
¼	54·0292	·0167	·0735	84·97	½	20·0591	·0688	·0800	+65·76
½	53·4582	·4336	·0554	63·71	2	20·7209	....	....	....
2	53·1153	....	....	....					

Weighted mean..................		+71·83
V_a..................	−24·89	
V_d..................	− ·04	
Curvature..........	− ·28	
Radial velocity.................		+46·6

τ TAURI 2193.

1909. Jan. 28.
G. M. T. 16ʰ 28ᵐ

Observed by } T. H. Parker.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	72·9042	....	....	....	1	45·3441	·3429	·0840	88·20
¼	72·8536	·8654	·0933	+135·66	2	45·2948	....	....	....
2	72·3422	....	....	....	½	27·6106	·6235	·0617	54·05
2	54·7157	....	....	....	2	27·3742	....	....	....
¼	54·0071	·0033	·0601	69·48	½	21·0580	·0964	·1076	+88·45
½	53·4272	·4241	·0459	52·74	2	20·6922	....	....	....
2	53·0920	....	....	....					

Weighted mean..................		+79·03
V_a..................	−24·89	
V_d..................	− ·21	
Curvature..........	− ·28	
Radial velocity.................		+53·7

τ TAURI 2194.

1909. Jan. 28.
G. M. T. 17h 11m

Observed by } T. H. Parker.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9289	....	....	....	2	53·1079	....	....	....
¼	72·8797	·8658	·0937	+136·24	1	45·3375	·3226	·0637	66·89
2	72·3689	....	....	....	2	45·3085	....	....	....
2	54·7297	....	....	....	¼	21·0319	·0683	·0795	+ 65·35
1	53·4717	·4532	·0750	86·18	2	20·6942	....	....	....

Weighted mean.................		+ 81·45
V_a.................	−24·89	
V_d.................	− ·27	
Curvature..........	− ·28	
Radial velocity..................		+ 56·0

τ TAURI 2223.

1909. Feb. 3.
G. M. T. 12h 37m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9043	....	....	....	2	30·9933	....	....	....
½	72·8182	·8313	·0592	+ 86·08	½	27·6473	·6555	·0937	81·99
2	72·3396	....	....	....	2	27·3889	....	....	....
2	54·7262	....	....	....	½	21·0565	·0847	·0959	78·83
1	53·4557	·4401	·0619	71·12	2	20·7024	....	....	....
2	53·1051	....	....	....	¼	15·7873	·8311	·1000	+ 78·20
1	45·3394	·3270	·0681	71·50	2	15·6153	....	....	....
2	45·3060	....	....	....					

Weighted mean.................		+ 76·05
V_a.................	— 26·94	
V_d.................		+ ·02
Curvature..........	− ·28	
Radial velocity.................		+ 48·9

τ TAURI 2247.

1909. Feb. 8.
G. M. T. 11h 53m

Observed by} T. H. Parker.
Measured by}

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·8856	....	....	....	2	45·2795	....	....	....
½	72·7725	·8001	·0280	+ 40·71	½	45·2639	·2780	·0191	+ 20·55
2	72·3293	....	....	....	½	27·4985	·5396	·0222	− 19·44
2	54·6981	....	....	....	2	27·3560	....	....	....
½	53·3405	·3537	·0245	−28·15	½	20·9084	·9675	·0213	+ 17·51
2	53·0762	....	....	....	2	20·6715	....	....	....

Weighted mean................		+ 6·23
V_a..................	−27·98	
V_d..........................		+ ·04
Curvature...........	− ·28	
Radial velocity.......	− 22·0	

τ TAURI 2247.*

1909. Feb. 8.
G. M. T. 11h 53m

Observed by} T. H. Parker.
Measured by}

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9153	....	....	....	½	48·3287	·3071	·0061	− 6·62
½	72·7727	·7684	·0037	− 5·28	2	45·3156	....	....	....
2	72·3633	....	....	....	½	45·2967	·2747	·0158	+ 16·59
2	54·7383	....	....	....	½	27·5356	·5399	·0219	− 19·25
½	53·3798	·3555	·0227	− 26·08	2	27·3928	....	....	....
2	53·1130	....	....	....	½	20·9305	·9510	·0378	− 31·07
2	48·7916	....	....	....	2	20·7101	....	....	....

Weighted mean.........	−11·95	
V_a..................	−27·98	
V_d..........................		+ 0·04
Curvature..........	− ·28	
Radial velocity.........	− 40·2	

*Check measurement.

τ TAURI 2255.

1909. Feb. 8.
G. M. T. 14h 49m

Observed by / Measured by — T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·8748	....	....	....	2	45·2888	....	....	....
½	72·7755	·8158	·0437	+ 63·54	1	45·2579	·2627	·0038	+ 3·99
2	72·3146	....	....	....	½	27·5488	·5681	·0062	+ 5·43
2	54·7048	....	....	....	2	27·3779	....	....	....
½	53·9566	·9661	·0229	+ 26·43	½	20·9747	·0062	·0174	+ 14·30
1	53·3267	·3337	·0407	− 42·69	2	20·6991	....	....	....
2	53·0773	....	....	....					

Weighted mean		+ 4·04
V_a	−27·98	
V_d		+ ·04
Curvature	− ·28	
Radial velocity	− 22·2	

τ TAURI 2256.

1909. Feb. 8.
G. M. T. 16h 00m

Observed by / Measured by — T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9163	....	....	....	1	53·3738	·4023	·0241	+ 27·69
½	72·7758	·7769	·0048	+ 6·98	2	53·1169	....	....	....
2	72·3514	....	....	....	2	45·3276	....	....	....
2	53·7433	....	....	....	1	45·2876	·2536	·0053	− 5·56
½	53·9903	·9605	·0173	+ 20·00					

Weighted mean		+ 7·11
V_a	−27·98	
V_d	− ·23	
Curvature	− ·28	
Radial velocity	− 21·4	

τ TAURI 2271.

1909, Feb. 10.
G. M. T. 14h 45m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	54·7139	....	....	....	2	45·2967	....	....	....
½	53·4025	·4014	·0232	+26·66	½	45·2917	·2886	·0297	+31·18
2	53·0900	....	....	....					

Weighted mean		+28·92
V_a	−28·37	
V_d	− ·18	
Curvature	− ·28	
Radial velocity		+ 0·1

τ TAURI 2296.

1909, Feb. 22.
G. M. T. 14h 05m

Observed by, Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	72·9225	....	....	....	2	53·0998	....	....	....
½	72·8020	·7938	·0217	+31·55	½	27·5282	·5865	·0247	21·64
2	72·3642	....	....	....	2	27·3388	....	....	....
2	54·7157	....	....	....	½	20·9177	·0087	·0199	+16·36
¼	53·9899	·9825	·0393	45·43	2	20·6396	....	....	....
1	53·3949	·3850	·0068	7·81					

Weighted mean		+18·85
V_a	−29·79	
V_d	− ·18	
Curvature	− ·28	
Radial velocity	− 11·4	

τ TAURI 2297.

1909, Feb. 22.
G. M. T. 15h 06m

Observed by, Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	54·7486	....	....	....	2	53·1236	....	....	....
¼	54·0117	·9759	·0327	+47·55	2	45·3090	....	....	....
½	53·4315	·3966	·0184	21·14	½	45·3249	·3095	·0506	+53·13

Weighted mean		+38·85
V_a	−29·79	
V_d	− ·18	
Curvature	− ·28	
Radial velocity		+ 8·6

τ TAURI 2307.

1909. Feb. 25.
G. M. T. $15^h 25^m$

Observed by / Measured by } T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	54·7373	....	....	....	½	27·5452	·5218	·0346	30·17
1	54·4296	·4180	·0278	+ 31·86	2	27·3453	....	....	....
2	54·1160	....	....	....	½	20·9298	·9038	·0189	+ 15·44
½	45·3108	·2939	·0452	47·32	2	20·6515	....	....	....
2	45·3005	....	....	....					

Weighted mean..................		+ 36·86
V_a..................	−29·35	
V_d..................	− ·27	
Curvature..........	− ·28	
Radial velocity..................		+ 6·9

τ TAURI 2308.

1909. Feb. 25.
G. M. T. $16^h 23^m$

Observed by / Measured by } T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	54·8582	....	....	....	2	53·2337	....	....	....
1	54·1242	·0079	·0431	+ 49·61	2	45·4195	....	....	....
½	53·5395	·4178	·0155	+ 17·72	½	45·4173	·2714	·0327	+ 34·14

Weighted mean..................		+ 37·77
V_a..................	−29·35	
V_d..................	− ·27	
Curvature..........	− ·28	
Radial velocity..................		+ 7·8

τ TAURI 2336.

1909. Mar. 8.
G. M. T. 13 49

Observed by / Measured by: T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	59·4587	....	....	....	¼	38·0528	·0554	·1138	113·46
½	58·3073	·3097	·0568	+ 71·40	2	37·9342	....	....	....
2	57·9885	....	....	....	¼	34·8870	·8976	·0755	72·71
2	54·0676	....	....	....	2	34·6632	....	....	....
¼	53·7372	·7450	·0857	102·24	½	28·9262	·9399	·0902	+ 81·54
1	50·9652	·9742	·0857	99·15	2	28·6053	....	....	....
2	50·9119	....	....	....					

Weighted mean		+ 90·08
V_a	−29·82	
V_d	− ·21	
Curvature	− ·28	
Radial velocity		+ 59·8

τ TAURI 2336.*

1909, Mar. 8.
G. M. T. 13h 49m

Observed by / Measured by: T. H. Parker.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length	Normal Wave Length.	Displacement.	Velocity.
2	59·8379	4489·102	....	·109	....	....
½	59·4993	4482·619	·619	·400	1·219	+81·55
½	58·9793	4472·739	·754	·676	1·078	72·33
2	58·6619	4466·751	....	·737	....	....
2	54·7395	4395·303	....	·382	....	....
½	54·4259	4389·789	·864	·100	1·764	120·30
1	51·6362	4341·939	·009	·634	1·375	95·01
2	51·5855	4341·090	....	·162	....	....
2	50·0212	4315·200	....	·255	....	....
½	38·7246	4145·598	·548	·928	1·620	117·12
2	38·6024	4143·914	....	·863	....	....
½	35·5758	4103·145	·075	·000	1·075	75·58
2	35·3360	4099·991	....	·921	....	....
½	29·6114	4027·699	·539	·352	1·187	+88·19
2	29·2785	4023·667	....	·508	....	....

Weighted mean		+93·51
V_a	−29·82	
V_d	− ·21	
Curvature	− ·28	
Radial velocity		+ 63·2

*Check measurement.

τ TAURI 2337.

1909. Mar. 8.
G. M. T. 14h 44m

Observed by } T. H. Parker.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	59·4873				¼	38·0050	·9955	·0539	53·74
½	58·3065	·2879	·0350	+ 44·34	2	37·9463			
2	58·0075				¼	34·8615	·8560	·0339	32·64
2	54·0839				2	34·6793			
¼	53·7488	·7403	·0810	96·63	¼	28·9620	·9602	·1105	+ 99·89
½	50·9520	·9450	·0565	64·24	2	28·6208			
2	50·9279								

Weighted mean		+ 62·51
V_a	−29·82	
V_d	− ·21	
Curvature	− ·28	
Radial velocity		+ 32·2

τ TAURI 2337.*

1909. Mar. 8.
G. M. T. 14h 44m

Observed by } T. H. Parker.
Measured by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement.	Velocity.
2	59·8169	4489·118		·109		
1	58·9419	4472·448	·463	·676	·787	+52·81
2	58·6379	4466·713		·737		
1	51·5832	4341·421	·542	·634	·908	62·74
2	51·5605	4341·041		·162		
2	49·9945	4315·123		·255		
½	38·6555	4144·948	·888	·928	·960	69·41
2	38·5811	4143·924		·863		
½	35·5435	4103·009	·924	·890	1·034	75·58
2	35·3155	4100·009		·921		
½	29·5891	4027·695	·505	·352	1·153	+85·67
2	29·2598	4023·696		508		

Weighted mean		+66·10
V_a	−29·82	
V_d	− ·27	
Curvature	− ·28	
Radial velocity		+ 35·7

*Check measurement.

τ TAURI 2353.

1909. Mar. 11.
G. M. T. 12h 53m

Observed by W. E. Harper.
Measured by T. H. Parker.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length	Normal Wave Length.	Displacement.	Velocity.
2	59·8285	4489·153	....	·109	....	....
½	59·4273	4481·471	·421	·400	....	....
1	58·9623	4472·637	·597	·676	·921	+61·80
2	58·6543	4466·816	....	·737	....	....
2	54·7300	4395·347	....	·382	....	....
½	54·3918	4394·365	·400	·286	·880	60·16
½	51·6066	4341·652	·717	·634	1·083	74·83
2	5 ·5739	4341·097	....	·162	....	....
½	35·5566	4103·055	·125	·890	1·125	82·24
2	35·3144	4099·866	....	·938	....	....
½	29·5814	4027·481	·476	·352	1·124	+83·51
2	29·2546	4023·527	....	·508	....	....

Weighted mean.................		+72·84
V_a..................	−29·56	
V_d..................	− ·18	
Curvature..........	− ·28	
Radial velocity.................		+ 42·8

τ TAURI 2378.

1909. Mar. 15.
G. M. T. 13h 57m

Observed by T. H. Parker.
Measured by J. B. Cannon.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	58·9187	....	....	....	½	34·9369	·8496	·0275	+26·49
¼	58·8499	·7501	·0151	−19·26	2	34·7611	....	....	....
½	58·3684	·2686	·0157	19·89	½	28·9246	·8414	·0083	− 7·50
4	51·0149	....	....	....	2	28·7022	....	....	....
1	50·9819	·8879	·0006	0·69	½	21·0274	·9530	....	....
¼	38·0490	·9522	·0106	−10·57	2	20·5759	....	....	....
2	38·0336	....	....	....					

Weighted mean..........	− 2·87
V_a..................	−29·15
V_d..................	− ·29
Curvature..........	− ·28
Radial velocity..........	−32·6

τ TAURI 2378.*

1909. Mar. 15.
G. M. T. 16h 36m

Weight.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement.	Velocity.
2	60·1072	4494·721	....	·755	....	....
2	S59·8159	....	....	....	....	....
½	58·8695	4471·087	·097	·676	·579	−38·85
½	59·4027	4481·201	·206	·400	·194	−12·98
2	58·6390	4466·750	....	....	....	....
2	51·5630	4341·089	....	....	....	....
1	51·5256	4340·461	·531	·634	·103	− 7·12
2	50·0004	4315·227	....	....	....	....
2	S48·7075	....	....	....	....	....
½	38·5993	4144·182	·132	·928	·204	+14·75
2	38·5810	4143·928	....	....	....	....
½	35·4705	4102·053	·051	·891	·160	+11·70
2	S35·3096	4099·938	....	....	....	....
½	29·4843	4026·432	·352	·352	·000	·00
2	29·2515	4023·611	....	....	....	....

Weighted mean......... − 0·16
V_a................. −29·15
V_d................. − ·29
Curvature.......... − ·28

Radial velocity......... − 29·9

*Check measurement.

τ TAURI 2407.

1909. Mar. 22.
G. M. T. 13h 42m

Observed by / Measured by } T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	59·4352	....	....	....	1	50·8850	·9134	·0249	31·30
½	58·7857	·8105	·0453	+57·80	2	50·8925	....	....	....
1	58·2450	·2692	·0163	20·65	½	37·9579	·9814	·0398	39·68
2	57·9672	....	....	....	2	37·9133	....	....	....
2	54·0470	....	....	....	½	34·8339	·8693	·0472	+45·45
½	53·6858	·7141	·0548	70·85	2	34·6384	....	....	....

Weighted mean................. +39·71
V_a....................−28·08
V_d....................− ·28
Curvature...........− ·28

Radial velocity.............. +11·1

τ TAURI 2407.*

1909. Mar. 22.
G. M. T. 13h 42m

Observed by / Measured by } T. H. Parker.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length	Normal Wave Length.	Displacement.	Velocity.
2	59·8295	4489·113	....	·109	....	....
1	59·4662	4482·160	·145	·400	·745	+49·84
1	58·9353	4472·077	·072	·676	·396	26·57
2	58·6535	4466·762	....	·737	....	....
2	54·7305	4395·304	....	·382	....	....
½	54·3728	4388·999	·069	·100	·969	66·18
2	51·5750	4341·065	....	·162	....	....
1	51·5668	4340·928	·018	·634	·384	26·53
½	38·6363	4144·505	·435	·928	·507	36·66
2	38·5947	4143·932	....	·863	....	....
1	35·5185	4102·510	·500	·890	·610	+44·59
2	35·3235	4099·944	....	....	....	....

Weighted mean.................		+39·79
V_a..................	−28·08	
V_d..................	− ·28	
Curvature..........	− ·28	
Radial velocity................		+ 11·2

*Check measurement.

τ TAURI 2408.

1909. Mar. 22.
G. M. T. 14h 31m

Observed by / Measured by } T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	59·4742	....	....	....	½	50·9482	·9467	·0563	64·97
½	58·8310	·8422	·0539	+68·56	2	50·9243	....	....	....
¼	58·2955	·3065	·0318	40·19	2	48·0611	....	....	....
2	58·0023	....	....	....	½	46·4174	·4088	·0659	+72·03
2	54·0817	....	....	....	2	44·3188	....	....	....
¼	53·7433	·7446	·0757	90·38					

Weighted mean.................		+67·71
V_a..................	−28·08	
V_d..................	− ·28	
Curvature..........	− ·28	
Radial velocity................		+40·01

τ TAURI 2408.*

1909. Mar. 22.
G. M. T. 14ʰ 31ᵐ

Observed by } T. H. Parker.
Computed by }

Weight.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length.	Normal Wave Length.	Displacement.	Velocity.
2	59·8230	4489·238	......	·109	....	....
1	59·4741	4482·558	·478	·400	1·078	+72·12
1	58·9405	4472·526	·490	·676	·814	54·62
2	58·6409	4466·769	....	....	....	....
1	51·5963	4341·640	·700	·634	1·066	+73·66
2	51·5642	4341·102	....	....	....	....

Weighted mean.................		+66·80
V_a.................	−28·08	
V_d.................	− ·29	
Curvature..........	− ·28	
Radial velocity.................		+ 38·2

*Check measurement.

τ TAURI 2427.

1909. Mar. 23.
G. M. T. 14ʰ 52ᵐ

Observed by J. B. Cannon.
Measured by T. H. Parker.

Weight.	Mean of Settings.	Computed Wave Length.	Corrected Wave Length	Normal Wave Length.	Displacement.	Velocity.
2	59·8133	4489·239	....	·109	1·008	+67·44
½	59·4630	4482·538	·408	·400	·922	61·87
1	58·9446	4472·688	·598	·676	....	....
2	58·6377	4466·897	....	·737..	....	....
2	54·7097	4395·342	....	·382	....	....
½	54·3483	4388·989	·954	·100	·854	58·33
1	51·6072	4341·992	·032	·634	1·398	96·60
2	51·5552	4341·119	....	·162	....	....
½	38·6514	4145·029	·059	·928	1·131	81·77
2	38·5646	4143·834	....	·863	....	....
½	35·5399	4103·094	·239	·890	1·349	+98·61
2	35·2890	4099·793	....	·938	....	....

Weighted mean.................		+77·38
V_a.................	−27·88	
V_d.................	− ·29	
Curvature..........	− ·28	
Radial velocity.................		+ 48·

τ TAURI 2775.

1909. Aug. 27.
G. M. T. 18h 25m

Observed by } T. H. Parker.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	59·5299	....	....	....	2	50·9620	....	....	....
½	58·8160	·7704	·0179	−22·77	½	50·8642	·8250	·0654	−75·47
½	58·3286	·2818	·0071	+ 8·97	1	34·7748	·7468	·0282	−27·07
2	58·0592	....	....	....	2	34·6543	....	....	....
2	54·1216	....	....	....	½	28·7364	·7144	·0681	−61·35
½	53·6793	·6407	·0282	−33·67	2	28·5729	....	....	....

Weighted mean......... −33·91
V_a.......................... +29·31
V_d.......................... + ·29
Curvature.......... − ·28

Radial velocity......... − 4·6

τ TAURI 2775.*

1909. Aug. 27.
G. M. T. 18h 25m

Observed by T. H. Parker.
Measured by W. E. Harper.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
1	54·0891	....	....	....	¼	34·7295	·7327	·0423	40·61
½	53·6344	·6287	·0402	−47·80	2	34·6230	....	....	....
½	50·8305	·8281	·0623	71·89	¼	28·7010	·7062	·0763	−68·75
2	50·9252	....	....	....	2	28·5445	....	....	....

Weighted mean......... −66·03
V_a.......................... +29·31
V_d.......................... + ·29
Curvature.......... − ·28

Radial velocity......... −36·7

*Check measurement.

τ TAURI 2779.

1909. Sept. 7.
G. M. T. 19h.59m

Observed by }
Measured by } T. H. Parker

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	59·5085	....	....	....	2	50·9578	....	....	....
1	58·3200	·2960	·0213	+26·96	½	34·8909	·8200	·0450	43·29
2	58·0365	....	....	....	2	34·6972	....	....	....
2	54·1179	....	....	....	½	28·9018	·8214	·0389	+35·09
½	53·7169	·6820	·0131	15·73	2	28·6313	....	....	....
1	50·9699	·9349	·0445	51·44					

Weighted mean................. +35·80
V_a......................... +29·43
V_d......................... + ·18
Curvature.......... − ·28

Radial velocity.................. +65·1

τ TAURI 2780.

1909. Sept. 7.
G. M. T. 20h 39m

Observed by }
Measured by } T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	59·4680	....	....	....	2	50·9169	....	....	....
¼	58·8250	·8301	·0096	+12·23	¼	37·9428	·9410	·0179	17·81
½	58·3194	·3242	·0604	76·46	2	37·9202	....	....	....
2	57·9969	....	....	....	1	34·8458	·8469	·0482	46·37
2	54·0742	....	....	....	2	34·6486	....	....	....
½	53·7058	·7110	·0469	56·33	½	28·8389	·8409	·0249	+23·95
1	50·9225	·9275	·0381	44·04	2	28·5830	....	....	....

Weighted mean................. +44·07
V_a......................... +29·43
V_d......................... + ·13
Curvature.......... − ·28

Radial velocity................ +73·3

τ TAURI 2798.

1909. Sept. 17.
G. M. T. 20ʰ 30ᵐ

Observed by / Measured by } T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	59·8617	....	....	....	½	50·7932	·8062	·0842	97·17
¼	58·2319	·2409	·0338	−42·72	2	37·8841	....	....	....
2	58·0030	....	....	....	¼	37·8239	·8398	·0650	−64·61
2	50·9098	....	....	....					

Weighted mean......... −75·43
V_a.......................... +28·64
V_d.......................... + ·09
Curvature.......... − ·28

Radial velocity......... −47·0

τ TAURI 2799.

1909. Sept. 17.
G. M. T. 21ʰ 40ᵐ

Observed by / Measured by } T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
1	59·4856	....	....	....	¼	53·6001	·6074	·0615	73·43
½	58·1905	·1909	·0838	−105·92	2	50·9176	....	....	....
2	54·0757	....	....	....	½	50·8491	·8543	·0361	−41·66

Weighted mean......... −73·79
V_a.......................... + 28·64
V_d.................. − ·04
Curvature.......... − ·28

Radial velocity......... −45·5

τ TAURI 2806.

1909. Sept. 20.
G. M. T. 19ʰ 35ᵐ

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	59·4560	....	....	....	2	50·8962	....	....	....
¼	58·2208	·2384	·0254	−32·16	¾	50·8269	·8526	·0368	42·54
2	54·0565	....	....	....	½	34·7355	·7554	·0433	−41·65
½	53·6073	·6302	·0339	40·71	2	34·6300	....	....	....

Weighted mean......... −40·54
V_a.......................... + 28·24
V_d.......................... + ·14
Curvature.......... − ·28

Radial velocity......... −12·4

τ TAURI 2807.

1909. Sept. 20.
G. M. T. 19h 35m

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	59·4777	....	....	....	¼	34·7699	·7995	·0008	+ 0·77
½	58·2030	·1978	·0660	−83·56	2	34·6203	....	....	....
2	58·0070	....	....	....	½	28·6950	·7308	·0852	−76·85
2	50·9146	....	....	....	2	28·5491	....	....	....
½	50·8346	·8419	·0475	−57·04					

Weighted mean.........	−62·02	
V_a........................		+28·24
V_d........................		+ ·11
Curvature...........	− ·28	
Radial velocity.........	−33·9	

τ TAURI 2821

1909. Sept. 24.
G. M. T. 18h 37m

Observed by, Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9842	....	....	....	¼	37·9228	·9356	·0125	+12·44
½	75·8437	·8483	·0097	−15·56	½	34·7776	·7963	·0024	− 2·31
2	75·4670	....	....	....	2	34·6312	....	....	....
2	59·4552	....	....	....	½	28·7828	·8026	·0134	−12·11
½	58·2320	·2517	·0121	+15·31	2	28·5651	....	....	....
2	57·9815	....	....	....	¼	23·9918	·0115	·0186	−15·98
2	50·9015	....	....	....	2	23·9430	....	....	....
1	50·8557	·8761	·0133	−15·37	½	20·6993	·7275	·0371	−30·83
2	37·9056	....	....	....	2	20·4259	....	....	....

Weighted mean.........	−8·46	
V_a........................		+27·59
V_d........................		+ ·21
Curvature..........	− ·28	
Radial velocity.................		+19·1

τ TAURI 2829.

1909. Sept. 28.
G. M. T. 19h 40m

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9871	....	....	....	1	50·9131	·9036	·0142	16·41
¼	75·8859	·8852	·0272	+43·63	¼	37·9570	·9431	·0190	20·18
2	75·4797	....	....	....	½	34·8331	·8212	·0225	21·64
2	59·4815	....	....	....	2	37·9333	....	....	....
1	58·2888	·2803	·0165	20·89	2	34·6618	....	....	....
2	58·0106	....	....	....	¼	28·8332	·8167	·0007	0·63
2	54·0892	....	....	....	2	28·6014	....	....	....
¼	53·6763	·6667	·0026	3·11	½	24·0736	·0561	·0260	+22·33
2	50·9314	....	....	....	2	23·9805	....	....	....

Weighted mean.................		+20·27
V_a..........................		+26·80
V_d..........................		+ ·11
Curvature..........	−·28	
Radial velocity.................		+ 46·9

τ TAURI 2830.

1909. Sept. 28.
G. M. T. 20h 29m

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9590	....	....	....	½	37·8927	·9283	·0052	5·47
¼	75·8274	·8563	·0017	−2·73	2	37·8828	....	....	....
2	75·4453	....	....	....	½	34·7905	·8297	·0310	29·82
2	59·4369	....	....	....	2	34·6107	....	....	....
¼	58·7758	·8118	·0351	+44·71	¼	28·7930	·8318	·0158	14·25
½	58·2668	·3018	·0380	48·11	2	28·5461	....	....	....
2	57·9666	....	....	....	¼	24·0369	·0763	·0462	+39·68
2	50·8869	....	....	....	2	23·9233	....	....	....
1	50·8873	·9223	·0329	38·03					

Weighted mean.................		+29·63
V_a..........................		+26·80
V_d..........................		+ ·08
Curvature..........	−·28	
Radial velocity.................		+56·2

τ TAURI 2846.

1909. Oct. 4.
G. M. T. 21h 25m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0335	....	....	....	½	37·9017	·9026	·0022	−2·19
¾	75·9063	·8914	·0022	+3·53	2	37·8991	....	....	....
2	75·5222	....	....	....	¾	34·7848	·7896	·0146	+14·02
2	59·4887	....	....	....	2	34·6215	....	....	....
¼	58·2765	·2742	·0005	−0·63	1	28·7752	·7840	·0015	+1·35
2	58·0140	....	....	....	2	28·5421	....	....	....
2	54·0868	....	....	....	¼	23·9878	·9929	·0047	+4·03
¼	53·7053	·7015	·0326	+38·92	2	23·9156	....	....	....
2	50·9205	....	....	....	¼	20·6730	·6846	·0322	−26·66
1	50·8924	·8947	·0043	+4·96	2	20·3941	....	....	....

Weighted mean.................		+ 4·45
V_a.........................		+25·36
V_d.................	− ·04	
Curvature..........	− ·28	
Radial velocity.................		+ 29·5

τ TAURI 2848.

1909. Oct. 5.
G. M. T. 18h 51m

Observed by } T. H. Parker.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9881	....	....	....	2	37·9202	....	....	....
½	75·8053	·8040	·0540	−86·56	½	37·8635	·8653	·0578	57·45
2	75·4785	....	....	....	½	34·7436	·7436	·0562	53·95
2	59·4747	....	....	....	2	34·6510	....	....	....
¼	58·7133	·7128	·0639	81·41	½	28·7338	·7385	·0775	69·73
½	58·2092	·2091	·0547	69·25	2	28·5802	....	....	....
2	58·0013	....	....	....	½	23·9457	·9470	·0831	71·21
2	54·0812	....	....	....	2	23·9614	....	....	....
½	53·6124	·6108	·0533	63·64	¼	20·6883	·7094	·0552	−45·70
2	50·9206	....	....	....	2	20·4330	....	....	....
1	50·8317	·8330	·0564	63·97					

Weighted mean.........	−60·31	
V_a.........................		+25·12
V_d.........................		+ ·13
Curvature..........	− ·28	
Radial velocity.........	−35·3	

τ TAURI 2857.

1909. Oct. 6.
G. M. T. 18h 05m

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0050	....	....	....	½	53·6550	·6755	0066	7·88
¼	75·8838	·8968	·0076	+12·18	2	50·9012	....	....	....
2	75·4960	....	....	....	1	50·8762	·8978	·0074	8·54
2	59·4633	....	....	....	½	37·9128	·9359	·0311	+30·91
1	58·2725	·2946	·0199	35·15	2	37·8769	....	....	....
2	57·9902	....	....	....	¼	34·7378	·7639	·0111	−10·66
2	54·0625	....	....	....	2	34·6002	....	....	....

Weighted mean................		+15·85
V_a........................		+24·86
V_d........................		+ ·21
Curvature..........	− ·28	
Radial velocity................		+40·6

τ TAURI 2873.

1909. Oct. 8.
G. M. T. 18h 00m

Observed by } T. H. Parker.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0296	....	....	....	2	37·9052	....	....	....
½	75·8403	·8313	·0579	−92·81	½	37·8773	·8721	·0327	32·56
2	75·5124	....	....	....	½	34·7427	·7368	·0382	36·67
2	59·4890	....	....	....	2	34·6322	·691	....	....
1	58·2118	·2115	·0632	79·88	½	28·6960	·6902	·0923	83·16
2	58·0118	....	....	....	2	28·5567	....	....	....
2	54·0840	....	....	....	¼	23·9502	·9410	·0472	40·45
¼	53·6236	·6226	·0463	55·28	2	23·9299	....	....	....
2	50·9192	....	....	....	½	20·6886	·6819	·0349	−28·90
1	50·8488	·8524	·0380	43·85	2	20·4124	....	....	....

Weighted mean.........	−59·82	
V_a........................		+24·30
V_d........................		+ ·18
Curvature..........	− ·28	
Radial velocity.........	−35·6	

τ TAURI 2882.

1909. Oct. 12.
G. M. T. 19h 51m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9722	....	....	....	1	50·8943	·8952	·0058	+ 6·70
1	75·8514	·8647	·0067	+10·75	½	38·0074	·9984	....	....
2	75·4673	....	....	....	2	37·9274	....	....	....
2	59·4676	....	....	....	1	34·8412	·8331	·0344	+33·09
¼	58·7728	·7773	·0006	+ 0·76	2	34·6580	....	....	....
2	57·9984	....	....	....	½	24·0372	·0260	·0041	− 3·52
2	54·0754	....	....	....	2	23·9739	....	....	....
½	53·6960	·6990	....	....	¼	28·8543	·8482	·0322	+25·82
2	50·9210	....	....	....	1	28·5910	....	....	....

Weighted mean.................		+13·35
V_a..........................		+23·05
V_d..........................		+ ·04
Curvature..........	− ·28	
Radial velocity.................		+36·2

τ TAURI 2887.

1909. Oct. 15.
G. M. T. 21h 10m

Observed by } T. H. Parker.
Measured by }

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	59·4696	....	....	....	½	50·9162	·9225	·0321	+37·04
¼	58·2644	·2844	·0097	+12·26	2	50·9165	....	....	....
2	57·9914	....	....	....					

Weighted mean.................		+28·75
V_a..........................		+22·04
V_d..................	− ·09	
Curvature..........	− ·28	
Radial velocity.................		+50·04

τ TAURI 2895.

1909. Oct. 19.
G. M. T. 20h 07m

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9510	....	....	....	½	50·8805	·8984	·0090	+10·39
½	75·8375	·8721	·0141	+22·60	½	37·9390	·9389	·0168	+16·70
2	75·4463	....	....	....	2	37·9185	....	....	....
2	59·4486	....	....	....	½	34·7897	·7941	·0046	− 4·42
½	58·7436	·7688	·0079	−10·48	2	34·6455	....	....	....
¼	58·2545	·2798	·0160	+20·22	½	28·8345	·8351	·0191	+17·21
2	57·9760	....	....	....	2	28·5843	....	....	....
2	54·0583	....	....	....	¼	20·7503	·7482	·0164	−13·58
¼	53·6348	·6553	·0108	−12·85	½	20·4562	....	....	....
2	50·9040	....	....	....					

Weighted mean.................		+ 6·25
V_a..........................		+20·63
V_d.................	− ·03	
Curvature..........	− ·28	
Radial velocity.................		+26·6

τ TAURI 2896.

1909. Oct. 19.
G. M. T. 20h 48m

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·0270	....	....	....	1	50·9390	·8982	·0078	+ 9·00
½	75·8981	·8887	·0005	− 0·80	½	34·8681	·7938	·0188	+18·05
2	75·5139	....	....	....	2	34·7006	....	....	....
2	59·5190	....	....	....	½	28·8508	·7624	·0200	−18·02
¼	58·3267	·2917	·0170	+21·49	2	28·6393	....	....	....
2	58·0473	....	....	....	½	24·0845	·9809	·0073	− 6·25
2	50·9636	....	....	....	2	24·0243	....	....	....

Weighted mean.................		+ 2·90
V_a..........................		+20·63
V_d.................	− ·09	
Curvature..........	− ·28	
Radial velocity.................		+23·1

τ TAURI 2905.

1909. Oct. 20.
G. M. T. $18^h\ 44^m$

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9430				1	50·8053	·8449	·0445	−51·44
½	75·7976	·8392	·0188	+ 30·17	2	37·8938			
1	75·4430				¼	37·7976	·8222	·1009	−100·39
1	59·4277				1	34·7245	·7577	·0410	−39·44
¼	58·6706	·7162	·0605	− 77·08	2	34·6167			
¼	58·1321	·1774	·0864	−109·38	½	28·7043	·7359	·0801	−72·25
1	57·9561				2	28·5533			
2	54·0383				¼	24·9398	·9687	·0614	−52·74
¼	53·5540	·5950	·0691	− 82·57	2	24·9338			
2	50·8823								

Weighted mean......... −51·19
V_a.......................... +26·46
V_d.......................... + ·07
Curvature.......... − ·28

Radial velocity......... − 24·9

τ TAURI 2906.

1909. Oct. 20.
G. M. T. $19^h\ 25^m$

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	59·4512				¼	37·8977	·9166	·0065	6·45
¼	58·7395	·7609	·0158	−20·03	2	37·8995			
¼	58·2003	·2209	·0429	54·31	¼	34·7391	·7551	·0436	41·94
2	57·9813				2	34·6339			
2	54·0583				¼	28·7330	·7425	·0735	66·30
¼	53·5929	·6140	·0501	59·87	2	28·5754			
2	50·8982				¼	20·7560	·7586	·0060	− 4·99
½	50·8246	·8483	·0411	47·51	2	20·4515			

Weighted mean......... −41·40
V_a.......................... +26·46
V_d.......................... + ·04
Curvature.......... − ·28

Radial velocity......... − 15·2

τ TAURI 2923.

1909. Oct. 29.
G. M. T. 18h 00m

Observed by W. E. HARPER.
Measured by T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
1	75·9440	....	....	....	½	50·8408	·8464	·0421	48·71
½	75·7887	·8007	·0259	− 41·59	2	37·9308	....	....	....
1	75·4365	....	....	....	½	37·9193	·9253	·0163	16·25
2	59·4507	....	....	....	½	34·7686	·7771	·0450	43·33
½	58·7387	·7492	·0160	20·40	2	34·6653	....	....	....
1	58·1925	·2030	·0499	63·22	¼	28·7822	·7930	·0567	51·25
2	57·9803	....	....	....	2	28·6082	....	....	....
2	54·0655	....	....	....	½	24·0037	·0172	·0550	− 47·30
½	53·5995	·6085	·0518	62·00	2	23·9915	....	....	....
2	50·9153	....	....	....					

Weighted mean......... −45·42
V_a......................... + 16·68
V_d......................... + ·09
Curvature.......... − ·28

Radial velocity......... − 28·9

τ TAURI 2924.

1909. Oct. 29.
G. M. T. 18h 44m

Observed by / Measured by } T. H. PARKER.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
1	75·9847	....	....	....	1	50·8823	·8757	·0137	− 15·84
½	75·8667	·8687	·0107	+ 17·16	½	37·9468	·9377	·0146	+ 14·53
1	75·4755	....	....	....	2	37·9295	....	....	....
2	59·4797	....	....	....	½	34·7921	·7774	·0215	− 20·68
1	58·7255	·7194	·0573	− 73·00	2	34·6646	....	....	....
1	58·2113	·2052	·0586	− 74·19	1	28·7820	·7636	·0524	− 47·26
2	58·0013	....	....	....	2	28·6033	....	....	....
2	54·0855	....	....	....	¼	20·7167	·6841	·0805	− 69·07
½	53·6431	·6370	·0271	− 32·46	2	20·4867	....	....	....
2	50·9285	....	....	....					

Weighted mean......... −38·10
V_a......................... + 16·68
V_d......................... + ·09
Curvature.......... − ·28

Radial velocity......... − 28·9

τ TAURI 2938.

1909. Nov. 8. Observed by W. E. Harper.
G. M. T. 22h 00m Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9573	....	....	....	¼	37·9829	·9912	·0496	49·45
¼	75·8633	·8613	·0347	+ 55·73	2	37·9285	....	....	....
2	75·4547	....	....	....	½	34·8667	·8800	·0579	55·76
2	59·4606	....	....	....	2	34·6605	....	....	....
¼	58·8105	·8116	·0039	5·04	½	28·8752	·8917	·0420	37·97
⅛	58·2675	·2689	·0160	20·27	2	28·6025	....	....	....
2	57·9892	....	....	....	¼	24·1125	·1276	·0554	47·64
2	54·0679	....	....	....	2	23·9899	....	....	....
¼	53·7202	·7277	·0684	81·87	½	20·8390	·8656	·0528	+ 43·93
½	50·9273	·9355	·0470	54·38	2	20·4753	....	....	....
2	50·9127	....	....	....					

Weighted mean..................		+ 46·90
V_a...........................		+ 11·90
V_d..................	− ·23	
Curvature...........	− ·28	
Radial velocity..................		+ 58·3

τ TAURI 2940.

1909. Nov. 9. Observed by J. B. Cannon.
G. M. T. 19h 20m Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9661	....	....	....	2	50·9285	....	....	....
½	75·8243	·8133	·0133	− 21·36	½	50·8851	·8775	·0110	− 12·73
2	75·4586	....	....	....	½	34·8276	·8141	·0080	− 7·70
2	59·4708	....	....	....	2	34·6873	....	....	....
¼	58·2266	·2190	·0339	− 42·95	¼	28·8478	·8334	·0163	− 14·73
2	57·9981	....	....	....	2	28·6334	....	....	....
2	54·0801	....	....	....	¼	24·0645	·0528	·0194	− 16·68
¼	53·6771	·6721	·0128	+·15 32	2	24·0167	....	....	....

Weighted mean.........	−12·72	
V_a...........................		+ 11·66
V_d..................	− ·09	
Curvature...........	− ·28	
Radial velocity.........	− 1·4	

τ TAURI 2941.

1909. Nov. 9.
G. M. T. 20ʰ 03ᵐ

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	75·9638	....	....	....	1	50·8858	·8784	·0101	11·68
½	75·8189	·8119	·0147	− 23·61	1	34·7938	·7900	·0321	30·91
1	75·4495	....	....	....	2	34·6777	....	....	....
2	59·4698	....	....	....	¼	24·0257	·0247	·0475	− 40·85
2	50·9283	....	....	....	2	24·0060	....	....	....

Weighted mean......... −23·50
V_a.......................... + 11·66
V_d................. − ·14
Curvature.......... − ·28

Radial velocity......... − 12·3

τ TAURI 2946.

1909. Nov. 12.
G. M. T. 16ʰ 54ᵐ

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	54·0784	....	....	....	2	34·6405	....	....	....
½	53·6694	·6704	·0063	+ 7·53	½	28·7686	·7822	·0338	− 30·48
1	50·9072	....	....	....	2	28·5713	....	....	....
1	50·8892	·9029	·0135	+ 15·60	¼	24·0085	·0220	·0081	− 6·96
½	37·9219	·9169	·0062	− 11·44	2	23·9492	....	....	....
2	37·9235	....	....	....	½	20·7552	·7816	·0170	+ 14·13
½	36·0193	·0193	....	....	1	20·4277	....	....	....
½	34·8008	·8102	·0115	+ 11·06					

Weighted mean................. + 2·46
V_a.......................... + 10·25
V_d.......................... + ·09
Curvature.......... − ·28

Radial velocity................. + 12·2

τ TAURI 2947.

1909. Nov. 12.
G. M. T. 17ʰ 38ᵐ

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	76·0119	....	....	....	2	50·9310	....	....	....
½	75·8700	·8453	·0133	− 21·32	1	50·8883	·8792	·0102	11·79
2	75·4964	....	....	....	½	34·7827	·7832	·0155	14·91
2	59·4890	....	....	....	2	34·6494	....	....	....
½	58·7816	·7655	·0112	14·27	1	28·7967	·8017	·0146	12·00
1	58·2372	·2538	·0100	12·66	2	28·5799	....	....	....
2	58·0183	....	....	....	½	24·0074	·0118	·0183	− 15·72
2	54·0883	....	....	....	2	23·9583	....	....	....
½	53·6693	·6604	·0037	4·42					

Weighted mean.........	−12·49	
V_a..........................		+ 10·25
V_d..........................		+ ·05
Curvature..........	− ·28	
Radial velocity.......	− 2·5	

τ TAURI 2955.

1909. Nov. 15.
G. M. T. 18ʰ 02ᵐ

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revⁿˢ.	Velocity.
2	76·0243	....	....	....	1	50·9062	·8766	·0128	14·80
½	75·8848	·8461	·0119	−19·10	2	37·9530	....	....	....
2	75·5199	....	....	....	¼	37·9202	·8856	·0375	37·31
2	59·5067	....	....	....	½	34·8093	·7842	·0145	13·95
½	58·8055	·7716	·0051	6·50	2	34·6750	....	....	....
¼	58·2663	·2318	·0320	40·51	¼	28·7959	·7719	·0442	39·87
2	58·0362	....	....	....	2	28·6089	....	....	....
1	54·1095	....	....	....	¼	23·9975	·9735	·0566	−48·62
¼	53·6804	·6503	·0138	16·49	2	23·9867	....	....	....
2	50·9515	....	....	....					

Weighted mean.........	−21·41	
V_a..........................		+ 8·83
V_d..........................		·00
Curvature..........	− ·28	
Radial velocity.........	−12·9	

τ TAURI 2956.

1909. Nov. 15.
G. M. T. 19h 04m

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	76·01[illegible]1	....	....	....	½	46·3531	·3518	·0034	+ 3·72
½	75·8626	·8362	·0222	−35·63	2	45·9210	....	....	....
2	75·5047	....	....	....	2	37·9140	....	....	....
2	59·4867	....	....	....	¼	37·8830	·8874	·0357	−35·52
½	58·7859	·7734	·0033	2·80	1	34·7575	·7669	·0318	30·59
½	58·2332	·2201	·0437	55·32	2	34·6405	....	....	....
2	58·0133	....	....	....	½	28·7431	·7598	·0562	50·69
2	54·0853	....	....	....	2	28·5682	....	....	....
1	53·6308	·6249	·0392	46·84	¼	23·9723	·9904	·0397	−34·10
2	50·9276	....	....	....	2	23·9446	....	....	....
1	50·8947	·8890	·0004	− 0·46					

Weighted mean.........	−27·92	
V_a..........................		+ 8·83
V_d..................	− ·09	
Curvature..........	− ·28	
Radial velocity.........	−19·5	

τ TAURI 2965.

1909. Nov. 18.
G. M. T. 13h 51m

Observed by W. E. Harper.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	59·4758	....	....	....	2	58·0053	....	....	....
¼	58·8047	·8017	·0250	+31·85	2	50·9355	....	....	....
½	58·2358	·2323	·0313	−39·62	1	50·8785	·8649	·0245	−28·32

Weighted mean.........	−23·61	
V_a..........................		+ 7·33
V_d..........................		+ ·14
Curvature..........	− ·28	
Radial velocity.........	−16·4	

τ TAURI 2984.

1909. Nov. 30. Observed by J. B. Cannon.
G. M. T. 19h 36m Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9492	....	....	....	¼	37·9430	·9695	·0279	+27·54
½	75·8343	·8413	·0147	+23·61	2	37·9103	....	....	....
2	75·4371	....	....	....	¼	34·7888	·8137	·0084	− 8·09
¼	69·7920	·8040	·0089	+13·13	2	34·6489	....	....	....
1	69·6683	....	....	....	¼	28·7843	·8168	·0329	−29·74
2	54·0609	....	....	....	2	28·5865	....	....	....
½	53·6232	·6375	·0218	−26 09	¼	24·0398	·0747	·0025	+ 2·15
2	50·9053	....	....	....	2	23·9701	....	....	....
1	50·8412	·8556	·0329	−38·06					

Weighted mean.........	−13·71	
V_a..........................		+ 0·98
V_d..................	− ·18	
Curvature..........	− ·28	
Radial velocity.........	−13·2	

τ TAURI 2985.

1909. Nov. 30. Observed by J. B. Cannon.
G. M. T. 20h 17m Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9407	....	....	....	2	37·9327	....	....	....
½	75·8107	·8227	·0039	− 6·26	½	37·9107	·9148	·0268	26·62
2	75·4364	....	....	....	1	34·7919	·8018	·0203	19·55
2	54·0700	....	....	....	½	28·7865	·8003	·0494	44·66
½	53·6112	·6164	·0429	51·35	¼	24·0169	·0319	·0403	—34·66
2	50·9142	....	....	....	2	23·9900	....	....	....
1	50·8620	·8687	·0198	22·91					

Weighted mean.........	−27·25	
V_a..........................		+ 0·98
V_d..................	− ·21	
Curvature..........	− ·28	
Radial velocity.........	−26·7	

τ TAURI 3001.

1909. Dec. 1.
G. M. T. $18^h\ 32^m$

Observed by J. B. Cannon.
Measured by T. H. Parker

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9642	....	....	....	2	50·9177	....	....	....
½	75·8620	·8523	·0257	+41·27	1	50·9107	·9139	·0254	29·39
2	75·4587	....	....	....	½	34·8163	·8286	·0065	6·26
2	59·4640	....	....	....	2	34·6615	....	....	....
¼	58·2627	·2613	·0084	10·64	¼	28·8529	·8754	·0257	23·23
2	57·9920	....	....	....	2	28·5965	....	....	....
2	54·0729	....	....	....	¼	24·0570	·0813	·0091	+ 6·97
½	54·6676	·6699	·0106	12·69	2	23·9807	....	....	....

Weighted mean.................		+ 21·45
V_a..........................		+ ·47
V_d.................	— ·11	
Curvature..........	— ·28	
Radial velocity.................		+ 21·5

τ TAURI 3002.

1909. Dec. 1.
G. M. T. $19^h\ 08^m$

Observed by J. B. Cannon.
Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	59·4727	....	....	....	1	34·8179	·8170	·0051	− 4·91
¼	58·2800	·2658	·0129	+16·34	2	34·6747	....	....	....
2	58·0059	....	....	....	¼	28·8592	·8599	·0102	+ 9·22
2	50·9297	....	....	....	2	28·6183	....	....	....
1	50·9135	·9047	·0162	+ 18·74					

Weighted mean........		+ 7·84
V_a..........................		+ ·98
V_d.................	− ·14	
Curvature..........	− ·28	
Radial velocity.................		+ 8·4

τ TAURI 3018.

1909. Dec. 4. Observed by J. S. Plaskett.
G. M. T. 18h 24m Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9630	....	....	....	1	50·9085	·9085	·0200	23·14
¼	75·8448	·8388	·0122	+19·59	¼	37·9517	·9469	·0053	5·28
2	75·4475	....	....	....	2	37·9416	....	....	....
2	59·4577	....	....	....	½	34·8294	·8302	·0081	7·78
½	58·8068	·8078	·0426	54·36	2	34·6730	....	....	....
1	58·2772	·2765	·0236	29·90	¼	28·8973	·9022	·0525	47·46
2	57·9920	....	....	....	2	28·6141	....	....	....
2	54·0735	....	....	....	¼	20·8456	·8585	·0457	+35·02
¼	53·6612	·6629	·0036	4·31	2	20·4890	....	....	....
2	50·9209	....	....	....					

Weighted mean..................		+ 26·37
V_a..................	− 1·10	
V_d..................	− ·11	
Curvature..........	− ·28	
Radial velocity..................		+ 24·9

τ TAURI 3019.

1909. Dec. 4. Observed by J. S. Plaskett.
G. M. T. 18h 48m Measured by T. H. Parker.

Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.	Wt.	Mean of Settings.	Corrected Star Setting.	Displacement in Revns.	Velocity.
2	75·9421	....	....	....	2	50·9058	....	....	....
½	75·8180	·8328	·0062	+ 9·96	1	50·8992	·9143	·0258	+29·85
2	75·0181	....	....	....	½	34·8332	·8470	·0249	+23·98
2	59·4477	....	....	....	¼	28·8414	·8580	·0083	+ 7·40
½	58·7812	·7952	·0300	+37·95	2	28·6024	....	....	....
½	58·2648	·2792	·0263	+33·32	⅛	20·8120	·8271	·0143	+11·90
2	57·9762	....	....	....	2	20·4932	....	....	....
2	54·0585	....	....	....					

Weighted mean..................		+ 25·41
V_a..................	− 1·10	
V_d..................	− ·14	
Curvature..........	− ·28	
Radial velocity..................		+ 23·9

APPENDIX 3.

REPORT OF THE CHIEF ASTRONOMER, 1910.

MERIDIAN WORK AND TIME SERVICE

BY

R. M. STEWART, M.A.

CONTENTS.

ILLUSTRATIONS.

APPENDIX 3.

REPORT OF R. M. STEWART, M.A., ON MERIDIAN WORK AND TIME SERVICE.

OTTAWA, ONT., March 31, 1910.

Dr. W. F. KING, C.M.G.,
Chief Astronomer,
Department of the Interior,
Ottawa.

SIR,—I have the honour to report as follows on the work carried out under my charge during the fiscal year ending March 31, 1910.

The fitting up of the Transit Annex has been practically completed, with the exception of some arrangements in connection with the azimuth marks, which cannot well be done until the azimuth mark piers shall have been built; these, it is hoped, will be finished by the autumn. A necessary improvement was made to the drainage of the piers in the meridian circle room, which had proved slightly defective; it now appears to be satisfactory. The wiring for electric lights and clock and chronograph circuits has been completed, as has also the fitting up and wiring of the chronograph room. A number of other details have received attention.

The meridian circle was mounted immediately upon the completion of the new pivots, and tests and adjustments proceeded with. The greater part of the work with this instrument during the year consisted in the carrying out of the various alterations outlined in my last report, and in test observations on standard stars. Owing to pressure of work in the workshop these alterations have proceeded very slowly; the greater part of the more important ones have, however, been practically completed. An outline of the modifications introduced is given below. Regular work in right ascension was begun in March.

Observations with the Cooke field transit, and computations of the results, were made as usual for the determination of clock correction, more particularly in connection with the operations carried on in the field for determination of longitudes. The longitudes of eleven stations in eastern Canada were determined from Ottawa; those of four stations in the west were determined relative to Winnipeg by the field observers, Messrs. McDiarmid and Jaques, who also made the field observations in the east. The question of personal equation was again carefully considered; the corrections deduced were of the same order of magnitude as those for the previous summer.

The time service has been maintained as in the past without important change; most of the work in connection with the up-town service has been done, as in previous years, by Mr. D. Robertson. A statement of the number of clocks in operation will be found below.

THE TRANSIT ANNEX.

Drainage of piers.—When the piers for the meridian instruments were rebuilt in 1908 the footings were surrounded by drains of broken stone which led into a specially prepared cistern; the casing of broken stone was not, however, continued to the surface of the ground surrounding the piers. In May, 1909, an accumulation of water took place in the pits of both collimator piers. On examination of the earth surrounding them it was found to have become thoroughly saturated with surface water which had evidently flowed in through and underneath the foundation walls; such was the peculiar consistency of the soil that the water, rather than soak downwards to the drains, had percolated through the concrete walls of the pits and accumulated in the bottom. It was, therefore, necessary to remove the earth surrounding the piers and insert a casing of broken stone which reached to within a few inches of the surface. As soon as this had been done the water in the pits percolated through the concrete into the drains and disappeared; they have since remained perfectly dry.

Temperature in pit of collimator pier.—About the beginning of March, 1909, an open-wound platinum thermometer was placed at the bottom of the pit in the south collimator pier. This was connected by a switch to the Callendar apparatus in Dr. Klotz's room, which is used for obtaining a continuous record of the outside temperature; by turning the switch a record of the temperature in the pit could be obtained at any time. Dr. Klotz has very kindly taken daily readings for me ever since the thermometer was installed. These, as well as the daily maxima and minima of the outside temperature, have been tabulated from March 2, 1909, to March 31, 1910, in degrees Centigrade. Means were taken of the daily maxima and minima (outside temperature), and these averaged for each week. The smoothed curve A (Fig. 1), which was drawn from them, thus represents in a general way the mean temperature throughout the year. The curve B represents similarly the weekly averages of the temperature shown by the thermometer in the pit. Until May, when the accumulation of water appeared, the entrance to the pit had been closed by two hatchways, between which was packed mineral wool; afterwards it was left entirely open. It will be noticed that the lowest temperature recorded was slightly below freezing point, the total variation being about 12° C. The effect of such a variation as this on the position of a mark fixed to the footings of the pier would presumably be very small; when the hatchways are replaced the variation of temperature will no doubt be considerably smaller.

Lenses for azimuth marks.—The long-focus collimating lenses for the azimuth marks, and the two underground lenses which are to serve as reference marks for these, have been ordered. The north and south collimating lenses, of 6 inches aperture, are to have focal lengths of 250 feet and 156 feet respectively; the focal lengths of the corresponding underground lenses of 3 inches aperture will be 20 feet 9½ inches and 20 feet 5 inches. The other two lenses, which will serve as the underground reference points for the azimuth marks, cannot be ordered until after the azimuth mark piers have been completed, which it is hoped will be the case by the autumn.

Electric wiring.—The wiring of the transit room and meridian circle room for electric lights, chronographs and electric clocks has been completed. In the meridian circle room provision is made for nine lights in convenient positions. Two of these are for the axis illumination; two others, for observation of the nadir, are mounted several feet respectively east and west of the position of the micrometer head when the telescope is pointed to the nadir; there are also two electric fans arranged to play upon the telescope to prevent deposition of moisture in damp weather when the temperature is changing rapidly. This was found to take place frequently in the winter months, but has been entirely prevented by the operation of the fans. In the transit room eight lights were

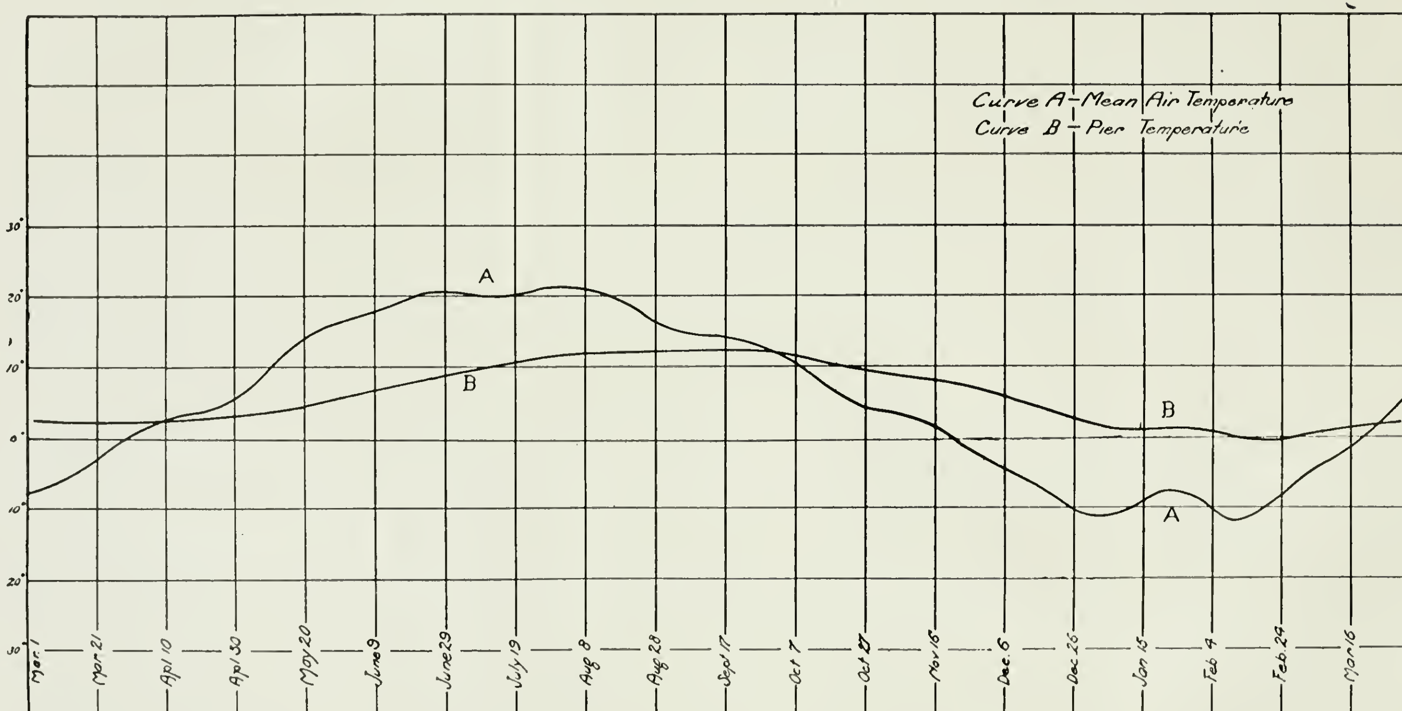


FIG. 1—Temperature in Pit of Collimator Pier.

installed; of these, three are at each of the transit piers, two being mounted on standards above the instrument for reading the level, the third a drop light for setting the circles, reading micrometer head, &c. In both rooms there is also a 5 volt alternating circuit led to each pier, including the collimator piers, for such low-power lights as may be required. These circuits are obtained from a step-down transformer in the basement of the transit room.

In each room there is a sidereal seconds-dial of the polarized type, worked by a current whose direction is reversed every second. These are operated from the secondary sidereal clock in the time room, which is in turn continuously synchronized by the Riefler standard clock; a similar dial in the chronograph room is operated by the same circuit.

To each of the two transit piers, and to the meridian circle pier, run circuits terminating in the chronograph room; these are for use in recording transits with the ordinary chronographs. In addition, another circuit terminating in the chronograph room runs in multiple to all three piers; still another includes the three piers in series; these latter are for use with the printing chronograph.

Chronograph switchboard.—The chronograph room has been fitted up, and permanent mountings provided for the chronographs. A small switchboard has been installed, which serves for making connections for the chronographs for ordinary work, as well as with the telegraph lines for longitude exchanges. Five chronograph circuits are provided; each of these passes through two spring jacks on the switchboard, by which connections to clock and telescope can be effected; there are three plugs, each connected to a pair of wires, one pair running to each of the three telescope piers; several other plugs are similarly connected to relays operated by different clocks. It is thus possible, by insertion of two plugs in the proper jacks, to connect any chronograph to any clock and to any one of the three telescope piers, or, if desired, to cause any two clocks to record together on a chronograph for purposes of comparison. For longitude exchanges two telegraph relays (a 'talking relay' and a 'signal relay') and a sounder are mounted on the board: they can be connected at will to either one of the two telegraph lines which enter the Observatory, by the insertion of a plug in the appropriate one of two jacks. For recording of signals on the chronograph a plug connected to the points of the signal relay is inserted in one of the jacks corresponding to that chronograph, the other jack being occupied by the clock plug; for the sending of clock beats the clock plug is removed from the chronograph jack and inserted in a jack through which the telegraph circuit passes. For comparison of sidereal and mean-time clocks by coincidence of beats another arrangement is provided; the sounder circuit is made to pass in multiple through two jacks; if plugs connected to any two break-circuit clocks be inserted in these, the sounder circuit will remain closed except while the beats of the clocks are coincident, during which time it will beat in synchronism with them.

The circuit-making contacts in the several jacks are so arranged that normally the circuit shall be either open or closed as required; where the circuit is normally open the insertion of a plug closes it automatically; consequently no switches are required. For convenient access to the connections the board is hinged at one end, and can be swung out at right angles to the wall upon which it is hung. This type of switchboard is very convenient and compact; besides the three telegraph instruments, it contains 15 plugs and 15 jacks, controlling the circuits supplied by 42 wires; yet, with ample room to spare, the total size is only 27 inches by 18 inches.

THE MERIDIAN CIRCLE.

Introduction.—A description was given in my last report of the renewing of the pivots of the meridian circle. The original pivots, which were of unhardened steel 4 inches in diameter, were turned down to a diameter of about 3½ inches, and hardened steel bushings forced over them. As steel in a state of extreme hardness is likewise very brittle, the bushings were not left glass-hard, but tempered by heating to a straw colour. At this degree of temper, steel retains enough of its original hardness to resist any but the most strenuous action of a file, while its toughness is very much increased. Tests with a sledge hammer on pieces of the same degree of hardness as the bushings fully established the latter point. After the bushings had been forced into place they were ground to practically the original size (4 inches diameter) and the surfaces finished by lapping with washed emery. The bushings were made of such a length as not to extend quite to the outer ends of the original pivots; thus the ends of the pivots, which engage with the end-thrust bearings on the mounting, were soft enough to be worked if necessary; this was required in order to ensure the possibility of equalizing the distances from the graduated circles to the respective ends of the axis, in order that the microscopes might remain in focus after reversal of the instrument. The tapered bearings on which the circles fit were also trued up, as a slight eccentricity with respect to the new pivots had been introduced; this made it necessary also to turn a corresponding amount off the faces against which the circles were clamped, so that the distance between the circles is now slightly less than originally.

Mounting of the instrument.—This work had been completed by the date at which this report begins (April 1, 1909). As soon after as possible, the telescope was put together and mounted, and the adjustment and testing proceeded with. This instrument differs from many meridian circles in that there is no screw adjustment for correcting the level and azimuth errors. This circumstance, while it increases the difficulty of the original adjustment, is probably an advantage, since there would appear to be less liability of variation of these errors when the standards are firmly bolted down and form practically an integral part of the piers. To each standard corresponds a base-plate which rests on, and is bolted to, four iron blocks, or lewises, embedded in the concrete pier; the standard proper is fastened to its base-plate by four bolts; the bolt holes are of a size which allows a slight adjustment of the position of the standard before bolting down. After recesses for the lewises had been cut in the piers, the base-plates, with lewises attached, were carefully levelled, and were adjusted in position as accurately as possible by reference to marks which had been placed in the meridian on the stone sills of the wall openings north and south. After their positions had been carefully marked they were removed, and, after the recesses had been filled with soft concrete, replaced, and the concrete allowed to harden. The standards were then placed approximately in position and lightly fastened down; after mounting the telescope, observations were taken for level and azimuth. In addition to the elimination of these errors of position of the telescope as a whole, the individual standards required to be correctly oriented and inclined, otherwise the microscopes could not be made to point to circle divisions 90° apart. All these adjustments were performed together by successive approximations, by orienting, shifting and packing up the standards, until all the conditions were approximately fulfilled, after which they were bolted firmly in place. This process, while a very laborious and tedious one, seems, as stated above, to be preferable to the adjustment by screws, in that it gives finally a more solid mounting.

Form of the pivots.—It was found that on reversing the instrument the level error changed by about two seconds of arc; it follows that the difference in the diameters of the pivots is approximately ·0003 inch. Though this was a somewhat larger difference than had been anticipated, it is not of very great importance. A preliminary test of pivot errors showed that the irregularities, if any, were too small for their existence to be definitely established without more refined and extended measurements than those made at the time; there was in addition, however, a relative ellipticity of pivots whose existence was evident, though its exact amount was not determined. It is possible that, in process of time, when the residual internal strains of the hardened bushings have adjusted themselves, there may be a slight change in the form of the pivots. Consequently, it did not seem worth while to attempt the removal of the ellipticity for the present at least. This can be more profitably done at some future time, if thought advisable.

Adjustment of the circles.—The adjustment of the circles perpendicular to the axis was then proceeded with; the desirability of this proceeding was discussed in my last report. As originally designed, one circle was fixed on the axis, and one movable. The fixed circle was attached to a flange on the axis by six screws, and also clamped by a screw collar; the movable circle was fastened by the screw collar alone, thus rendering it capable of rotation on the axis. It is evident that, for the proper adjustment of a movable circle, the surface against which it engages must be truly perpendicular to the axis of the telescope, while at the same time the engaging surface on the circle must be strictly parallel to the plane of the graduations; in the case of a fixed circle neither of these conditions need be fulfilled, so long as the two surfaces are complementary. After consideration, however, though a considerable increase in the labour of adjustment was involved, it seemed desirable to treat both circles, at least during the process of adjustment, as movable. In that case the position of the originally fixed circle could at any future time be altered if desired. In conformity with this decision, the terms 'fixed circle' and 'movable circle' will in future be replaced by 'circle A' and 'circle B', circle A being on the end of the axis remote from the clamp.

As before, the tests of adjustment were made by replacing the lower southern microscope on the western pier by a steel rod sliding in brass bearings; one end of the rod could thus be brought into contact with the graduated band when desired. A mark on this rod was set on with the microscope, which had been mounted with its optical axis perpendicular to the rod. Readings were taken at every 60° around the circle, and immediately repeated in the reverse direction; the circle was then shifted 120° on the axis and the process repeated; the same was done with the circle 240° from its initial position.

Let the angle between the axis of the telescope and the normal to the surface of the bearing on the axis be a'', and let the plane containing these two lines intersect the position of the lower southern microscope when the pointer reading on the circle is φ. Also let the normals to the plane of the graduations and to the plane of the bearing on the circle include an angle b'', and let χ be the pointer reading when the plane containing these two normals cuts the lower southern microscope. Then, for the position of the telescope corresponding to a pointer reading θ, the displacement of the graduated band from its mean position, as measured by the microscope, will be

$$a \cos (\theta - \varphi) + b \cos (\theta - \chi).$$

Taking a series of readings at intervals of 60° around the circle, and diminishing each by the mean of all, we have six equations of the form

$$a \cos (\theta - \varphi) + b \cos (\theta - \chi) = m,$$

θ having the values 0°, 60°, 120°, &c. For the second position of the circle we have six equations of the form

$$a \cos (\theta - \frac{2\pi}{3} - \varphi) + b \cos (\theta - \chi) = m,$$

and similarly for the remaining position. From these 18 equations, a, b, φ and χ may be determined, thus obtaining a complete knowledge of the magnitude and location of the errors considered. Further, by substituting the values so found in the observation equations, we may from an examination of the residuals gain some knowledge as to the planeness of the circle.

As a sample, one such set of measurements on circle B is given below:—

Pointer.	Circle Division.	(First position) m	(Second position) m	(Third position) m
°	°	"	"	"
0	225	0·2	16·9	−6·4
60	285	−11·1	6·6	7·3
120	345	−14·0	−7·5	6·5
180	45	0·4	−21·8	−6·0
240	105	15·1	−7·4	0·5
300	165	9·2	13·0	−1·9

From these 18 observations, by combining the readings for points 180° apart, the following 9 observation equations are derived:—

$$\begin{aligned}
2a \cos (0° - \varphi) + 2b \cos (0° - \chi) &= -0{\cdot}2''\\
2a \cos (60 - \varphi) + 2b \cos (60 - \chi) &= -26{\cdot}2\\
2a \cos (120 - \varphi) + 2b \cos (120 - \chi) &= -23{\cdot}2\\
2a \cos (240 - \varphi) + 2b \cos (0 - \chi) &= 38{\cdot}7\\
2a \cos (300 - \varphi) + 2b \cos (60 - \chi) &= 14{\cdot}0\\
2a \cos (0 - \varphi) + 2b \cos (120 - \chi) &= -20{\cdot}5\\
2a \cos (120 - \varphi) + 2b \cos (0 - \chi) &= -0{\cdot}4\\
2a \cos (180 - \varphi) + 2b \cos (60 - \chi) &= 6{\cdot}8\\
2a \cos (240 - \varphi) + 2b \cos (120 - \chi) &= 8{\cdot}4
\end{aligned}$$

From these are deduced the normal equations

$$\begin{aligned}
9a \cos \varphi &= -45{\cdot}35''\\
9a \sin \varphi &= -96{\cdot}04\\
9b \cos \chi &= 53{\cdot}05\\
9b \sin \chi &= -35{\cdot}25
\end{aligned}$$

Hence $a = 11{\cdot}80''$, $\varphi = 245\tfrac{1}{2}°$
$b = 7{\cdot}08$, $\chi = 326\tfrac{1}{2}°$.

In one position of the circle on the axis this would involve, as the telescope was rotated, an oscillation in the position of the graduated band of over ·003 inch, exclusive of irregularities. Noting that the lower southern microscope is distant 225° from the pointer, and that, for the first position of the circle, the telescope pointed approximately to the nadir when the pointer reading was zero, it follows that the highest point on the axis bearing was situated about 245° from the object end, measured in the clock-wise direction, and that the highest point on the circle bearing was about opposite the division mark 191°. Since the greatest diameter of the bearing was about 8 inches, the amounts to be scraped off the axis and circle at these points were about ·0005 inch and ·0003 inch respectively, diminishing to zero at points opposite these. Evidently this could be done only by trial, by successive approximations.

This process was gone through a number of times for each circle, until the values of a and b were satisfactorily small. The adjustment of circle A, including both measurement and scraping, was done by C. C. Smith and myself; that of circle B, by D. B. Nugent and C. C. Smith.

After the adjustment of the circles had been completed, it was found that there was a slight difference in their distances from the respective ends of the pivots, so that the microscopes did not remain in perfect focus after reversal. A careful measurement was made of this difference by means of the rod and microscope mounted as already described. Settings were made at equal intervals around one circle; the instrument was then reversed and the process repeated on the other circle without disturbing the microscope; the difference of the means of the micrometer readings, when reduced to linear measure, gave the difference required. The telescope was then dismounted, and a cut taken off the end of the proper pivot, these ends having been left soft for the purpose, as mentioned above. The instrument was then remounted and the adjustment completed by scraping, in conjunction with further tests of the same kind, as required. The flatness of the ends of the pivots was controlled by tests with a surface-plate, and their perpendicularity to the axis by tests with the microscope and rod.

Form of the circles.—It has been mentioned above that an examination of the residuals formed by substituting the computed values of a, b, φ and χ in the observation equations would give some information as to the planeness of the graduated bands of the circles. The residuals from the measurements of circle A are collected in Table I, those for circle B in Table II. Each of the columns V_1, V_2, &c., contains the residuals of one complete measurement in three positions of the circle; in general an adjustment by scraping was made between each set of measurements. The column V is the mean of columns V_1, V_2, &c. The general similarity of the residuals in each horizontal line is at once apparent, and affords proof of the reality of inequalities. Grouping the values of V which correspond to the same circle divisions will give an approximate value of the departures of the graduated band from the plane form. These are collected for both circles in Table III, the column V_C being in each case the mean of columns V_1, V_2 and V_3. Again the general similarity of the quantities in the same horizontal line affords evidence of the reality of the inequalities.

It is apparent from the run of the quantities V_C that the irregularities may in a general way be explained by a simple distortion of each circle about a diameter, the distortion for circle A being nearly double that for circle B. In the case of circle A the change of position of the graduated band with respect to any microscope, as the telescope is rotated, would be over ·001 inch. A reference to my last report will show that, for the mean of two opposite microscopes, if telescope settings be made so that the star is always at the same point in the field of view, this would involve in some cases a systematic error in zenith distance of ·1″. Hence it will be necessary in every case to make settings of the telescope exactly upon division marks, leaving the brunt of the measurement upon the zenith distance micrometer.

Flexure of the axis.—If, after subtracting the quantities V_C in Table III from the corresponding V's in Table I and Table II, the remainders be grouped according to nadir distance, we shall have the effect, if any, depending on the position of the axis of the telescope. These remainders have been so grouped, and the means taken, in Table IV. Though the residuals in each horizontal line are not in this case so markedly similar as previously, the quantities V_A would appear to have some definite meaning. It will be noticed that each series would be exactly represented by a sine curve of period 180°; it may be remarked, however, that this is a necesssary consequence of the method of reduction; if the quantities corresponding to the columns V_A had been formed directly from the V's of Table I and Table II, and the quantities V_C deduced from them, the latter could then have been represented by a half-period sine curve, and the former could not; in fact, the two sets of quantities V_C and V_A are not completely independent.

In spite of this, both sets of quantities appear to have a meaning, and it seemed worth while to inquire into the possible sources of an oscillation of the graduated band, having a phase depending on the zenith distance of the telescope.

Considering the limitations of the data (the measurements having been made at the position of only one of the microscopes), the effect might conceivably have arisen from a small oscillation of the telescope as a whole along its axis, due to an inequality in the ends of the pivots and the fixed end-thrust bearing. To test this supposition it was only necessary to set up the microscope and rod, which had previously been used on the circles, in such a position that the end of the rod could be brought into contact with the central point of one end of the axis. As no displacement comparable with that sought for was observed, this hypothesis was disposed of.

As the pivot errors were certainly too small to account for the effect, the only remaining adequate cause appeared to be an irregularity in the flexure of the axis in different positions. If this were the true explanation we might expect that the position of maximum flexure indicated by each circle would be the same; we might also reasonably expect that this would be either the vertical or horizontal position of the telescope. The measurements had all been made at the lower southern microscope on the western pier, a positive residual indicating that the graduated band was displaced to the west of its mean position; when the clamp is east the pointer readings increase (for both circles) as the collimation line is revolved from the nadir through the northern horizon; circle A is in this case next the western pier. Hence, if the rigidity of the axis be least in the plane which is vertical when the nadir distance of the telescope is φ, the variable part of the effect which will be observed at the microscope in question when the nadir distance is θ, will be of the form $A \cos 2\ (\theta + 22\tfrac{1}{2}° - \varphi_A)$ for circle A, and of the form $B \cos 2\ (\theta - 22\tfrac{1}{2}° - \varphi_B)$ for circle B. It may be remarked that in solving for these quantities it is immaterial whether these terms be introduced into the original observation equations, or whether the values be determined from the residuals grouped as in Table IV. The values obtained from the solution are as follows:—

$$A = 1''\cdot 24 \qquad \varphi_A = 1°$$
$$B = 2''\cdot 43 \qquad \varphi_B = -\ 3\tfrac{1}{2}°.$$

The agreement of φ_A and φ_B, and their close approach to zero, is striking; it was taken as strong confirmatory evidence of the existence of variable flexure in the axis, the plane of least rigidity apparently passing through the telescope tube. This in itself would have been harmless enough, provided the inequality were distributed symmetrically along the axis, so as not to affect the line of collimation. The difference between A and B, however, if real, indicating as it did that the point of maximum flexure was not at the middle point of the axis, made the matter more serious, as in that case the line of collimation would vary with the zenith distance. It seemed worth while, therefore, to make some special measurements of the flexure by a more direct method, in order to either verify or disprove the inequality.

The measurements that follow are not to be taken as definitive, as they were made only with a view to deciding whether or not such an irregularity existed, as a preliminary to considering the possibility of its elimination. Once this object was attained, no purpose could be served by prolonging the investigation, as the actual variations of the collimation line could not in any case be determined by the method used.

The arrangement intended for measurement of pivot errors consists of the mercury-dot apparatus devised by Sir David Gill.* Provision is made for the insertion in one pivot of a small circular dot of mercury cemented between two pieces of glass, whose position is made easily adjustable. This, together with a lens in the other pivot, forms a collimator revolving with the instrument, and is viewed by a small telescope attachable to either standard at will. By means of a slight alteration to the mercury-dot mounting, it was made to carry a small mirror, the normal to whose surface could thus be readily brought very nearly into coincidence with the prolongation of the axis of revolution of the telescope. By attaching a collimating eye-piece to the pivot-tester the direction of the normal to the mirror was measured for different zenith distances of the telescope by coincidence of the wires with their reflected images. As originally arranged, the effective focal length of the pivot-tester was considerably increased by the interposition of a concave lens between object glass and micrometer; as it was found impossible to get satisfactory reflected images with this arrangement, it was necessary to remove the concave lens; a longer focus object-glass which happened to be at hand was substituted for the original one to counterbalance this, but the resulting magnifying power was still considerably lower than originally, one revolution of the micrometer screw being very nearly 100″; however, in the absence of anything better this arrangement was used.

Measurements with micrometer vertical and micrometer horizontal were made separately. Pointings for coincidence of the wires with their reflected images were made with the telescope set successively at nadir distances 0°, 30°, 60°, &c., and were immediately repeated in the reverse order. As the definition of the reflected images did not appear uniformly good for all nadir distances, due probably to optical defects in mirror and lens, four such sets of readings were taken, the mirror being rotated about 90° with respect to the telescope between successive sets. These measurements were made on each end of the axis, and in both the vertical and horizontal positions of the micrometer; the measuring apparatus remained on the eastern pier throughout.

The deviations of the normal to the mirror from its mean position consist of two parts: (1) the effect arising from lack of parallelism between the normal and the prolongation of the axis; (2) the part arising from flexure and pivot errors. The first part, which consists of a simple sine function, was eliminated separately from each set of readings, and the residuals formed. The means of the residuals for the four positions of the mirror were taken as indicating the deviations of the prolongation of the axis from its mean direction. These means are collected in Table V. As all the observations were made on the eastern pier,

* See Monthly Notices, Vol. LIX, p. 236.

the position of the telescope was clamp west for the measurements on pivot A, and clamp east for those on pivot B; the nadir distances in Table V are measured through the southern horizon for pivot A, and in the opposite direction for pivot B; thus the quantities in any horizontal line refer to the same actual inclination of the telescope. In the case of the vertical component, a positive quantity indicates that the end of the axis pointed above its average direction; in that of the horizontal component, that it pointed too far north.

From a consideration of Table V it is evident that we have to do mainly with a case of flexure; for any given nadir distance both pivots are deflected in the same direction, and hence the deflections may be explained by a motion of the telescope tube (relative to its mean position) in a direction opposite to this.

It may easily be shown that, with the notation used, the variable part of the vertical component of the deflection due to flexure is of the form $A \cos 2 (\theta - \varphi)$, and the horizontal component $\pm A \sin 2 (\theta - \varphi)$. Assuming for the moment that the total effect is due to flexure, and using each column in Table V for a separate solution, we would have from the vertical component

$$A = 0{\cdot}92'' \qquad \varphi_A = 356\tfrac{1}{2}^\circ$$
$$B = 1{\cdot}03'' \qquad \varphi_B = 1^\circ$$

and from the horizontal component

$$A = 0{\cdot}60'' \qquad \varphi_A = 359^\circ$$
$$B = 1{\cdot}42'' \qquad \varphi_B = 3^\circ.$$

The difference between A and B as obtained from the horizontal component arises partially at least from the relative ellipticity of pivots mentioned above, which affects only the horizontal component. The effect of ellipticity may be represented by a term of the form $\alpha \sin 2 (\theta - \chi)$; if we also assume $\varphi_A = \varphi_B$ (which means simply that the flexure takes place in a plane), the four columns of Table V will be represented respectively by equations of the form

$$A \cos 2 (\theta - \varphi) = m_V$$
$$B \cos 2 (\theta - \varphi) = m'_V$$
$$A \sin 2 (\theta - \varphi) + \alpha \sin 2 (\theta - \chi) = m_H$$
$$-B \sin 2 (\theta - \varphi) + \alpha \sin 2 (\theta - \chi) = m'_H$$

θ having successively the values 0°, 30°, 60°, &c. The simultaneous solution of these 48 equations gives the following values for the quantities involved:—

$$A = 0{\cdot}93'' \pm {\cdot}02'' \qquad \varphi = 0^\circ 30' \pm 22'$$
$$B = 1{\cdot}05'' \pm {\cdot}02''$$
$$\alpha = 0{\cdot}36'' \pm {\cdot}03'' \qquad \chi = 96^\circ 30' \pm 1^\circ 29'$$

If the value of α deduced above is the true one, it may be shown that if only one pivot be elliptical its greatest and least diameters must differ by about ·0002 inch;* if the ellipticity be divided between the pivots there must be at least one of them the difference of whose diameters amounts to half this quantity or more. Quantities of this order of magnitude are easily amenable to lapping; hence there will be no great difficulty in almost entirely removing the ellipticity if desired; its presence is evidence of insufficient lapping

The probable errors given were deduced directly from the residuals, i.e., the assumption is involved that there are no pivot irregularities except the relative ellipticity; hence the values are an upper limit to the probable errors, and are probably somewhat too large. It appears evident, then, that flexure of the axis is a maximum when the telescope points to the zenith or the nadir, and a minimum when it points to either horizon. Further, since the values of A and B

* Diameter of pivots = 4 inches; distance between pivots = 45 inches.

differ by at least six times their probable error, we may conclude that the flexure is not quite symmetrical along the axis. As to the cause of this, there has been found to be a difference of 17 pounds between the weights of the circles, circle B being the heavier. It is possible that, without the supposition of a longitudinal asymmetry in the rigidity of the axis, this might be sufficient to explain the greater observed flexure at pivot B. The amount by which this difference of flexure will affect the direction of the collimation line will depend on the distribution of the flexure along the axis, but on any reasonable supposition of this distribution it would probably be very small. If, however, as seems possible, it can be eliminated by the addition of a balancing weight in the vicinity of circle A, it will be worth while to do so.

By substituting the values of A, B, &c., in the original equations, forming the residuals, and taking means of pivot A and pivot B, values of the pivot errors could be obtained. It does not seem worth while to give these here, as the intervals (30°) are too great to be of practical use, and in any case the deduced errors would not be worthy of being classed as definitive. They are all fairly small, the largest in either vertical or horizontal component (exclusive of the effect of ellipticity) being ·12″.

So far we have had to do only with variations of flexure, the measurements giving no clue to its total amount. This was measured in another manner as follows. With the mirror attached to the axis as before, micrometer readings for coincidence of the wires with their reflected images (with micrometer vertical) were taken for every 60° zenith distance; the mean of these gave a micrometer reading defining the inclination of the end of the axis to the horizon. The mirror was then removed, and replaced by the mercury-dot and collimating lens as regularly used for measurement of pivot error. The mean of settings on the mercury-dot for every 60° zenith distance then gave a micrometer reading defining the inclination of the line passing through the centres of the pivots. The difference between these two mean micrometer readings gave the total deviation at that pivot due to flexure. This measurement was made at both pivots; the flexure was found to be approximately 10″ for each.

We may now obtain some idea of the relative rigidity of the axis in the planes parallel to and perpendicular to the line of collimation of the telescope. If the average flexure be 10″, and the argument of the variable part 1″, the total flexure with the telescope vertical would be 11″, and with the telescope horizontal, 9″; hence the rigidity of the axis in the direction perpendicular to the collimation line is greater than that in the direction parallel to it in the ratio of 11 to 9. This difference may arise wholly from the unsymmetrical construction of the cube; the perforations which lead to the eye and object ends have a diameter of 6⅝ inches; those in the perpendicular direction (permitting the intervisibility of the collimators) of only 4½ inches; the rigidity (i.e., resistance to gravity) would be greater when the sides containing the smaller perforations are horizontal, i.e., when the telescope points to the horizon. This tendency is increased by the arrangement of the strengthening ribs on the inner surface of the cube. The presence of the flanges which form part of the two halves of the telescope tube, and which are bolted to the cube, would tend to counteract the effect, but are evidently insufficient to eliminate it.

It has been remarked above that, provided the flexure is symmetrically distributed along the axis, any variation in its amount for different zenith distances of the telescope can have no effect on the direction of the line of collimation. The complementary proposition also holds, that provided the flexure is the same for all zenith distances any asymmetry in its distribution along the axis will be harmless; the only effect would be an apparent inequality of pivots. It would appear, therefore, that the danger of ill effects from axis flexure could be considerably lessened in the construction of a meridian circle by making the perforations in all four faces of the cube more nearly of the same size. The total flexure would thereby be slightly increased, though the increase would probably be small; the flexure in different planes would, however, be more nearly constant, and the effect of any unavoidable asymmetry along the axis would tend to be minimized.

It may be interesting here to compare the results obtained by Prof. Boss* in an investigation of the Olcott meridian circle of Dudley Observatory at Albany. His investigation (made in a similar way, by means of a mirror attached to the end of the axis) was for the purpose of determining pivot errors, the perforations in the pivots being too small to admit of the axis-collimator method. His measurements, when reduced in the same way as those given above, lead to the following values:—

$$A = 0{\cdot}78'' \qquad \varphi = 0^\circ$$
$$B = 0{\cdot}82''$$
$$\alpha = 0{\cdot}09'' \qquad \chi = 102^\circ$$

In this case also the maximum flexure occurs when the telescope is vertical, the amplitude of the variable part being slightly less than for the Ottawa meridian circle. The distance between the counterpoise hangers is 28 inches, as against about 40 for the Ottawa instrument; the perforations in the cube (for setting of collimators) are 2·4 inches only. The difference between A and B is very small; they were assumed equal by him. No measurement was made of the total flexure.

It will be noted that the values of A and B derived from the pivots are considerably smaller, and more nearly equal, than those obtained from the measurements of the circles. If both methods were equally trustworthy we should have expected A and B to be somewhat smaller at the circles, the distance between the latter being less. The discrepancy may conceivably be due to the greater indirectness of the observations on the circles, together with errors introduced by slight deformations of the circles, which might be different in different positions of the latter on the axis. If circumstances permit, some further investigations may possibly be made with a view to clearing up this point.

The counterpoises.—The unsatisfactory nature of the original counterpoises was mentioned in my last report. The counterpoise weights were each only 10 pounds, involving in each case a double lever system with a magnification factor of 35 or 40, the arrangement of the lever supports being also such as to introduce much friction. The uselessness of the arrangement may be judged by the fact that, with the counterpoises in adjustment, and a considerable weight resting on the pivots, if either pivot were lifted out of its Y by slightly depressing the counterpoise, the effect of friction was sufficient to make it remain there until the counterpoise was lifted to its previous position. Needless to say, any effective control of the weights resting on the pivots was impossible. New counterpoises have been made and installed. Each lever consists of a forging in the form of a cross; the lengths of the arms are 21 inches and 8 inches, the shorter arm being 5 inches from one end of the longer one. At each end of the shorter arm is a knife-edge of hardened steel; these rest in V's supported by a casting fastened to the standard. The inner end of the long arm is attached to the hanger on the axis; the outer end is threaded, and carries three circular

* Astronomical Journal, Vol. XXIV, p. 167.

cast-iron weights which serve as the counterpoises; these can be easily adjusted by screwing in or out on the lever. The multiplication factor is about 2·5. Immediately beneath each set of weights is a casting which rests on the pier; two screws are so placed as to support the weights when the telescope is lifted from its bearings for reversal. These counterpoises have been found to work very satisfactorily.

The micrometer head.—The eye-end of the telescope carries two micrometer slides, for measurement of transits and zenith distances. The eye-piece tube is attached to a slide which is actuated by a screw connected by gearing with the transit micrometer screw, so that the two parallel transit threads remain always in the middle of the field of the eye-piece; another slide permits motion of the eye-piece in zenith distance. The screw controlling the motion of the eye-piece slide in right ascension was slightly bent when received; partly on this account, and partly owing to defects in the slide itself, the movement in right ascension worked very stiffly. While waiting the relief of pressure in the workshop, an attempt was made during the summer of 1909 to use the instrument as it stood, but with very poor results. Accordingly, at the earliest possible moment the micrometer head was dismounted and thoroughly overhauled. A new screw was made for the eye-piece slide, and the slide itself and the surface upon which it bore, both of which were far from flat, were scraped true; a number of minor adjustments were also made. Connected with the zenith distance micrometer there is a recording device which obviates the necessity of reading the micrometer head. On a bearing concentric with the micrometer screw there are two wheels connected by gearing; one of these, driven by a pin on the micrometer head, carries type figures corresponding with the divisions of the head; the other carries similar figures marking whole revolutions of the former. After making a bisection, a strip of paper carried by two drums is pressed into contact with the type wheels by a screw of very coarse pitch; the paper is then moved along by rotating one of the drums upon which it is carried, and the record of that bisection is complete. As originally arranged the record consisted simply of the indentations made in the paper by the pressure of the type; this necessitated the application of considerable pressure to ensure a readable record, and did not seem altogether satisfactory. An arrangement was therefore added by which an inked ribbon was introduced between the type wheels and the paper; this was held in position by a system of rollers, its two ends being carried on small drums in the same way as the paper; by rotating one of the drums occasionally a fresh part of the ribbon could be brought into use as often as required.

The spacing of the original pairs of micrometer threads, both in right ascension and zenith distance, which had been 12″ or 15″, was considered to be entirely too great. The threads were therefore renewed, the distance aimed at being between 4″ and 5″. The actual distance of the vertical threads is now 4·2″, that of the horizontal ones, 4·5″; this appears to be a decided improvement.

On the completion of the repairs and alterations to the micrometer head, about the beginning of February, 1910, it became possible to proceed with work in right ascension. Some time was taken up with test observations and various adjustments before regular work was begun. The work in progress will be mentioned below.

The microscopes.—On examination of the microscopes it had been found that a number of the micrometer slides did not work freely; even in the case of those that were free, the shortness of the springs caused a very uneven tension at different parts of the run; this, besides causing a very appreciable difference in the ease of turning the screw, would have caused uneven wear of the latter; it was therefore judged better to increase the length of the springs, so as to insure a sensibly even tension throughout the whole run. This involved dispensing with one of the springs (of which each microscope had originally two); otherwise one of them would have been exposed in the field of the eye-piece. The remaining one (which was hidden from view by the comb) was lengthened so as to extend the whole length of the micrometer frame, extending to six or eight times its original length. This was found to greatly improve the working of the micrometers. The slides were carefully fitted, as also were the plates which carried the combs; some of these had previously bound the slides and prevented their proper working. The micrometer threads were also renewed, and the numbering of the graduations on the head of one of each pair of opposite microscopes was reversed, so as to eliminate the effect of unequal wear of the screws.* Eye-pieces of about double the original power have also been ordered for all eight microscopes. As it was impossible at the time to have all eight microscopes overhauled, four only were completed, two for each circle; this gave an opportunity of using the instrument for test observations in zenith distance.

After only a few nights' work it was evident that the accuracy of the observations was far from satisfactory. On examination it was found that the mounting of the microscopes was not sufficiently rigid. These are not, as in the case of most modern meridian circles, mounted on a continuous ring, but on separate arms extending radially from the standards. These arms are quite sufficiently rigid in the sense of preventing a rotation of any microscope as a whole in zenith distance; a very slight *twist*, however, is sufficient to rotate the arm, and consequently the line of collimation of the attached microscope, about a line radial to the instrumental axis; in fact, a twisting pressure applied by two fingers to the arm is sufficient to displace the image of a circle division by several minutes of arc; evidently microscopes so mounted cannot be depended on to remain constant in position. As the microscope carriers proper project from the supporting arms towards the circles for nearly their whole length, it will be possible to connect the inner ends of each set of four by a metallic ring; if the rings are carefully fitted so as to introduce no strains it should be possible in this way to very materially stiffen the mounting and perhaps eliminate all trouble. Two such rings are now being made, and will be fitted into place as soon as possible; until this is done it is useless to attempt declination work.

Collimation and level.—The collimators have been mounted temporarily on the piers provided; the permanent mounting cannot well be proceeded with until the completion of the azimuth marks. The wire systems of the collimators have been so rearranged as to eliminate the necessity of estimation of coincidence of wires. The north collimator contains two vertical wires at a distance of 15″, and also two horizontal wires (of which only one is necessary); the wire frame is movable by a vertical micrometer screw. The south collimator contains two vertical wires at a distance of 9″, and one horizontal wire; these are movable in the horizontal direction. Settings are made from the south collimator by placing its double wire system within the image of that of the north collimator; when the spacings of the two systems are suitable this is a fairly delicate method. Settings of the telescope on either collimator are made by bringing the images of the two collimator wires successively a number of times between the close vertical wires of the telescope. Measurements of flexure can be made in

* See Monthly Notices XXXVII, p. 18; XLV, p. 64; LIX, p. 73.

the same way by turning each collimator through a right angle about its axis of collimation. To facilitate this the collimators rest at each end on circular bearings, and are capable of easy rotation.

All readings for collimation, whether by night or day, are made by artificial light. When making settings on either collimator. the eye-piece is replaced by a tube containing a disc of ground glass, upon which light from a near-by lamp is reflected. It has been found advantageous to restrict the illumination to a circle of about 3′ diameter surrounding the intersection of the collimator threads; this is effected by the use of a diaphragm containing a small hole, which is mounted in the tube carrying the ground glass, and comparatively close to the threads. This materially reduces the total amount of light striking the eye, though not interfering with the brightness of the unrestricted part of the field; it appears to enable a considerable improvement in the accuracy of pointings.

The magnification of the original collimator eye-pieces was about 65; as this was too low, one of the meridian circle eye-pieces (power 200) has been used for this purpose; when used with the collimator it gives a magnification of about 130. A new reversing eye-piece of the same power has been ordered; it is intended to use this both in collimation readings and in star observations with the circle telescope, in order to check and eliminate systematic errors.

A modification of the ordinary method of nadir observation has been adopted; the estimation of coincidence of wires consists in the obliteration of bright by dark wires in a dark field, the dark wires being invisible. A description of this method will shortly appear in the Journal of the Royal Astronomical Society of Canada.

Observations.—As mentioned above, transit observations with the meridian circle were attempted in the summer of 1909, previous to the repairs to the micrometer head. These were begun towards the end of June, and carried on intermittently during the summer. As longitude operations were in progress during a portion of this period, observations with Cooke transit No. 1 were made on every night on which exchanges took place; sometimes observations with the meridian circle were also made on the same night. Though the meridian circle observations, when reduced, were obviously very poor, an attempt was made to investigate for personal differences in a general way, but the variations between the results for different nights, and the discordances with the results of the small transit, were so marked that nothing could be done. Experiments were made with eye-pieces of powers 100, 160 and 200; so far as could be judged, there appeared to be systematic differences between the observations with different powers, while the highest power appeared the most suitable except for especially poor seeing. It was decided, therefore, to adopt the power 200 as that to be used exclusively. The observations made were not used in any other way, as they were not considered reliable enough for application to the longitude work in combination with the results from the small transits.

As the workshop was to a great extent monopolized by necessary repairs to field instruments for a considerable part of the winter, the repairs to the micrometer head were not completed until the spring of 1910; the regular observation of transits was begun in March. It was not considered advisable to attempt any strictly fundamental work for the present, but rather to confine the work (in addition to determinations of clock error as required for longitude work and other purposes) to differential observations of the positions of such stars as were required for the field work carried on by this Observatory. For the longitude work the star-list of the Berlin Jahrbuch has been used in the past; in 1908 and 1909 some additional stars from Newcomb's Fundamental Catalogue were employed, in the former year without, in the latter with, the application of systematic corrections depending on the declination; the addition of these stars has been found of considerable convenience in observing. It was decided, therefore, to observe a selected list of Newcomb stars, including most of those north of the equator which are not contained in the Berlin Jahrbuch, and to refer their places to the system of the latter catalogue, especial attention being paid to the right ascensions. This programme, besides being capable of immediate application to the needs of this Observatory, will also be of scientific value in wider applications. With regard to declinations, a pressing need has been felt for more recent determinations than in many cases exist of the places of stars for latitude work by Talcott's method. It is proposed, therefore, as soon as declinations can be measured, to extend the observing list to include such stars as are likely to be most useful for this purpose.

In addition to the regular programme of work outlined above, the first necessity which arose was for the determination of the longitude of Winnipeg. This is a station of considerable importance, as it is intended to be used as a base station for points in western Canada. For this reason it is proposed to determine the relative personal equations of the observers engaged both before and after the series of longitude exchanges has taken place. The first series of observations for this purpose was begun in March.

Auxiliary instruments.—A new standard barometer was ordered and received during the course of the year. Unfortunately the tip was broken off the tube in shipment, and a small quantity of air thereby admitted, part of the mercury being spilled; in an attempt to remedy this the tube was broken. A new tube to replace it has been ordered. Three thermographs, a Regnault hygrometer, and two dial hygrometers have also been obtained, with a view to a study of atmospheric temperature and moisture within and without the meridian circle room, and their effects on conditions of observation.

TABLE I.—RESIDUALS FROM ADJUSTMENT OF CIRCLE A.

Nadir distance.	Circle division.	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V
°	°	"	"	"	"	"	"	"	"	"	"
0	135	6·9	5·8	10·7	6·7	6·6	8·6	8·1	7·4	8·7	7·7
60	195	−7·2	−5·1	−6·2	−3·5	−4·1	−5·3	−5·0	−3·1	−5·1	−5·0
120	255	2·3	4.2	0·2	4·1	1·9	2·9	1·4	1·6	0·1	2·1
180	315	6·6	5·0	6·2	4·6	3·7	5·6	4·8	3·8	5·6	5·1
240	15	−4·8	−5·4	−8·3	−7.3	−4·0	−7·6	−5·4	−6·3	−5·3	−6·0
300	75	−4·0	−4·5	−2·8	−4·4	−4·2	−4·4	−4·1	−3·4	−3·9	−4·0
240	135	6·4	7·7	7·7	10·1	4·4	8·4	6·3	7·5	6·8	7·3
300	195	−4·7	−4·3	−9·2	−6·5	−3·0	−5·6	−5·5	−6·3	−5·8	−5·7
0	255	1·8	−0·6	−0·4	−2·4	−1·1	−2·3	−0·6	−2·3	−0·8	−1·0
60	315	1·7	0·9	5·1	2·1	0·7	2·3	2·0	2·8	3·1	2·3
120	15	−5·8	−5·1	−5·1	−4·9	−2·5	−3.9	−3·4	−2·9	−3·1	−4·1
180	75	0·9	1·4	2·2	1·8	1·3	1·1	1·0	1·2	−0·2	1·2
120	135	7·4	6·1	6·5	5·5	6·2	5·6	5·2	5·7	6·6	6·1
180	195	−6·9	−8·1	−6·2	−8·5	−5·5	−7·7	−5·7	−6·3	−6·0	−6·8
240	255	−2·6	−2·3	−0·5	−1·8	−2·5	−1·2	−0·9	−1·3	−1·0	−1.6
300	315	5·6	6·8	8·3	8·9	6·8	8·0	6·1	8·3	6·6	7·3
0	15	−1·3	0.0	−2·9	0·4	0·0	−0·7	−0·8	−0·5	−1·8	−0·8
60	75	−2·2	−2·6	−5·4	−4·4	−4·7	−3·9	−3·8	−5·6	−4·3	−4·1

TABLE II.—RESIDUALS FROM ADJUSTMENT OF CIRCLE B.

Nadir distance.	Circle division.	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V
°	°	″	″	″	″	″	″	″	″	″	″
0	225	−0·6	−1·8	−3·7	−4·1	−4·7	−2·4	−0·2	−0·4	0·5	−1·9
60	285	1·1	−1·1	−0·7	1·0	−0·3	−0·8	−0·2	0·5	−1·4	−0·2
120	345	−0·9	−0·5	2·1	2·2	2·3	0·2	0·5	0·8	−1·4	0·6
180	45	1·2	−1·3	−3·3	−2·0	−2·7	−2·1	−1·8	−1·3	−0·4	−1·5
240	105	2·9	3·2	2·9	1.0	2·9	2·7	0·4	0·3	2·5	2·1
300	165	−3·9	1·1	2·4	1·7	2·7	2·7	0·6	0·1	0·3	0·9
240	225	−0·7	−5·1	−5·6	−5·4	−7·0	−2·8	−2·9	−3·1	−2·3	−3·9
300	285	0·3	1·0	0·6	1·5	1·9	−0·7	−2·5	−1·5	−2·4	−0·4
0	345	3·9	8·2	6·7	5·5	7·2	4·7	4·2	4·0	5·4	5·5
60	45	−4·2	−4·4	−5·0	−6·6	−6·2	−1·2	−1·9	−3·1	−0·8	−3·7
120	105	−1·1	−0·6	−0·2	0·1	−0·5	−0·2	−1·5	−1·4	−1·4	−0·8
180	165	1·6	2·8	3·6	5·0	4·5	0·5	4·4	5·0	1·5	3·2
120	225	−5·6	−5·9	−5·4	−6·1	−4·7	−5·1	−3·1	−3·4	−2·6	−4·7
180	285	2·7	3·5	2·3	0·8	1·8	1·5	1·2	0·6	2·2	1·8
240	345	1·1	5·9	4·9	4·8	3·4	6·4	2·1	1·8	3·8	3·8
300	45	−6·8	−11·9	−8·7	−7·5	−7·7	−8·5	−1·3	−1·0	−6·8	−6·7
0	105	5·1	3·7	1·6	2·8	1·7	−1·0	−1·5	−0·9	1·0	1·4
60	165	3·5	4·8	5·5	5·4	5·6	6·6	2·7	3·0	2·4	4·4

TABLE III.—RESIDUALS DEPENDING ON CIRCLES.

Circle division.	Circle A.				Circle division.	Circle B.			
	V_1	V_2	V_3	V_C		V_1	V_2	V_3	V_C
°	″	″	″	″	°	″	″	″	″
135	7·7	7·3	6·1	7·0	225	−1·9	−3·9	−4·7	−3·5
195	−5·0	−5·7	−6·8	−5·8	285	−0·2	−0·4	1·8	0·4
255	2·1	−1·0	−1·6	−0·2	345	0·6	5·5	3·8	3·3
315	5·1	2·3	7·3	4·9	45	−1.5	−3·7	−6·7	−4·0
15	−6·0	−4·1	−0·8	−3·6	105	2·1	−0·8	1·4	0·9
75	−4·0	1.2	−4·1	−2·3	165	0·9	3·2	4·4	2·8

TABLE IV.—RESIDUALS DEPENDING ON POSITION OF TELESCOPE.

Nadir distance.	Circle A.				Nadir distance.	Circle B.			
	V_1	V_2	V_3	V_A		V_1	V_2	V_3	V_A
°	″	″	″	″	°	″	″	″	″
0	0·7	−0·8	2·6	0·8	0	1·6	2·2	0·5	1·4
60	0·8	−2·6	−1·8	−1·2	60	−0·6	0·3	1·6	0·4
120	2·3	−0·5	−0·9	0·3	120	−2·7	−1·7	−1·2	−1·9
180	0·2	3·5	−1·0	0·9	180	2·5	0·4	1·4	1·4
240	−2·4	0·3	−1·4	−1·2	240	1·2	−0·4	0·5	0·4
300	−1·7	0·1	2·4	0·3	300	−1·7	−0·8	−2·7	−1·7

TABLE V.—FLEXURE OF AXIS OF MERIDIAN CIRCLE.

Nadir distance.	Vertical component.		Horizontal component.	
	Pivot A	Pivot B	Pivot A	Pivot B
°	"	"	"	"
0	1·01	1·02	−·05	·24
30	·30	·60	·54	−1·08
60	−·61	−·61	·51	−1·43
90	−·88	−·94	−·06	−·13
120	−·30	−·55	−·46	1·20
150	·51	·42	−·48	1·32
180	·84	1·09	−·09	·08
210	.43	·49	·57	−1·18
240	−·51	−·42	·53	−1·24
270	−·96	−1·03	·04	−·11
300	−·41	−·61	−·71	1·10
330	·57	·54	−·33	1·22

OBSERVATIONS WITH FIELD TRANSITS.

Longitude work.—During the summer of 1909 the longitudes of eleven stations in eastern Canada were determined from Ottawa, two observers being engaged in the field operations (including determination of latitudes), and three at Ottawa. There were 77 exchanges of clock signals on 53 nights; in the conduct of these the same practice was followed as in the preceding summer; the exchanges were held at the hours most convenient to the field observers, irrespective of observations or weather conditions at Ottawa; for nights on which no observations were obtained at Ottawa the clock error was computed by interpolation from the two adjacent nights; the exchanges were conducted by Mr. D. Robertson. Later in the season the longitudes of four stations in the west were determined relative to Winnipeg by Messrs. F. A. McDiarmid and W. C. Jaques; in this work there were 37 exchanges on 34 nights, besides latitude observations. Additional observations were made in the autumn to determine the relative personal equations of the five observers engaged. The instruments used were the three portable Cooke transits belonging to the Observatory, No. 1 being employed by the Ottawa observers, and Nos. 2 and 3 in the field observations.

Star list.—The star list contained all the Berlin Jahrbuch stars of suitable declination; to these were added a number of stars from Newcomb's Fundamental Catalogue. A comparison was made between the right ascensions of all B. J. stars between the limits 0° and 80° declination, and their right ascensions as given by Newcomb. The differences were first grouped for zones 5° in width; as the means did not run very smoothly, being apparently affected by accidental differences, a smoothing process was applied by taking the weighted mean for every two consecutive zones. The mean differences so obtained are shown in Table VI, under the heading $\Delta\alpha_\delta$. From these figures a curve was plotted and, partly by actual and partly by graphic interpolation, the list of corrections given in Table VII was obtained. These corrections were applied to the right ascensions of all non-Jahrbuch stars in the observing list. To deduce the corresponding correction $\Delta\alpha_\alpha$ depending on right ascension, the corrections in Table VII were applied to each star separately, and the remaining differences grouped for each hour of right ascension. These are exhibited for three different ranges of declination in Table VIII, the subscript numbers denoting the number of stars in each case. As the corrections are in all cases small, and appear to vary considerably with the limits of declination included. they have not been applied.

Personal equation.—The data for personal equation were of two different types, as in the season of 1908. By assuming regularity of the clock rate, values of the relative personal equations of the home observers were obtained from the regular observations; as. however, much of the field work had been done in the west, using Winnipeg as base station. the observations taken at Ottawa with the field transit were rather meagre; they consisted of only nine weeks' continuous work, during which period observations were obtained on 41 nights. The indirect results so obtained were combined with those of a special series of observations in the autumn, in which all five observers took part. The personal equations were referred to C. S.* as standard observer. The separate results for clock correction on those nights which were used for longitudes and personal equation are shown in Table IX.

In the discussion of the group of observations included between June 7 and August 10, the whole period was divided into two shorter ones, June 7 to July 20 and July 25 to August 10. For each of these periods the mean of the observations on any one night was represented by the observation equation

$$a + bt + ct^2 + e = \Delta T,$$

t being the interval from a fixed epoch, a, b and c undetermined constants, ΔT the observed clock correction. and e the personal equation of the observer referred to the standard observer. After combining the observation equations and deducing the values of e for S and N, referred to C S as standard, and also of a, b and c, these values were substituted in the observation equations and the residuals formed. From these was deduced the quantity r, the "probable error of a single observation": in addition to actual errors of observation this also includes in the present case the effect of fluctuations of clock rate not expressed by the assumed formula: the values of r were eventually used in deducing the weights with which the separate determinations entered the final result. The normal equations after elimination of a, b and c, as well as the deduced personal equations (denoted by S and N), and the values of r, are as follows for each of the two periods considered:

June 7 to July 20

$$3{\cdot}124\ S - 1{\cdot}549\ N = {\cdot}308 \text{ sec.}$$
$$-1{\cdot}549\ S + 5{\cdot}617\ N = -{\cdot}072 \text{ "}$$
$$S = {\cdot}107 \text{ sec.}$$
$$N = {\cdot}017 \text{ "}$$
$$r_1 = \pm{\cdot}0289 \text{ "}$$

July 25 to Aug. 10

$$3{\cdot}908\ S - 2{\cdot}570\ N = {\cdot}353 \text{ sec.}$$
$$-2{\cdot}570\ S + 3{\cdot}619\ N = -{\cdot}317 \text{ "}$$
$$S = {\cdot}061 \text{ sec.}$$
$$N = -{\cdot}044 \text{ "}$$
$$r_2 = \pm{\cdot}0227 \text{ "}$$

In the treatment of the autumn observations the influence of clock rate (except as involved in small differential corrections, in no case exceeding ·004

* The signatures of the observers are as follows: Home observers: R. M. Stewart—S; D. B. Nugent—N; C. C. Smith—C S; Field observers: F. A. McDiarmid—M; W. C. Jaques—J.

sec.) was entirely eliminated. The fact that sometimes two and sometimes three of the five observers worked simultaneously necessitated a special treatment, which may be worth describing. The observations considered, after the application of corrections for clock-rate where necessary for reduction of observations by different observers to the same epoch, and after correction for longitude (−·011 sec.) in the case of the observations taken on the eastern pier, are given in Table X. If A denote the most probable value of clock-correction according to C S at any given epoch, and S, N, M and J the personal equations of the other observers relative to C S, the most probable values of the clock-corrections obtained by them would be respectively A–S, A–N, &c. Hence from the figures in Table X we obtain the observation equations.

$$
\begin{aligned}
A_1 &= 12{\cdot}505 \text{ sec.} \\
A_1 - S &= 12{\cdot}439 \text{ “} \\
A_1 - J &= 12{\cdot}419 \text{ “} \\
A_2 &= 12{\cdot}417 \text{ “} \\
A_2 - S &= 12{\cdot}359 \text{ “} \\
A_2 - J &= 12{\cdot}360 \text{ “} \\
A_3 &= 11{\cdot}379 \text{ “} \\
A_3 - N &= 11{\cdot}368 \text{ “} \\
A_3 - J &= 11{\cdot}275 \text{ “} \\
&\text{etc.}
\end{aligned}
$$

We might now combine these into normal equations and so deduce the values of all the unknowns; as, however, this would involve the solution of 22 normal equations, the labour would be considerable. It is evident that, so far as the values of S, N, M and J are concerned, we may, without affecting the result, combine all observations in which the same group of observers was engaged by taking the simple mean. Putting $\frac{A_1 + A_2}{2} = B_1$, $\frac{A_3 + A_4 + A_5}{3} = B_2$, &c., the observation equations become

$$
\left.\begin{aligned}
B_1 &= 12{\cdot}^{s}461 \\
B_1 - S &= 12{\cdot}399 \\
B_1 - J &= 12{\cdot}389
\end{aligned}\right\} \text{weight } 2
$$

$$
\left.\begin{aligned}
B_2 &= 11{\cdot}171 \\
B_2 - N &= 11{\cdot}191 \\
B_2 - J &= 11{\cdot}063
\end{aligned}\right\} \text{weight } 3
$$

etc.

The number of normal equations is now reduced to 12; solving these, we obtain values of S, N, M and J. To find r_3, the probable error of a single observation, we first proceed to find A_1, A_2, etc. from the original observation equations, using the now known values of S, N, &c. Then, substituting the values of all the unknowns in the observation equations and forming residuals, the value of r_3 is deduced. The reduced normal equations involving only S, N, M and J, and the deduced values of the latter and of r_3, are as follows:

$$
\begin{aligned}
5{\cdot}167\,S - 1{\cdot}000\,N - 1{\cdot}500\,M - 1{\cdot}333\,J &= {\cdot}218 \text{ sec.} \\
-1{\cdot}000\,S + 5{\cdot}000\,N - {\cdot}333\,M - 1{\cdot}667\,J &= -{\cdot}223 \text{ “} \\
-1{\cdot}500\,S - {\cdot}333\,N + 5{\cdot}000\,M - 2{\cdot}500\,J &= {\cdot}008 \text{ “} \\
1{\cdot}333\,S - 1{\cdot}667\,N - 2{\cdot}500\,M + 7{\cdot}167\,J &= {\cdot}271 \text{ “}
\end{aligned}
$$

$$
\begin{aligned}
S &= {\cdot}080 \text{ sec.} \\
N &= {\cdot}001 \text{ “} \\
M &= {\cdot}003 \text{ “} \\
J &= {\cdot}075 \text{ “} \\
r_3 &= \pm {\cdot}0173 \text{ “}
\end{aligned}
$$

We have now deduced, from the three periods considered, three sets of equations involving the required personal equations, and also the probable error of a single observation for each period; the relative weights corresponding to the latter are respectively ·36, ·58 and 1·00. Now it may be shown that if, using these weights, we had combined all our original observation equations, 87 in number, into a single set of normal equations, involving 30 unknowns, and had proceeded to eliminate all the unknowns except S, N, M and J, the four resulting equations would have been identical with those obtained by taking the weighted sums of the corresponding equations of the three groups deduced above. This is a principle of great practical convenience when it is required to combine the results of several groups of observations, each group containing different unknowns in addition to those whose values are required.

Combining the three groups in this way, we obtain the final set of equations:

$$8{\cdot}553\ S - 2{\cdot}048\ N - 1{\cdot}500\ M - 1{\cdot}333\ J = {\cdot}534 \text{ sec.}$$
$$-2{\cdot}048\ S + 9{\cdot}121\ N - {\cdot}333\ M - 1{\cdot}667\ J = -{\cdot}433 \text{ “}$$
$$-1{\cdot}500\ S - {\cdot}333\ N + 5{\cdot}000\ M - 2{\cdot}500\ J = {\cdot}008 \text{ “}$$
$$-1{\cdot}333\ S - 1{\cdot}667\ N - 2{\cdot}500\ M + 7{\cdot}167\ J = {\cdot}271 \text{ “}$$

The resulting definitive values of personal equation are as follows; the corresponding values for 1908 are subjoined for comparison.

	1909.	1908.
S	·080 sec.	·034 sec.
N	– ·014 “	– ·014 “
C S	·000 “	·000 “
M	·060 “	·025 “
J	·070 “	·061 “

The curious phenomenon appears that the relative personal equations of N, C S and J have remained practically unchanged, while those of S and M, though relatively to one another practically unchanged, have changed relatively to the remaining three observers.

Probable errors.—In the series of observation equations for the period Oct. 20 to Dec. 4, the probable error of a single observation, as derived from the residuals, is evidently nothing else than the probable error of a single observed clock-correction; its value, as given above, is ·017 sec. An independent determination of the same quantity was obtained from the average discordance of two sets on the same night, after correction for clock-rate, as given in the fifth column of Table IX; this average, ·031 sec., obtained from observations on 33 nights, corresponds to a probable error of between ·018 sec. and ·019 sec. The value of the probable error as deduced from discordances in 1908 was ·020 sec., as given in my last report; it was there pointed out, however, that by allowing for an excessive error in level readings which was present in that year, it would have been reduced to ·017 sec.

TABLE VI.—$\Delta\alpha_\delta$. BERLIN JAHRBUCH 1909.0—NEWCOMB.

Zone.	Mean Declination.	No. of stars.	$\Delta\alpha_\delta$ (B. J.—N.)
° °	° ′		s
0—10	5 50	56	—·0033
5—15	10 13	63	—·0027
10—20	15 11	59	—·0021
15—25	20 14	60	—·0043
20—30	25 18	63	—·0077
25—35	29 59	58	—·0079
30—40	35 34	57	—·0096
35—45	40 15	65	— 0172
40—50	44 48	63	—·0261
45—55	49 40	50	—·0354
50—60	55 38	58	—·0414
55—65	59 31	64	—·0340
60—70	64 55	55	—·0334
65—75	69 55	55	—·0447
70—80	74 48	51	—·0505

TABLE VII.—ADOPTED CORRECTIONS TO NEWCOMB'S FUNDAMENTAL CATALOGUE, 1909.

Declination.	$\Delta\alpha$	Declination.	$\Delta\alpha$
° ′ ° ′	s	° ′ ° ′	s
0 00 to 12 00	—·003	51 00 to 51 40	—·037
12 00 ,, 17 30	—·002	51 40 ,, 52 20	—·038
17 30 ,, 19 30	—·003	52 20 ,, 53 00	—·039
19 30 ,, 20 30	—·004	53 00 ,, 54 00	—·040
20 30 ,, 21 30	—·005	54 00 ,, 56 30	—·041
21 30 ,, 22 30	—·006	56 30 ,, 57 38	—·040
22 30 ,, 24 00	—·007	57 38 ,, 58 02	—·039
24 00 ,, 32 30	—·008	58 02 ,, 58 25	—·038
32 30 ,, 35 00	—·009	58 25 ,, 58 48	—·037
35 00 ,, 36 00	—·010	58 48 ,, 59 15	—·036
36 00 ,, 37 00	—·011	59 15 ,, 59 45	—·035
37 00 ,, 37 42	—·012	59 45 ,, 60 30	—·034
37 42 ,, 38 18	—·013	60 30 ,, 65 48	—·033
38 18 ,, 38 54	—·014	65 48 ,, 66 13	—·034
38 54 ,, 39 30	—·015	66 13 ,, 66 37	—·035
39 30 ,, 40 06	—·016	66 37 ,, 67 02	—·036
40 06 ,, 40 36	—·017	67 02 ,, 67 27	—·037
40 36 ,, 41 15	—·018	67 27 ,, 67 50	—·038
41 15 ,, 41 45	—·019	67 50 ,, 68 10	—·039
41 45 ,, 42 15	—·020	68 10 ,, 68 30	—·040
42 15 ,, 42 45	—·021	68 30 ,, 68 50	—·041
42 45 ,, 43 15	—·022	68 50 ,, 69 10	—·042
43 15 ,, 43 45	—·023	69 10 ,, 69 30	—·043
43 45 ,, 44 15	—·024	69 30 ,, 69 50	—·044
44 15 ,, 44 45	—·025	69 50 ,, 70 25	—·045
44 45 ,, 45 17	—·026	70 25 ,, 71 15	—·046
45 17 ,, 45 50	—·027	71 15 ,, 72 05	—·047
45 50 ,, 46 23	—·028	72 05 ,, 72 55	—·048
46 23 ,, 46 57	—·029	72 55 ,, 73 45	—·049
46 57 ,, 47 30	—·030	73 45 ,, 74 35	—·050
47 30 ,, 48 03	—·031	74 35 ,, 75 30	—·051
48 03 ,, 48 37	—·032	75 30 ,, 76 30	—·052
48 37 ,, 49 10	—·033	76 30 ,, 77 30	—·053
49 10 ,, 49 43	—·034	77 30 ,, 78 30	—·054
49 43 ,, 50 20	—·035	78 30 ,, 80 00	—·055
50 20 ,, 51 00	—·036		

TABLE VIII—$\Delta\alpha_\alpha$ BERLIN JAHRBUCH 1909.0—NEWCOMB.

R. A.	$\Delta\alpha_\alpha$ (B. J.—N.)		
	0°—30°	0°—60°	0°—80°
h.	s.	s.	s.
0— 1	$-\cdot012_{6}$	$-\cdot015_{14}$	$\cdot006_{19}$
1— 2	$-\cdot006_{8}$	$-\cdot002_{13}$	$\cdot007_{19}$
2— 3	$-\cdot006_{9}$	$-\cdot005_{17}$	$-\cdot006_{21}$
3— 4	$-\cdot010_{9}$	$-\cdot003_{20}$	$-\cdot006_{24}$
4— 5	$-\cdot007_{8}$	$-\cdot005_{14}$	$-\cdot004_{17}$
5— 6	$-\cdot002_{5}$	$\cdot008_{13}$	$\cdot000_{16}$
6— 7	$\cdot003_{11}$	$-\cdot013_{17}$	$-\cdot010_{23}$
7— 8	$-\cdot005_{7}$	$-\cdot003_{14}$	$-\cdot006_{17}$
8— 9	$-\cdot004_{7}$	$-\cdot014_{16}$	$-\cdot017_{20}$
9—10	$\cdot007_{6}$	$\cdot012_{13}$	$\cdot010_{18}$
10—11	$\cdot012_{6}$	$\cdot007_{14}$	$-\cdot008_{19}$
11—12	$\cdot002_{7}$	$\cdot001_{13}$	$\cdot000_{16}$
12—13	$\cdot001_{5}$	$-\cdot008_{12}$	$\cdot000_{17}$
13—14	$-\cdot002_{5}$	$-\cdot005_{10}$	$\cdot007_{14}$
14—15	$\cdot000_{5}$	$-\cdot005_{13}$	$-\cdot010_{18}$
15—16	$\cdot005_{12}$	$\cdot003_{19}$	$\cdot001_{23}$
16—17*	$\cdot034_{6}$	$\cdot015_{14}$	$\cdot017_{19}$
17—18	$-\cdot009_{9}$	$\cdot002_{19}$	$\cdot010_{24}$
18—19	$\cdot014_{6}$	$\cdot004_{13}$	$\cdot002_{19}$
19—20	$\cdot003_{10}$	$\cdot005_{18}$	$-\cdot001_{22}$
20—21	$-\cdot012_{7}$	$-\cdot002_{15}$	$-\cdot001_{19}$
21—22	$\cdot004_{7}$	$\cdot009_{14}$	$\cdot003_{18}$
22—23	$-\cdot008_{8}$	$-\cdot001_{17}$	$\cdot000_{22}$
23— 0	$\cdot003_{9}$	$\cdot006_{14}$	$\cdot010_{18}$

* If the star ω Herculis be omitted the figures in this line become ·005, ·002 and ·008 respectively

TABLE IX—TRANSIT OBSERVATIONS IN 1909.

Date.	Time.	ΔT	Observer.	Discordance.	ΔT_o
	h. m.	s		s	s
June 7	14 15	−3·263	N		−3·277
June 10	14 15	−3·017	N		−3·031
June 15	14 15	−2·499	N	·074	−2·513
	15 45	−2·417	N		−2·431
June 16	15 40	−2·328	C S	·024	−2·328
	17 50	−2·292	C S		−2·292
June 17	15 35	−2·170	N		−2·184
June 21	16 55	−1·547	C S	·005	−1·547
	18 20	−1·533	C S		−1·533
June 23	19 35	−1·153	C S	·006	−1·153
	21 00	−1·138	C S		−1·138
June 24	15 00	−1·054	N	·051	−1·068
	16 45	−1·092	N		−1·106
June 25	15 15	−·830	C S	·009	−·830
	16 55	−·826	C S		−·826
June 28	15 40	−·223	C S	·022	−·223
	17 10	−·232	C S		−·232
June 29	15 05	−·004	N	·053	−·018
	16 55	·065	N		·051
June 30	15 25	·060	S	·006	·140
	16 45	·078	S		·158
July 3	19 00	·760	S		·840
July 4	16 05	1·142	N	·025	1·128
	17 25	1·130	N		1·116
July 6	15 30	1·512	N		1·498
July 7	18 10	1·703	S		1·783
July 8	15 40	2·082	C S		2·082
July 9	15 30	2·293	N		2·279
July 12	15 50	3·147	C S		3·147
July 13	16 20	3·409	N		3·395
July 14	17 15	3·811	C S		3·811
July 16	17 00	4·414	N		4·400
July 17	16 40	4·664	S		4·744
July 19	16 35	5·388	C S		5·388
July 20	15 55	5·718	N		5·704
July 25	16 10	7·404	N		7·390
July 26	17 15	7·718	S		7·798
July 27	16 10	8·179	N		8·165
July 28	16 55	8·471	S		8·551
July 29	19 35	8·951	C S		8·951
July 30	16 40	9·318	N		9·304
July 31	17 35	9·615	S		9·695
August 1	17 00	10·004	S		10·084
August 2	16 55	10·518	C S		10·518
August 3	16 40	10·913	N		10·899
August 4	18 20	11·264	S		11·344
August 5	17 05	11·749	N		11·735
August 6	19 00	12·220	N	·066	12·206
	20 40	12·183	N		12·169
August 7	18 45	12·531	S		12·611
August 9	19 10	13·315	C S	·017	13·315
	21 55	13·331	C S		13·381
August 10	18 30	13·634	S		13·714
October 20	22 10	12·439	S	·065	12·519
	0 05	12·359	S		12·439
	22 10	12·505	C S	·073	12·505
	0 05	12·417	C S		12·417
	22 10	12·430*	J	·043	12·489
	0 15	12·371*	J		12·430
October 27	22 15	11·278*	J	·021	11·337
	23 10	11·293*	J		11·352
	22 35	11·368	N		11·354
	22 35	11·379	C S		11·379

TABLE IX.—TRANSIT OBSERVATIONS IN 1909 (continued).

Date.	Time.		ΔT	Observer.	Discordance.	ΔT_0
	h.	m.	s		s	s
October 29	21	05	10·966*	J	·014	11·025
	22	25	10·972*	J		11·031
	21	15	11·092	N	·031	11·078
	22	45	11·114	N		11·100
	21	15	11·074	C S	·006	11·074
	22	45	11·059	C S		11·059
November 6	22	35	9·933*	J	·025	9·992
	0	05	9·951*	J		10·010
	23	00	9·928	S	·043	10·008
	1	00	9·876	S		9·956
	23	00	9·974	N	·016	9·960
	1	00	9·949	N		9·935
November 9	22	20	9·586	N	·029	9·572
	23	50	9·550	N		9·536
	22	20	9·601	C S	·003	9·601
	23	50	9·591	C S		9·591
November 12	22	25	9·274*	M	·023	9·323
	0	20	9·243*	M		9·292
	22	50	9·244	S	·081	9·324
	1	00	9·155	S		9·235
	22	50	9·311	C S	·064	9·311
	1	00	9·239	C S		9·239
November 18	21	35	8·722	S	·018	8·802
	22	55	8·736	S		8·816
	21	40	8·761*	M	·013	8·810
	22	55	8·770*	M		8·819
	22	55	8·807	N		8·793
November 29	21	25	8·505*	M	·039	8·554
	22	20	8·543*	M		8·592
	21	50	8·533	J	·022	8·603
	23	15	8·554	J		8·624
November 30	21	45	8·540*	M	·013	8·589
	23	00	8·552*	M		8·601
	21	55	8·534	J	·037	8·604
	23	00	8·496	J		8·566
December 4	0	05	8·460	J		8·530
	0	15	8·444*	M		8·493
Mean discordance					± ·031	

* These observations were made on the eastern transit pier, all the others on the western one. The distance between the piers is ·011 sec.; this correction, as well as that for personal equation, has been applied to the last column.

TABLE X.—OBSERVATIONS FOR PERSONAL EQUATION.

(Corrected for clock-rate and difference of longitude).

Date.	Time.		Clock-correction.				
			C S.	S.	N.	M.	J.
1909.	h.	m.	s.	s.	s.	s.	s.
Oct. 20	22	10	12·505	12·439	....	....	12·419
" 20	0	05	12·417	12·359	....	....	12·360
" 27	22	35	11·379	....	11·368	....	11·275
" 29	21	15	11·074	....	11·092	....	10·954
" 29	22	45	11·059	....	11·114	....	10·959
Nov. 6	23	00	....	9·928	9·974	....	9·920
" 6	1	00	....	9·876	9·949	....	9·936
" 9	22	20	9·601	....	9·586	....	....
" 9	23	50	9·591	....	9·550	....	....
" 12	22	50	9·311	9·244	....	9·261	....
" 12	1	00	9·239	9 155	....	9·229	....
" 18	21	35	....	8·722	....	8·750	....
" 18	22	55	....	8 736	8·807	8·759	....
" 29	21	25	....	....	....	8·494	8·533
" 29	22	20	....	....	....	8·532	8·555
" 30	21	45	....	....	....	8·529	8 534
" 30	23	00	....	....	....	8·541	8·496
Dec. 4	0	15	....	....	....	8·433	8·460

TIME SERVICE.

The time service has been continued practically unchanged, except for occasional unimportant extensions, changes in location of clocks, &c. As usual, chronometers have occasionally been rated, aneroid barometers tested, &c.: the usual amount of work has been done in connection with maintenance of clocks and apparatus, observations for clock error, sending out of time signals, &c. Below is a list of the total number of clocks in operation:—

	March 31, 1910.	March 31, 1909.
Minute Dials—Parliament Building	53	49
East Block	40	36
West "	65	63
Langevin Block	49	48
Post Office	20	20
Thistle Block	2	2
Ottawa Electric Co	2	1
Mint	16	16
Archives	7	7
Observatory	28	28
Tower Clocks	2	2
Program Clock	1	1
Seconds Dials	5	3
Total electrically driven clocks	290	276
Secondary master-clocks	8	8
Primary clocks	4	4
Total	302	288

I have the honour to be, sir,
Your obedient servant,

R. M. STEWART.

APPENDIX 4.

REPORT OF THE CHIEF ASTRONOMER, 1910.

TABULAR STATEMENT OF LONGITUDE AND LATITUDE OBSERVATIONS, 1909

BY

J. MACARA.

CONTENTS.

MAP.

APPENDIX 4.

TABULAR STATEMENT OF LONGITUDE AND LATITUDE OBSERVATIONS.

Department of the Interior,
Dominion Astronomical Observatory,
Ottawa, Canada, March 31, 1910.

Dr. W. F. King, C.M.G.,
Chief Astronomer,
Ottawa.

Sir,—I have the honour to transmit herewith a tabular statement of the differences of longitude and the latitude results of stations determined in 1909. Annexed hereto is, also, a description of the stations occupied. A synopsis of the statement giving the longitude and latitude of the various stations will be found on page 439.

The accompanying map shows the position of the astronomical stations established up to the date of this report.

I have the honour to be, sir,
Your obedient servant,

J. MACARA.

DIFFERENCE OF LONGITUDE BETWEEN COCHRANE, ONT., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v.	
1909.	h. m. s.	h. m. s.	m. s.	s.	h. m. s.	h. m. s.	h. m. s.	s.	s.
June 10	0 14 55·256	0 14 55·109	−6 22·761	−3·022	0 21 14·995	0 21 14·848	0 21 14·922	−·041	·074
" 14	15 05·818	15 05·676	−6 11·810	−2·582	15·046	14·904	14·975	·012	·071
" 15	15 07·328	15 07·207	−6 10·206	−2·467	15·067	14 946	15·007	·046	·061
" 18	15 19·843	15 19·707	−5 57·187	−2·027	15·003	14·867	14·935	−·028	·068
" 19	15 23·601	15 23·439	−5 53·324	−1·868	15·057	14·895	14·976	·013	·081

Observers { West—F. A. McDiarmid.
{ East—C. C. Smith, D. B. Nugent.

	h.	m.	s.
Observed $d\lambda$	0	21	14·963
Corr. to meridian circle			−·014
$d\lambda$ to meridian circle	0	21	14·949
λ Ottawa	5	02	51·998
λ Cochrane	5	24	06·947

DIFFERENCE OF LONGITUDE BETWEEN CHARLOTTETOWN, P.E.I., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	r.	
1909.	h. m. s.	h. m. s.	s.	s.	h. m. s.	h. m. s.	h. m. s.	s.	s.
June 19	0 49 53·544	0 49 53·386	−1·880	27·019	0 50 22·443	0 50 22·285	0 50 22·364	−·029	·079
" 21	50 36·209	50 36·058	−1·567	−15·293	22·483	22·332	22·407	·014	·075
" 22	50 34·431	50 34·267	−1·374	−13·337	22·468	22·304	22·386	−·007	·082
" 23	50 32·691	50 32·547	−1·189	−11·445	22·435	22·291	22·363	−·030	·072
" 24	50 30·715	50 30·549	−1·090	−09·279	22·526	22·360	22·443	·050	·083

Observers { West—C. C. Smith, D. B. Nugent.
East—W. C. Jaques.

	h.	m.	s.
Observed $d\lambda$	0	50	22·393
Corr. to meridian circle			+·014
$d\lambda$ to meridian circle	0	50	22·407
λ Ottawa	5	02	51·998
λ Charlottetown	4	12	29·591

DIFFERENCE OF LONGITUDE BETWEEN PICKEREL, ONT., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v.	
1909.	h. m. s.	h. m. s.	s.	s.	h. m. s.	h. m. s.	h. m. s.	s.	s.
June 21	0 18 40·750	0 18 40·582	−36·256	−1·551	0 19 15·455	0 19 15·287	0 19 15·371	−·048	·084
" 22	18 42·315	18 42·157	−34·581	−1·370	15·526	15·368	15·447	·028	·079
" 23	18 44·010	18 43·835	−32·715	−1·183	15·542	15·367	15·454	·035	·087
" 24	18 45·831	18 45·668	−30·741	−1·088	15·484	15·321	15·403	−·016	·082

Observers { West—F. A. McDiarmid.
{ East—C. C. Smith, D. B. Nugent.

	h. m. s.
Observed $d\lambda$	0 19 15·419
Corr. to meridian circle	−·014
$d\lambda$ to meridian circle	0 19 15·405
λ Ottawa	5 02 51·998
λ Pickerel	5 22 07·403

DIFFERENCE OF LONGITUDE BETWEEN HALIBURTON, ONT., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	ε.	
1909.	h. m. s.	h. m. s.	s.	s.	h. m. s.	h. m. s.	h. m. s.	s.	s.
June 29	0 11 34·299	0 11 34·195	23·392	0·017	0 11 10·924	0 11 10·820	0 11 10·872	−·053	·052
" 30	11 36·368	11 36·259	25·562	0·148	10·954	10·845	10·900	−·025	·055
July 1	11 37·777	11 37·659	27·133	0·370	11·014	10·896	10·955	·030	·059
" 3	11 41·286	11 41·143	31·050	0·813	11·049	10·906	10·977	·052	·071
" 4	11 43·512	11 43·405	33·651	1·111	10·972	10·865	10·919	−·006	·054

Observers { West—F. A. McDiarmid.
East—R. M. Stewart, D. B. Nugent.

	h.	m.	s.
Observed $d\lambda$	0	11	10·925
Corr. to meridian circle			−·014
$d\lambda$ to meridian circle	0	11	10·911
λ Ottawa	5	02	51·998
λ Haliburton	5	14	02·909

DIFFERENCE OF LONGITUDE BETWEEN SYDNEY, N.S., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v.	
1909.	h. m. s.	h. m. s.	s.	m. s.	h. m. s.	h. m. s.	h. m. s.	s.	s.
June 30	0 58 00·034	0 57 59·843	0·147	4 04·620	1 02 04·507	1 02 04·316	1 02 04 411	−·006	·095
July 6	57 48·818	57 48·587	1·500	17·250	04·568	04·337	04·453	·036	·116
" 9	57 43·730	57 43·481	2·283	23·080	04·527	04·278	04·403	−·014	·125
" 10	57 41·678	57 41·468	2·569	25·397	04·506	04·296	04·401	−·016	·105

Observers. West—R. M. Stewart, C. C. Smith, D. B. Nugent. East—W. C. Jaques.

	h. m. s.
Observed $d\lambda$	1 02 04·417
Corr. to meridian circle	+·014
$d\lambda$ to meridian circle	1 02 04·431
λ Ottawa	5 02 51·998
λ Sydney	4 00 47·567

DIFFERENCE OF LONGITUDE BETWEEN BANCROFT, ONT., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v.	
1909.	h. m. s.	h. m. s.	m. s.	s.	h. m. s.	h. m. s.	h. m. s.	s.	s.
July 6	0 09 52·237	0 09 52·113	1 19·374	1·505	0 08 34·368	0 08 34·244	0 08 34·306	−·025	·062
" 7	09 54·327	09 54·213	21·803	1·759	34·283	34·169	34.226	−·105	·057
" 8	09 56·203	09 56·067	23·812	2·082	34·473	34·337	34·405	·074	·068
" 8	09 56·345	09 56·216	23·994	2·101	34·452	34·323	34·387	·056	·064

Observers. West—F. A. McDiarmid.
East—R. M. Stewart,
C. C. Smith,
D. B. Nugent.

	h. m. s.
Observed $d\lambda$	0 08 34·331
Corr. to meridian circle..	− ·014
$d\lambda$ to meridian circle.....	0 08 34·317
λ Ottawa................	5 02 51·998
λ Bancroft	5 11 26·315

DIFFERENCE OF LONGITUDE BETWEEN MULGRAVE, N.S., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	r.	
1909.	h. m. s.	h. m. s.	s.	s.	h. m. s.	h. m. s.	h. m. s.	s.	s.
July 14	0 57 23·197	0 57 23·948	3·793	−0·634	0 57 18·770	0 57 18·521	0 57 18·646	·002	·125
" 15	57 21·783	57 21·566	4·088	0·985	18·680	18·463	18·572	−·072	·109
" 18	57 16·778	57 16·588	5·055	7·085	18·808	18·618	18·713	·069	·095

Observers { West—R. M. Stewart, C. C. Smith, D. B. Nugent.
{ East—W. C. Jaques.

	h.	m.	s.
Observed $d\,\lambda$	0	57	18·644
Corr. to meridian circle			+·014
$d\,\lambda$ to meridian circle	0	57	18·658
λ Ottawa	5	02	51 998
λ Mulgrave	4	05	33·340

DIFFERENCE OF LONGITUDE BETWEEN SHIPPIGAN, N.B. AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v.	
1909.	h. m. s.	h. m. s.	s.	m. s.	h. m. s.	h. m. s.	h. m. s.	s.	s.
July 16	0 39 34·964	0 39 31·765	4·394	4 29·980	0 44 00·550	0 44 00·351	0 44 00·451	·042	·100
" 18	39 31·480	39 31·286	5·057	34·088	00·511	00·317	00·414	·005	·097
" 20	39 26 363	39 26·167	5·703	39·804	00·464	00·268	00·366	− ·043	·098
" 22	39 20·856	39 20·653	6·379	46·031	00·508	00·305	00·407	− ·002	·102

Observers { West—R. M. Stewart, C. C. Smith, D. B. Nugent.
East—F. A. McDiarmid.

	h. m. s.
Observed $d\lambda$	0 44 00·409
Corr. to meridian circle	+ ·014
$d\lambda$ to meridian circle	0 44 00·423
λ Ottawa	5 02 51·998
λ Shippigan	4 18 51·575

DIFFERENCE OF LONGITUDE BETWEEN BATHURST, N.B., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v.	
1909.	h. m. s.	h. m. s.	s.	s.	h. m. s.	h. m. s.	h. m. s.	s.	s.
July 25	0 40 00·599	0 40 00·406	7·394	21·776	0 40 14·981	0 40 14·788	0 40 14·884	·050	·096
" 26	39 58·376	39 58·205	7·778	24·378	14·976	14·805	14·891	·057	·086
" 27	39 55 663	39 55·502	8·163	27·314	14·814	14·653	14·734	−·100	·081
" 28	39 53·105	39 52·939	8·543	30·348	14·910	14·744	14·827	−·007	·083

Observers { West, R. M. Stewart.
D. B. Nugent.
East, F. A. McDiarmid.

	h.	m.	s.
Observed $d\lambda$	0	40	14·834
Corr. to meridian circle			+·014
$d\lambda$ to meridian circle	0	40	14·848
λ Ottawa	5	02	51·998
λ Bathurst	4	22	37·150

DIFFERENCE OF LONGITUDE BETWEEN YARMOUTH, N.S., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v.	
1909.	h. m. s.	h. m. s.	s.	s.	h. m. s.	h. m. s.	h. m. s.	s.	s.
July 30	0 38 31·007	0 38 30·825	09·305	1·577	0 38 23·279	0 38 23 097	0 38 23·188	−·003	·091
" 31	38 29·685	38 29 523	09·684	3·285	23·286	23·124	23·205	·014	·081
Aug. 1	38 28·025	38 27·853	10·076	5·330	23·279	23·107	23·193	·002	·086
" 2	38 26·522	38 26·339	10·512	7 260	23·270	23·087	23·179	−·012	·092

Observers { West, R. M. Stewart. / C. C. Smith. / D. B. Nugent. / East, W. C. Jaques. }

	h.	m.	s.
Observed $d\ \lambda$	0	38	23·191
Corr. to meridian circle			+·014
$d\ \lambda$ to meridian circle	0	38	23·205
λ Ottawa	5	02	51·998
λ Yarmouth	4	24	28·793

DIFFERENCE OF LONGITUDE BETWEEN DIGBY, N.S., AND DOMINION OBSERVATORY, OTTAWA.

Date.	Difference of Chronograph.		Clock Correction.		Difference of Longitude.				Time of Transmission.
	Western Signals.	Eastern Signals.	Western Station.	Eastern Station.	Western Signals.	Eastern Signals.	Mean.	v.	
1909.	h. m. s.	h. m. s.	s.	m. s.	h. m. s.	h. m. s.	h. m. s.	s.	s.
Aug. 5	0 38 22·696	0 38 22·519	11·737	1 40·008	0 39 50·967	0 39 50·790	0 39 50·878	·091	·088
" 8	38 18·795	38 18·599	12·947	44·960	50·808	50·612	50·710	−·067	·098
" 9	38 17·226	38 17·059	13 291	46·894	50·829	50·662	50·746	−·041	·084
" 11	38 13·027	38 12·859	14·071	51·942	50·898	50·730	50·814	·027	·084

Observers { West, R. M. Stewart.
C. C. Smith.
D. B. Nugent.
East, W. C. Jaques.

	h.	m.	s.
Observed $d\lambda$	0	39	50·787
Corr. to meridian circle			+·014
$d\lambda$ to meridian circle	0	39	50·801
λ Ottawa	5	02	51·998
λ Digby	4	23	01·197

LONGITUDE AND LATITUDE OF STATIONS OBSERVED IN 1909.

Place.	Difference of Longitude.			To	Longitude.			Longitude.			Latitude.		
	h.	m.	s.		h.	m.	s.	°	′	″	°	′	″
Cochrane......	0	21	14·949	Dominion Observatory...	5	24	06·947	81	01	44·205	49	03	41·88
Charlottetown..	0	50	22·407	"	4	12	29·591	63	07	23·865	46	13	58·48
Pickerel........	0	19	15·405	"	5	22	07·403	80	31	51·045	45	58	24·05
Haliburton.....	0	11	10·911	"	5	14	02·909	78	30	43·635	45	02	43·78
Sydney.........	1	02	04·431	"	4	00	47·567	60	11	53·505	46	08	27·86
Bancroft	0	08	34·317	"	5	11	26·315	77	51	34·725	45	03	34·52
Mulgrave.......	0	57	18·658	"	4	05	33·340	61	23	20·100	45	36	18·84
Shippigan......	0	44	00·423	"	4	18	51·575	64	42	53·625	47	44	38·62
Bathurst	0	40	14·848	"	4	22	37·150	65	39	17·250	47	37	12·95
Yarmouth	0	38	23·205	"	4	24	28·793	66	07	11·895	43	50	14·75
Digby..........	0	39	50·801	"	4	23	01 197	65	45	17·955	44	37	13·58

LOCAL POSITIONS OF ASTRONOMICAL STATIONS.

Cochrane.—The pier is 24·8 feet west and 173·6 feet north of the southeast corner of 2nd street and Third avenue, town of Cochrane.

Charlottetown.—The pier is situate off Water street, 94·13 feet south and 19·73 feet west of the northwest corner of the stone verandah of Richard Grant's house.

Pickerel.—The pier is on a rocky knoll south of the Canadian Pacific Railway main line and nearly opposite the station. The centre of the pier is 90·8 feet south and 60·1 feet east of the southeast corner of the Canadian Pacific Railway station house.

Haliburton.—The pier is 22·0 feet north and 32·9 feet west of the southwest corner of Lot 3, Block L, north side of Queen street, village of Haliburton.

Sydney.—The pier is situate on the esplanade 49·24 feet south and 89·66 feet west of the northwest corner of the Sydney hotel.

Bancroft.—The pier is 99·8 feet west and 220·8 feet north of the centre point of the crossing of Station street and the Central Ontario Railway.

Mulgrave.—The pier is situate 40·51 feet north and 60·59 feet west of the northwest corner of Mr. Kawaga's house.

Shippigan.—The pier is 309·3 feet south and 2643·1 feet west of the southwest corner of the shore end of the curb lying on the west side of the Shippigan wharf. It is also 793·1 feet south and 1041·4 feet west of the main spire of the Roman Catholic church.

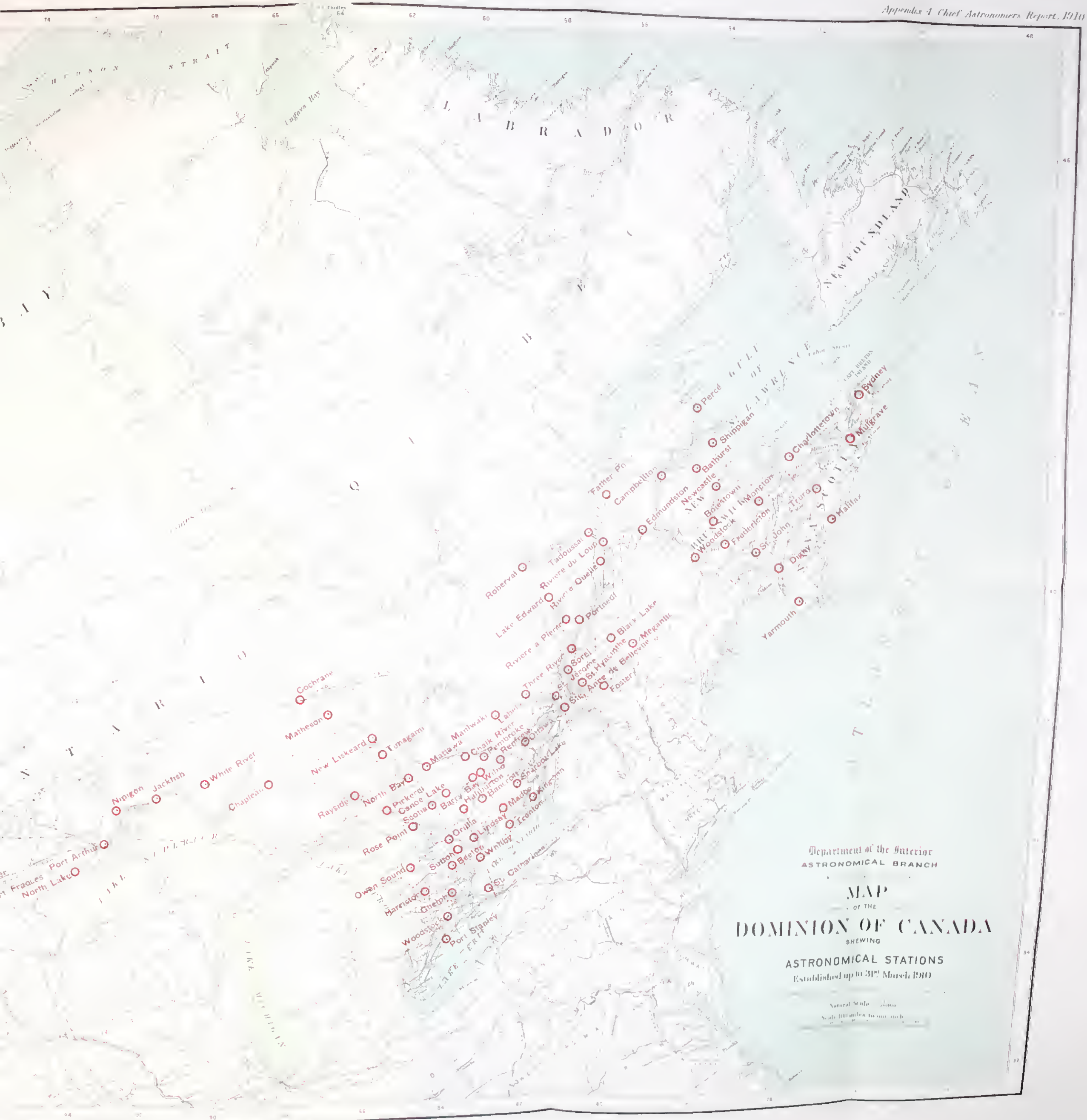
Bathurst.—The pier is 54·1 feet west and 79·2 feet north of the southeast corner of King and Water streets, town of Bathurst.

Yarmouth.—The pier is on Mr. Jacob Bingie's vacant lot, corner of Water and Townsend streets, 258·96 feet west and 64·78 feet north of the stone post at the southwest corner of Mr. James Lovett's property, corner of Main and Townsend streets.

Digby.—The pier is 7·03 feet south and 183·44 feet east of the stone foundation of the northeast corner of the entrance to the school room of the Baptist church.

Dominion Observatory.—The meridian to which the longitudes observed in 1909 are referred is that of the Meridian Circle in the Transit Annex, and is 0^s·201 west of the temporary pier to the meridian of which the longitudes have formerly been referred.

Mackenzie Bay
Franklin Bay
Prince Albert Sd
Victoria Island
Wollaston Land
Coronation Gulf
GREAT BEAR LAKE
Mackenzie River
NORTH WEST TERRITORIES
Southampton I
Wager Bay
HUDSON BAY
YUKON
Boundary
Dawson
Selkirk
Tantalus
White Horse
White Pass
BRITISH COLUMBIA
QUEEN CHARLOTTE ISLANDS
Onion Lake
Edmonton
Field
Calgary
Revelstoke
Kamloops
Vancouver
Port Moody
Midway
Boundary
Gateway
Victoria
Wapella
Winnipeg
Kalmar
Sprague
Rainy River
Fort Frances
North Lake
Port Arthur
Nipigon
Jackfish
LAKE SUPERIOR


HUDSON STRAIT
Ungava Bay
LABRADOR
NEWFOUNDLAND
GULF OF ST. LAWRENCE
NEW BRUNSWICK
NOVA SCOTIA
LAKE ERIE
Percé
Shippigan
Sydney
Mulgrave
Charlottetown
Bathurst
Newcastle
Campbellton
Father Point
Edmundston
Boiestown
Moncton
Truro
Halifax
Fredericton
Woodstock
St. John
Digby
Yarmouth
Tadoussac
Roberval
Riviere du Loup
Riviere Ouelle
Lake Edward
Portneuf
Riviere a Pierre
Black Lake
Three Rivers
Sorel
St. Jerome
St. Hyacinthe
Megantic
Ste. Anne de Bellevue
Foster
Labelle
Maniwaki
Ottawa
Cochrane
Matheson
New Liskeard
Temagami
Mattawa
Chalk River
Pembroke
Renfrew
White River
Chapleau
Jackfish
Nipigon
Port Arthur
North Lake
Rayside
North Bay
Pickerel
Canoe Lake
Scotia
Barry Bay
Wilno
Haliburton
Bancroft
Sharbot Lake
Kingston
Madoc
Rose Point
Orillia
Lindsay
Sutton
Beeton
Whitby
Owen Sound
St. Catharines
Harriston
Guelph
Woodstock
Port Stanley
Department of the Interior
ASTRONOMICAL BRANCH
MAP
OF THE
DOMINION OF CANADA
SHEWING
ASTRONOMICAL STATIONS
Established up to 31st March 1910

APPENDIX 5.

REPORT OF THE CHIEF ASTRONOMER, 1910.

PRECISE LEVELLING WORK.

BY

F. B. REID, D.L.S.

CONTENTS.

APPENDIX 5.

REPORT OF F. B. REID, D.L.S., ON PRECISE LEVELLING WORK.

OTTAWA, ONT., 31st March, 1910.

C. A. BIGGER, Esq.,
Asst. Supt. of the Geodetic Survey,
Ottawa.

SIR,—The results of precise levelling work done by the Geodetic Survey of Canada up to March 31, 1910, are given below for the following lines:—

St. Stephen, N.B., to Rivière-du-Loup, Que.

St. Stephen, N.B., to St. John, N.B.

Rouse Point, N.Y., to Sherbrooke, Que., with branch lines to the International boundary from Farnham, Foster and Sherbrooke.

Rouse Point, N.Y., to Colborne, Ont.

Table I, given below, indicates the routes followed between terminal points, and gives complete descriptions of all bench marks established along these routes. The standard bench mark established previous to the year 1908 consists of a copper bolt, ½ inch in diameter and 4 inches long, stamped on the end with the letters "B.M., D.A.O." (Bench Mark, Dominion Astronomical Observatory.)

During 1908 and since then the standard bench mark has been a copper bolt, ¾ inch in diameter and 4 inches long, stamped on the end with the letters "G.S.C., B.M." (Geodetic Survey of Canada, Bench Mark.) In each case the bolt is sunk horizontally in rock or masonry so that only the circular end is visible; the number of the bench mark is stamped on this end, as well as the letters mentioned above. A horizontal chisel line is also placed there, upon which the elevation is taken.

Table II shows the approximate distances (in miles) between the bench marks and the elevations (in feet) above mean sea level. The columns headed "Discrepancy" give the difference (in feet) between the forward and backward running for each section between bench marks and for the whole line from the initial bench mark. The last column gives the elevations of the bench marks as shown in the second column.

None of the elevations given has been adjusted. Those given on the lines starting from St. Stephen are derived from a bench mark placed on the St. Stephen's Bank by United States engineers in 1873. It is improbable that any of these elevations will be changed, on account of adjustments, by a greater amount than 4 inches.

All the other elevations are derived from the bench mark at Rouse Point, N.Y., established by the United States Coast and Geodetic Survey.

The elevations given from Rouse Point to Coteau and to St. Johns, Que., will probably be held to within two or three inches; west of Coteau the adjustment may be greater, though it is improbable the change will be greater than four inches; regarding the elevations east of St. Johns, the same remark applies.

Table III shows the elevations at railway stations along the different lines of levels. The elevation was in every case taken on top of the rail; at open telegraph stations it was taken in front of the telegraph office; at flag stations it was taken in front of the station house or platform.

I have the honour to be, sir,
Your obedient servant,

F. B. REID,
Inspector of Precise Levelling.

TABLE I.

BENCH MARKS BETWEEN ST. STEPHEN, N.B., AND RIVIERE-DU-LOUP, QUE., *VIA* NEW BRUNSWICK SOUTHERN RAILWAY TO BRUNSWICK JUNCTION, CANADIAN PACIFIC RAILWAY TO EDMUNDSTON, AND TEMISCOUATA RAILWAY TO RIVIERE-DU-LOUP.

1-B—In northeast wall of rear section of City Building, Church street, Calais, Maine. Bench mark is 3 feet 7 inches to the rear of front section of building and 2 feet above ground.

2-B—In first course of stonework below water table course in south end of east wall of the St. Stephen's Bank, at St. Stephen, N.B.

3-B—In first course of stonework below water table course in front wall of St. Stephen post office, to the west of east doorway.

4-B—In large boulder at south side of New Brunswick Southern railway track, about one-half mile west of Oak Bay station and 1,040 feet east of mile post 5 from St. Stephen.

5-B—In top course of stonework in south face of east abutment of small plate girder bridge on New Brunswick Southern railway, 4¾ miles west of Brunswick Junction and 200 feet east of mile post 10 from St. Stephen.

6-B—In north face of boulder 10 feet north of New Brunswick Southern railway track and 200 feet west of diamond crossing at Brunswick Junction.

7-B—In boulder 25 feet west of Canadian Pacific railway track, 4¾ miles south of Watt Junction and at seventh telegraph pole north of mile post 5 from Watt Junction.

8-B—In boulder 8 feet east of west fence of Canadian Pacific railway right-of-way, 65 feet north and 85 feet west of northwest corner of Watt Junction station house.

9-B—In boulder 18 feet east of Canadian Pacific railway track, beside rail bench, 5 miles north of Watt Junction and 100 feet north of mile post 10 from McAdam Junction.

10-B—In boulder 15 feet west of Canadian Pacific railway track, at north end of small cutting and 390 feet south of mile post 5 from McAdam Junction.

11-B—In third course of stonework above platform in north wall of Canadian Pacific railway station-house at McAdam Junction, between fifth and sixth doorways from east end of building.

12-B—In sixth course of stonework below bridge seat in second stone from north end in face of east abutment wall of subway on main line of Canadian Pacific railway, 5½ miles west of McAdam Junction and 330 feet east of St. Croix River bridge.

13-B—In third course of stonework below top in face of southeast retaining wall of bridge over St. Croix river, on main line of Canadian Pacific railway, 5½ miles west of McAdam Junction.

14-B—In west face of large mass of granite, 12 feet east of Canadian Pacific railway track, 580 feet north of north switch at Sugar Brook siding and between eleventh and twelfth telegraph poles north of mile post 10 from McAdam Junction.

15-B—In south face of large granite boulder, 40 feet east of Canadian Pacific railway track, 480 feet south of north switch at Deer Lake siding and between twelfth and thirteenth telegraph poles north of mile post 16 from McAdam Junction.

16-B—In northwest concrete pier under Canadian Pacific railway water tank at Canterbury station.

17-B—In exposed rock surface at west side of Canadian Pacific railway track, ½ mile south of Scott station and at tenth telegraph pole south of mile post 27 from McAdam Junction. Bench mark is 20 feet south of small gate in west fence of right-of-way.

18-B—In third course of stonework below top in east end of south face of retaining wall behind north abutment of plate girder bridge over Eel river, 300 feet south of Benton station.

19-B—In east side of small rock-cut on Canadian Pacific railway, 25 feet north of mile post 37 from McAdam Junction.

20-B—In northwest concrete pier under Canadian Pacific railway water tank at Debec Junction.

21-B—In boulder 15 feet north of track, on Houlton branch of Canadian Pacific railway, at twelfth telegraph pole east of international boundary monument No. 14-A, and 4·6 miles west of Debec Junction.

22-B—In north side of stone boundary monument No. 14-A, about 5 miles west of Debec Junction, on Houlton branch of Canadian Pacific railway.

23-B—In top course of stonework in south end of east abutment of overhead bridge No. 45·1, on Canadian Pacific railway, about 450 feet north of highway crossing at Teed's Mill station.

24-B—In south end of west side of cap stone on west end of stone arch culvert under Canadian Pacific railway, about 1½ miles south of Woodstock yard station.

25-B—In second course of stonework below top, in second stone from south end of southwest retaining wall of Canadian Pacific railway bridge over Meduxnekeag river, at Woodstock, N.B.

26-B—In second course of stonework above ground at north end of west wall of Woodstock post office.

27-B—In third course of stonework below water table course at north end of east wall of Armoury, Chapel street, Woodstock, N.B.

28-B—In south face and 3 feet 3 inches below top of concrete retaining wall behind east abutment of Canadian Pacific railway bridge over west channel of St. John river, at Upper Woodstock.

29-B—In north face of concrete cap on east end of concrete culvert No. 57·7 under Canadian Pacific railway, 2·4 miles north of Newburg Junction.

30-B—In third course of stonework below top in face of northeast retaining wall of small bridge on Canadian Pacific railway, 2½ miles south of Hartland.

31-B—In second course of stonework below top in east end of south face of retaining wall behind north abutment of plate girder bridge on Canadian Pacific railway, about 1,500 feet north of Hartland station.

32-B—In second course of stonework below cap-stone in east face of south abutment of Canadian Pacific railway bridge No. 70·5, about 450 feet north of Stickney station.

33-B—In exposed rock surface at east side of Canadian Pacific railway track, 120 feet south of culvert No. 73-A, 780 feet south of farm crossing and 1½ miles south of Florenceville.

34-B—In west face of concrete retaining wall behind north abutment of Canadian Pacific railway bridge over creek at Bristol.

35-B—In third course of stonework below top, in face of southwest retaining wall of Canadian Pacific railway bridge No. 81·6, about ½ mile north of Bath.

36-B—In west face of concrete culvert under Canadian Pacific railway in deep ravine, one mile north of Beechwood station.

37-B—In top course of stonework at west end of south face of retaining wall behind north abutment of plate girder bridge No. 91·9, on Canadian Pacific railway, at Muniac station.

38-B—In south face and 2 feet 2 inches below top of north concrete abutment of small plate girder bridge on Canadian Pacific railway, 1¼ miles south of Perth, N.B.

39-B—In north end of west face and 1 foot 7 inches below top of concrete retaining wall behind east abutment of Canadian Pacific railway bridge over St. John river, at Perth, N.B.

40-B—In south wall of Victoria county court house, at Andover, 2 feet 0 inches west of southeast corner and 1 foot 3 inches above water table.

41-B—In west face and 9 inches below top of concrete abutment at south end of plate girder bridge over Aroostook river, ½ mile north of Aroostook Junction, on Edmundston branch of Canadian Pacific railway.

42-B—In south side of concrete base of stone boundary monument No. 82, at international boundary, about 4¾ miles west of Aroostook Junction, on Aroostook branch of Canadian Pacific railway.

43-B—In boulder in field 220 feet west of track, behind small frame school house, and 430 feet south of mile post 5 from Aroostook Junction, on Edmundston branch of Canadian Pacific railway.

44-B—In boulder 15 feet west of track, 160 feet south of south switch at Limestone siding and 90 feet north of Costigan post office.

45-B—In face of northeast wing wall of concrete culvert No. 13·8 in deep ravine, 750 feet south of south switch, at Argosy siding.

46-B—In west wall of south transept of Grand Falls Roman Catholic church, in corner stone of fourth course below water table.

47-B—In south end of rear, or east face, of concrete retaining wall behind east abutment of Canadian Pacific railway bridge over St. John river, 1¼ miles north of Grand Falls.

48-B—In west face of small concrete culvert on Grand Trunk Pacific railway, about 900 feet east of a point on Canadian Pacific railway opposite tenth telegraph pole north of mile post 24, from Aroostook Junction.

49-B—In east face of small concrete arch culvert on Grand Trunk Pacific railway, about 90 feet west of a point on Canadian Pacific railway (old location), 2,100 feet north of mile post 28, from Aroostook Junction.

50-B—In east face of concrete retaining wall behind south abutment of Canadian Pacific railway bridge No. 33·4 over Grand river, about 2 miles north of St. Leonard station.

51-B—In southeast concrete pier under Canadian Pacific railway water-tank, at Sigas.

52-B—In north end of concrete cap on top of east face wall of arch culvert on Grand Trunk Pacific railway, 300 feet west of Canadian Pacific railway bridge, at mileage 38·9 from Aroostook Junction.

53-B—In west face of small concrete culvert on Grand Trunk Pacific railway at second telegraph pole north of Canadian Pacific railway mile post 43 from Aroostook Junction and 360 feet south of Theriault watertank.

54-B—In west end of south face and 23 inches below top of concrete retaining wall behind north abutment of Canadian Pacific railway bridge over Green river, ¾ mile south of Green river station.

55-B—In east face of small concrete culvert under Grand Trunk Pacific railway, at eighth telegraph pole north of Canadian Pacific railway mile post 50 from Aroostook Junction.

56-B—In east face of concrete culvert on Canadian Pacific railway, about ½ mile south of St. Basil station and between first and second telegraph poles north of mile post 52 from Aroostook Junction.

57-B—In exposed rock surface in field about 150 feet east of Canadian Pacific railway track, 2 miles south of Edmundston, and opposite fifth telegraph pole north of mile post 55 from Aroostook Junction.

58-B—In second course of stonework above bridge seat in north face of northwest retaining wall of Temiscouata railway bridge over Madawaska river, at Edmundston.

59-B—In face of northeast retaining wall of concrete subway on Grand Trunk Pacific railway, 300 feet west of bridge over Madawaska river, at Edmundston.

60-B—In face of rock-cut at north side of track, 140 feet west of west end of Canadian Pacific railway station-house at Edmundston.

61-B—In south face of cap-stone of south east retaining wall of Temiscouata railway bridge over Madawaska river, 2½ miles northwest of Edmundston.

62-B—In first course of stonework below water table in east wall of Roman Catholic church at Ste. Rose, 10 feet south of front wall of building.

63-B—In centre of south wall of rock-cut on Temiscouata railway, about 3 miles west of Ste. Rose, 435 feet east of trestle bridge, and at ninth telegraph pole east of mile post 57 from Rivière-du-Loup.

64-B—In south side of rock-cut on Temiscouata railway, one mile east of Notre-Dame-du-Lac, 70 feet west of blacksmith shop, and 220 feet west of mile post 53 from Rivière-du-Loup.

65-B—In north side of rock-cut on Hayes point, lake Temiscouata, 2 miles west of Notre-Dame-du-Lac, and 250 feet east of mile post 50 from Rivière-du-Loup.

66-B—In large granite boulder, 10 feet south of Temiscouata railway track, 2¾ miles east of Cabano, and at ninth telegraph pole west of mile post 46 from Rivière-du-Loup.

67-B—In north side, 42 feet east of west end, of first rock-cut (about 3½ miles) west of Cabano, on Temiscouata railway.

68-B—In boulder 6 feet north of north fence of Temiscouata railway right-of-way, 1½ miles east of Vauban, and opposite fifth telegraph pole east of mile post 35 from Rivière-du-Loup.

69-B—In exposed rock surface at north side of Temiscouata railway track, 2½ miles west of Vauban, and 360 feet east of mile post 31 from Rivière-du-Loup.

70-B—In small boulder 9 feet north of Temiscouata railway track and ¼ mile west of St. Honoré station.

71-B—In exposed rock surface at south side of Temiscouata railway track, 4¾ miles west of St. Honoré, and close to first telegraph pole east of mile post 22 from Rivière-du-Loup.

72-B—In north side of rock-cut on curve at summit of grade, 3¼ miles east of Whitworth station, on Temiscouata railway, and about ½ mile west of mile post 20 from Rivière-du-Loup.

73-B—In exposed rock surface at north side of Temiscouata railway track in shallow cut, 2¼ miles west of Whitworth and at first telegraph pole west of mile post 14 from Rivière-du-Loup.

74-B—In large boulder, 25 feet north of Temiscouata railway track, 1½ miles east of Ste. Modéste, and between fifteenth and sixteenth telegraph poles east of mile post 8 from Rivière-du-Loup.

75-B—In large piece of rock, 8 feet south of south fence of Temiscouata railway right-of-way and 250 feet east of mile post 3 from Rivière-du-Loup.

76-B—In sixth course of stonework below bridge seat in north face of west pier of two-span truss bridge over the Rivière-du-Loup, on the Temiscouata railway, about one mile southeast of Rivière-du-Loup station.

77-B—In second course of stonework below top in west face of northwest retaining wall of Intercolonial railway bridge over the Rivière-du-Loup, a few yards north of Rivière-du-Loup station.

78-B—In first course of stonework above water table in south wall of St. François-Xavier Roman Catholic church at Rivière-du-Loup, 3 feet 3 inches east of front wall of church.

BENCH MARKS BETWEEN BRUNSWICK JUNCTION AND ST. JOHN, NB., *VIA* NEW BRUNSWICK SOUTHERN RAILWAY TO BAY SHORE AND CANADIAN PACIFIC RAILWAY TO FAIRVILLE AND ST. JOHN.

79-B—In large piece of rock, 70 feet south of New Brunswick Southern railway track, on east side of public highway, 1½ miles west of Dyer station, and at seventeenth telegraph pole west of mile post 20 from St. Stephen.

80-B—In large boulder at south side of New Brunswick Southern railway track, 1½ miles east of Dyer station and at sixteenth telegraph pole west of mile post 23 from St. Stephen.

81-B—In boulder, 8 feet south of New Brunswick Southern railway track, 1¾ miles west of Bonny River station, and 65 feet east of mile post 28 from St. Stephen.

82-B—In exposed rock surface, 25 feet south of New Brunswick Southern railway track, 1¼ miles east of Bonny River station, and 135 feet west of mile post 31 from St. Stephen.

83-B—In stone foundation of front wall of Roman Catholic church at St. George, N.B., 8 feet 6 inches west of northeast corner.

84-B—In boulder, 8 feet by 12 feet, in field—12 feet south of south fence of New Brunswick Southern railway right-of-way—about ¼ mile east of "Lake Shore road" crossing at Utopia station.

85-B—In vertical rock surface in side of rocky hill, 75 feet north of New Brunswick Southern railway track, 1¾ miles west of Pennfield.

86-B—In boulder, 6 feet by 8 feet, 37 feet south of New Brunswick Southern railway track, about 3 miles west of Pocologan station, and 1,750 feet west of mile post 48 from St. Stephen.

87-B—In fourth course of stonework below concrete, in north end of face of east abutment of New Brunswick Southern railway bridge over Little New river, 1½ miles east of Pocologan station.

88-B—In boulder, 16 feet south of New Brunswick Southern railway track, 1¾ miles east of New River station and 2,400 feet west of mile post 56 from St. Stephen.

89-B—In second course of stonework below bridge seat in north end of east abutment of truss bridge over Lepreau river, 1,200 feet east of Lepreau station.

90-B—In south side of small rock-cut on New Brunswick Southern railway, 3¼ miles east of Lepreau and 420 feet east of mile post 62 from St. Stephen.

91-B—In third course of stonework below bridge seat in south face of west abutment of bridge over West Musquash river, 1¼ miles west of Musquash station.

92-B—In vertical face of ledge on top of south end of concrete pier at east end of swing span of bridge over East Musquash river, one mile east of Musquash station.

93-B—In south side of rock-cut on New Brunswick Southern railway, 2·3 miles east of Prince of Wales station and 1,220 feet east of mile post 72 from St. Stephen.

94-B—In exposed rock surface at south side of New Brunswick Southern railway track, 35 feet east of west end of rock, and 1,400 feet east of Allan Cot station.

95-B—In southwest corner of rocky hill, 33 feet north of north fence of New Brunswick Southern railway right-of-way, 1,500 feet west of Duck Cove station and immediately east of lane leading to St. John Asylum annex.

96-B—In second course of stonework above bridge seat in north end of east face of abutment at west end of steel trestle approach, at Fairville end of cantilever bridge over St. John river, between St. John and Fairville.

97-B—In foundation stone of south wall of Union station at St. John, 6 inches from southwest corner of main building, and immediately to the rear of facade.

98-B—In granite foundation stone of rear wall of St. John post office, 16 inches from southwest corner.

99-B—In foundation stone at south end of front wall of customs house, Prince William street, St. John, N.B.

100-B—In stone water table course in centre of north wall of Nase's grocery store, at southwest corner of Bridge and Main streets, at Indian Town wharf, St. John, N.B.

BENCH MARKS BETWEEN ST. JOHNS, QUE., AND SHERBROOKE, *VIA* CANADIAN PACIFIC RAILWAY THROUGH FARNHAM AND FOSTER.

75—In third course of stonework below water table course in south end of west wall of post office, at St. Johns, Que.

74—In north end of east face of west concrete abutment—3 feet above roadway—of subway under Canadian Pacific railway, 200 feet east of Richelieu River bridge, between St. Johns and Iberville.

72—In boulder, 15 feet south of Canadian Pacific railway track and 20 feet west of highway crossing at Versailles station.

71—In boulder, 25 feet north of Canadian Pacific railway track and 60 feet east of highway crossing at St. Brigide station.

62—In top course of stone foundation at east end of south wall of Canadian Pacific railway station-house at Farnham.

61—In second course of stonework below top in southwest retaining wall of small bridge on Canadian Pacific railway, 3·1 miles west of Brigham Junction.

60—In northeast concrete foundation pier under Canadian Pacific railway water-tank at Brigham Junction.

59—In boulder beside elm tree, 45 feet east and 100 feet south of southeast corner of Adamsville station-house.

58—In boulder, 10 feet south of Canadian Pacific railway track, 3¾ miles east of Adamsville station and at second telegraph pole east of mile post 118 from Megantic.

57—In west end of cap-stone of northwest retaining wall of Canadian Pacific railway bridge over north branch of Yamaska river, 1¼ miles east of West Shefford station.

56—In south side of rock-cut, 800 feet east of Fulford station and 230 feet east of mile post 109 from Megantic.

47—In west foundation wall of railroad hotel at Foster, 4 feet south of north-west corner.

46—In west end of cap-stone of southwest retaining wall of plate girder bridge on Canadian Pacific railway, 2 miles east of Foster station and at mileage 103·7 from Megantic.

45—In south end of west face of east abutment of small concrete culvert under Canadian Pacific railway, about ½ mile east of South Stukely station and at mileage 100·3 from Megantic.

44—In boulder 6 feet south of north fence of Canadian Pacific railway right-of-way, 150 feet east of section-house, and 1,200 feet west of station-house at Eastman Junction.

43—In exposed rock surface on north side of Canadian Pacific railway track, 18 feet east of sixth telegraph pole west of mile post 93 from Megantic.

42—In west end of cap-stone of northwest retaining wall of Canadian Pacific railway bridge over Castle creek, 3 miles west of Magog and at mileage 89·8 from Megantic.

41-A—In third course of stonework below water table course in west end of south wall of Magog post office.

41—In second course of stonework above ground in masonry base of Canadian Pacific railway water-tank at Magog, 15 feet to the right of doorway under tank.

40—In boulder 200 feet south of southwest corner of Magog station-house, 50 feet west of main line of Canadian Pacific railway, and on south street line of road to Magog wharf.

39—In north end of west face of concrete retaining wall, behind west abutment of Canadian Pacific railway bridge, about 2½ miles east of Magog station and at mileage 85·4 from Megantic.

38—In boulder at north side of Canadian Pacific railway track, 1¼ miles west of Bedard station, and close to culvert at mileage 79·23 from Megantic.

37—In east end of south face wall of stone culvert under Canadian Pacific railway, about one mile east of Lake Park station, and at mileage 76·5 from Megantic.

36—In east face of cap-stone of southeast retaining wall of Canadian Pacific railway bridge over Magog river, about ¾ mile west of Sherbrooke.

35—In stone water table course at south end of west wall of old Canadian Pacific railway passenger station at Sherbrooke.

BENCH MARKS BETWEEN FARNHAM AND INTERNATIONAL BOUNDARY NEAR ST. ARMAND, QUE., *VIA* CANADIAN PACIFIC RAILWAY TO STANBRIDGE AND CENTRAL VERMONT RAILWAY FROM STANBRIDGE TO BOUNDARY.

63—In west face of dressed corner stone at northwest corner of Farnham fire station.

64—In top course of granite foundation at south end of west wall of Eastern Townships Bank at Farnham.

65—In exposed rock surface, 15 feet west of Canadian Pacific railway track, 720 feet south of Mystic station.

66—In top course of granite foundation at south end of west wall of Eastern Townships Bank at Bedford.

67—In top course of stone foundation at west end of south wall of post office and general store at Stanbridge station.

68—In second course of brickwork below water table in east end of north wall of Central Vermont station-house at St. Armand.

69—In second course of stonework from top in west face of north abutment of old stone culvert under Central Vermont railway, about ½ mile south of St. Armand station.

70—In small granite boulder, 20 feet west of Central Vermont railway track, 190 feet south of international boundary post beside track, and about 1¼ miles south of St. Armand station.

BENCH MARKS BETWEEN FOSTER AND INTERNATIONAL BOUNDARY NEAR ABERCORN, QUE., *VIA* CANADIAN PACIFIC RAILWAY (DRUMMONDVILLE BRANCH AND NEWPORT SECTION).

48—In east side of rock-cut on Canadian Pacific railway, 1¼ miles north of Knowlton station and 20 feet north of fourth telegraph pole north of mile post 8 from Drummondville Junction.

49—In fourth course of stonework below water table in northeast end of northwest wall of Knowlton Academy, about 500 feet south of Canadian Pacific railway station at Knowlton.

50—In west face of second foundation pier from north end of oil tank directly opposite Canadian Pacific railway station at Brome.

51—In square boulder, 15 feet west of Canadian Pacific railway main line at Drummondville Junction, and 70 feet south of south end of station platform.

52—In top course of granite foundation at west end of north wall of Mountain View hotel, at Sutton, Que.

53—In cap-stone at west end of old granite culvert under Canadian Pacific railway, 1½ miles north of Abercorn station and at mileage 23·4 from Brigham Junction.

54—In west face of concrete culvert under Canadian Pacific railway, 960 feet north of Abercorn station and at mileage 24·68 from Brigham Junction.

55—In east face of concrete culvert under Canadian Pacific railway, one mile south of Abercorn station, 250 feet north of diagonal highway crossing, and at mileage 25·8 from Brigham Junction.

BENCH MARKS BETWEEN SHERBROOKE, QUE., AND NORTON MILLS, VERMONT, *VIA* GRAND TRUNK RAILWAY.

1—In first course of stonework below water table course in south face of pilaster at southwest corner of Sherbrooke post office.

2—In stone water table course of north side of Eastern Townships Bank at Sherbrooke, 21 feet west of northeast corner of building.

3—In second course of stonework, below top in west end of south face of retaining wall, behind north abutment of Grand Trunk railway bridge over Magog river, at Sherbrooke, 2,000 feet north of Grand Trunk railway station.

4—In east side of second rock-cut on Grand Trunk railway, about 1½ miles south of Sherbrooke station.

5—In second course of stonework below top in south end of east face wall of Canadian Pacific railway culvert No. 66·2, about 1,300 feet north of diamond crossing of Grand Trunk railway and Canadian Pacific railway, between Sherbrooke and Lennoxville.

6—In top course of stonework in west end of north face of retaining wall behind north abutment of Grand Trunk railway bridge over Massawippi river, ½ mile south of Lennoxville station.

7—In top course of stonework in west end of north face of retaining wall behind north abutment of Grand Trunk railway bridge over Salmon river, 1¾ miles south of Lennoxville station.

8—In large stone—58 feet from south end—of dry stone retaining wall on east side of Grand Trunk railway track, 1¾ miles north of Waterville; this is the farther north of the two retaining walls near this point.

9—In north face of cap-stone of northwest retaining wall of Grand Trunk railway bridge over Coaticook river, 1,200 feet north of Waterville station.

10—In west side of rock-cut on Grand Trunk railway, 200 feet south of farm crossing, ¾ mile north of Compton station, and 1,925 feet north of mile post 114 from Montreal.

11—In west side of rock-cut on Grand Trunk railway—2 feet from south end—1¼ miles south of Compton station, 420 feet north of subway, and 2,040 feet north of mile post 116 from Montreal.

13—In rear or northwest face of top course of stonework of retaining wall behind northerly abutment of subway, ½ mile south of Hillhurst station.

14—In north face of northwest cap-stone of subway under Grand Trunk railway, at Coaticook station.

15—In first course of stonework below water table course, near centre of west wall of Eastern Townships Bank, at Coaticook.

16—In first course of stonework below water table course in west wall of Coaticook post office, 8 feet south of main entrance.

17—In south end of west side of first rock-cut on Grand Trunk railway, one mile south of Coaticook station.

18—In east side of rock-cut on Grand Trunk Railway, 2½ miles south of Coaticook station and 278 feet north of mile post 125 from Montreal.

19—In centre of east side of rock-cut on Grand Trunk railway, 1½ miles north of Dixville station and 870 feet south of mile post 126 from Montreal.

21—In west side of rock-cut on Grand Trunk railway—50 feet from north end—on sharp curve, about 1¼ miles south of Dixville station and 225 feet north of mile post 129 from Montreal.

22—In west side of rock-cut on Grand Trunk railway—20 feet from south end—on sharp curve, about 1¾ miles south of Dixville station, and 2,440 feet south of mile post 129 from Montreal.

23—In southeast face of second course of stonework below top of curved southeast retaining wall of bridge at international boundary, 400 feet north of Norton Mills station.

24—In second course of stonework above ground in east end of south face of north abutment of Grand Trunk railway bridge at international boundary, 400 feet north of Norton Mills station.

25—In first course of stonework above ground in east end of north face of south abutment of Grand Trunk railway bridge at international boundary, 400 feet north of Norton Mills station.

BENCH MARKS BETWEEN ST. JOHNS, QUE., AND ST. POLYCARPE JUNCTION VIA GRAND TRUNK RAILWAY THROUGH LACOLLE JUNCTION AND COTEAU JUNCTION.

76—In stone water table course at west end of south wall of Grand Trunk station house at St. Johns, Que.

77—In southeast end of second course of stonework below top of southeast curved retaining wall of plate girder bridge on Grand Trunk railway, 1½ miles south of St. Johns, and at fourteenth telegraph pole south of mile post 21 from Rouse Point.

78—In south face of corner-stone—second course above ground—in southwest corner of central section of Roman Catholic church at Grand Ligne.

79—In third course of stonework below water table course in north side of pilaster at northeast corner of Roman Catholic church at Stottsville.

81—In north abutment of bridge on Grand Trunk railway about 2½ miles south of Lacolle Junction.

83—In second course of stonework below cap-stone in north face of east abutment of small culvert under Grand Trunk railway, 1½ miles west of Henrysburg station and 1,560 feet west of mile post 16 from Alburgh Junction.

85—In small rock-cut at south side of Grand Trunk railway track, 120 feet east of farm crossing and ½ mile east of Holton station.

86—In third course of stonework below cap-stone in south face of west abutment of small, dry stone culvert under Grand Trunk railway, 1¼ miles west of Aubrey station and at twelfth telegraph pole east of mile post 33 from Alburgh Junction.

87—In southwest end of third course of stonework below top of southwest retaining wall of circular stone culvert under Grand Trunk railway, ½ mile east of Howick Junction and at third telegraph pole west of highway crossing.

88—In northeast end of top course of stonework in northeast retaining wall of circular cattle-pass under Grand Trunk Railway, about 720 feet east of St. Louis station.

89—In first course of stonework above platform in west end of south wall of Grand Trunk railway station house at Valleyfield.

90—In north face of northeast stone footing under southerly Grand Trunk water tank at Coteau Junction.

91—In southwest face—12 inches below top—of southerly concrete retaining wall of plate girder bridge on Grand Trunk railway, about 1½ miles northwest of Coteau Junction.

92—In fourth course of stonework below top in southwest face of northwesterly abutment of open culvert under Grand Trunk railway, 1,600 feet southeast of St. Polycarpe Junction.

BENCH MARKS BETWEEN ST. POLYCARPE JUNCTION, QUE., AND COLBORNE, ONT., VIA CANADIAN PACIFIC RAILWAY THROUGH KEMPTON TO PRESCOTT AND GRAND TRUNK RAILWAY FROM PRESCOTT TO COLBORNE.

93—In west end of cap-stone of southwest retaining wall of plate girder bridge over Delisle river, one mile west of St. Polycarpe Junction.

94—In top of south end of 36 inch concrete tile culvert under Canadian Pacific railway, ½ mile west of St. Télesphore station.

95—In masonry base of Canadian Pacific railway water tank at Dalhousie Mills, 7 feet to the left of the doorway underneath tank and 7 inches above door sill.

96—In south face of concrete culvert under Canadian Pacific railway, 2¾ miles west of Dalhousie Mills station and at mileage 44·5 from Montreal Junction.

97—In south side of boulder—6 feet by 6 feet—about 15 feet south of north fence of Canadian Pacific railway right-of-way and 1 mile east of Green Valley station.

98—In north side of boulder—4 feet by 4 feet—about 9 feet north of south fence of Canadian Pacific railway right-of-way, 220 feet east of concrete tile culvert and ¼ mile east of Glen Roy station.

99—In east side of boulder 15 feet north of south fence of Canadian Pacific railway right-of-way, 2¾ miles west of Glen Roy station and 460 feet west of mile post 55 from Montreal Junction.

100—In west end of cap-stone of northwest retaining wall of plate girder bridge, ½ mile east of Apple Hill station.

101—In north side of boulder 10 feet north of south fence of Canadian Pacific railway right-of-way, 2 miles west of Apple Hill station, 1,000 feet east of subway and 650 feet east of mile post 60 from Montreal Junction.

102—In masonry base of Canadian Pacific railway water tank at Monckland, 18 inches to the left of the doorway underneath tank and 20 inches above door sill.

103—In top course of stone foundation at east end of north wall of Avonmore Presbyterian church.

104—In south face of concrete culvert under Canadian Pacific railway, 1½ miles west of Avonmore station.

105—In south face of cap-stone at south end of retaining wall behind west abutment of plate girder bridge over Payne river, ¼ mile east of Finch station.

106—In top of south face of concrete culvert under Canadian Pacific railway, 3 miles west of Finch and ¼ mile east of east end of long curve.

107—In masonry base of Canadian Pacific railway water tank at Chesterville, 15 feet to the left of doorway underneath tank and 4 feet above ground.

108—In south face of concrete retaining wall behind west abutment of subway under Canadian Pacific railway, 2¾ miles east of Winchester.

109—In south side of boulder on Canadian Pacific railway right-of-way—close to north fence—50 feet west of road from Winchester station to village.

110—In top of south face of concrete culvert under Canadian Pacific railway, about ½ mile west of Inkerman.

111—In east foundation wall of frame school house at Mountain station, 5 feet 3 inches from southeast corner.

112—In top of south face of concrete culvert under Canadian Pacific railway, 2 miles east of Kempton.

113—In masonry base of Canadian Pacific railway water tank at Kempton, 2 feet 5 inches to the right of the doorway underneath tank and 3 feet 8 inches above doorsill.

114—In top of east face of concrete culvert under Canadian Pacific railway, one mile north of Oxford station.

115—In north side of boulder—6 feet by 6 feet—on east side of Canadian Pacific railway track, 3 miles south of Oxford station and 750 feet south of mile post 38 from Ottawa.

116—In west end of south wall of stone school house, 200 feet east of Canadian Pacific railway track and 1¾ miles north of Spencerville station.

117—In top of east face of concrete culvert under Canadian Pacific railway, 2¾ miles south of Spencerville station.

118—In north face of east abutment of Canadian Pacific railway subway under main line of Grand Trunk railway near Prescott. The bench mark is a few inches above the Canadian Pacific railway rail.

119—In third course of stonework above water table in east end of north wall of Grand Trunk station house at Prescott.

120—In east face of cap-stone on south end of stone arch culvert under Grand Trunk railway, 3¼ miles west of Prescott.

121—In south face of southeast cap-stone of plate girder bridge on Grand Trunk railway, one mile east of Maitland.

122—In south face of southwest cap-stone of plate girder bridge on Grand Trunk railway, 2 miles west of Maitland.

123—In south face of cap-stone on south end of small stone culvert under Grand Trunk railway, 100 feet east of Ormond street, Brockville, and 100 feet west of mile post 209 from Toronto.

124—In centre of north face of south abutment of Grand Trunk railway subway under Brockville-Westport and North-western railway, 1½ miles west of Brockville. The bench mark is 1 foot above G.T.R. rail.

125—In south face of southeast cap-stone of plate girder bridge on Grand Trunk railway, about 1,000 feet west of Lyn.

126—In top course of stonework in south face of east abutment of cattle pass under Grand Trunk railway, 2¾ miles west of Lyn.

127—In top course of stonework in south face of west abutment of cattle pass under Grand Trunk railway, 2 miles east of Mallorytown.

128—In south face of cap-stone on south end of square stone culvert under Grand Trunk railway, 1 mile west of Mallorytown and 400 feet east of highway crossing.

129—In west end of south face of cap-stone on south end of square stone culvert under Grand Trunk railway, 3¾ miles west of Mallorytown and 1,000 feet east of mile post 192 from Toronto.

130—In top course of stonework in north face of east abutment of open culvert under Grand Trunk railway, ½ mile east of Lansdowne.

131—In first course of stonework above water table in west end of south wall of Lansdowne Town Hall.

132—In top course of stonework in north face of east abutment of open culvert under Grand Trunk railway—beside highway crossing—4¼ miles east of Thousand Islands Junction.

133—In top course of stonework in north face of east abutment of open culvert under Grand Trunk railway, 2 miles east of Thousand Islands Junction.

134—In east end of north face of cap-stone on northeast retaining wall of Grand Trunk railway bridge over Gananoque river, 2 miles west of Thousand Islands Junction.

135—In south face of southwest cap-stone of plate girder bridge on Grand Trunk railway over Grass creek, 1¼ miles east of Findley station.

136—In north face of north east cap-stone of plate girder bridge on Grand Trunk railway, 2 miles west of Findley station.

137—In east end of north face of cap-stone on north end of square stone culvert under Grand Trunk railway, 5 miles west of Findley station and 1,200 feet west of highway crossing.

138—In east face of cap-stone on northeast retaining wall of Grand Trunk railway bridge over Rideau canal at Kingston Mills, about ½ mile west of Rideau station.

139—In first course of stonework above water table at east end of north wall of Grand Trunk railway station house at Kingston Junction.

140—In south face of southwest cap-stone of plate girder bridge on Grand Trunk railway, 3 miles west of Kingston Junction and ¼ mile east of highway crossing.

141—In third course of stonework above ground—in first pilaster from northwest corner—in west wall of Kingston City Hall.

141-A—In water table course of stonework at south end of east wall of Kingston Post Office.

142—In corner stone of third course of stonework above platform in north end of west wall of Kingston and Pembroke railway station house at Kingston.

143—In south face of southwest cap-stone of open culvert under Grand Trunk railway, 1½ miles east of Collins Bay station.

144—In west face of cap-stone on southwest retaining wall of Grand Trunk railway bridge over McGuinn brook, ½ mile west of Collins Bay station.

145—In south face of cap-stone on south end of stone arch culvert under Grand Trunk railway, 3¼ miles west of Collins Bay station and 1,300 feet east of mile post 150 from Toronto.

146—In south wall of Grand Trunk railway station house at Ernestown, 3 feet west of waiting room door.

147—In east face of west abutment—3 feet below southwest cap-stone—of very small culvert under Grand Trunk railway, 4 miles west of Ernestown.

148—In west face of cap-stone on south end of stone arch subway under Grand Trunk railway, 3 miles east of Napanee.

149—In second course of stonework below water table in east wall of Napanee Court House, 1 foot 6 inches south of first window from north east corner of building.

150—In north wall of Grand Trunk station house at Napanee, 1 foot east of westerly doorway.

151—In east face of southwest cap-stone of plate girder bridge on Grand Trunk railway, 3½ miles west of Napanee. This bridge is the farther west of the two bridges near this point.

152—In west face of cap-stone on north end of stone arch culvert under Grand Trunk railway, ¼ mile east of Marysville.

153—In east face of cap-stone on northeast retaining wall of Grand Trunk railway bridge over Salmon river, 1½ miles east of Shannonville station.

154—In north face of first corner stone above water table at north west corner of Grand Trunk railway station house at Shannonville.

155—In north face of north east cap-stone of plate girder bridge on Grand Trunk railway, 3 miles west of Shannonville and 1,000 feet west of highway crossing.

156—In north wall of Grand Trunk railway station house at Belleville—in first stone above water table—immediately west of easterly doorway.

157—In east wall of Belleville City Hall, 16 inches below water table course of stonework, and 4 feet 6 inches south of first basement window from northeast corner of building.

158—In east face of northeast cap-stone of plate girder bridge on Grand Trunk railway, 3 miles west of Belleville.

159—In southeast face of southwest cap-stone of open culvert under Grand Trunk railway, 5½ miles west of Belleville.

160—In north face of northeast cap-stone of open culvert under Grand Trunk railway, 3¾ miles east of Trenton.

161—In rounded southeast corner of top course of stonework of east abutment of Central Ontario railway subway under Grand Trunk railway at Trenton station.

162—In north face of northeast cap-stone of open culvert under Grand Trunk railway, half way between Trenton and Brighton.

163—In east face of northeast cap-stone of open culvert under Grand Trunk railway, ¾ mile east of Brighton station.

164—In north face of northeast cap-stone of open culvert under Grand Trunk railway, 1½ miles west of Brighton and midway between two highway crossings.

165—In east face of cap-stone on north end of stone arch culvert under Grand Trunk railway, 4½ miles west of Brighton.

166—In north end of west face of east abutment of open culvert under Grand Trunk railway, about 1,700 feet east of Colborne station.

TABLE II.

RESULTS OF PRECISE LEVELLING FROM ST. STEPHEN, N.B., TO RIVIERE-DU-LOUP, QUEBEC.

Bench Marks.		Distance between successive bench marks.	Distance from bench mark 1 B.	Discrepancy.		Elevation above mean sea level.
From.	To.			Partial.	Total.	
		Miles.	Miles.	Feet.	Feet.	Feet.
... .	1B	....	....	....	....	53·578
1B	2B	1·0	1·0	+·005	+·005	26·064
2B	3B	....	1·0	+·001	+·006	23·239
3B	4B	5·3	6·3	+·011	+·017	82·584
4B	5B	4·7	11·0	+·013	+·030	135·118
5B	6B	4·7	15·7	+·008	+·038	275·905
6B	7B	5·8	21·5	−·025	+·013	216·340
7B	8B	4·7	26·2	−·028	−·015	313·253
8B	9B	5·0	31·2	−·028	−·043	412·622
9B	10B	5·0	36·2	−·023	−·066	421·679
10B	11B	5·0	41·2	+·017	−·049	461·832
11B	12B	5·5	46·7	+·010	−·039	382·637
12B	13B	....	46·7	·000	−·039	388·423
11B	14B	10·2	51·4	+·018	−·031	484·243
14B	15B	6·0	57·4	+·018	−·013	541·108
15B	16B	6·3	63·7	−·018	−·031	563·625
16B	17B	4·2	67·9	+·025	−·006	464·068
17B	18B	6·2	74·1	−·008	−·014	412·210
18B	19B	4·0	78·1	−·026	−·040	549·955
19B	20B	3·5	81·6	−·017	−·057	548·292
20B	21B	4·6	86·2	+·013	−·044	544·508
21B	22B	0·4	86·6	−·002	−·046	530·198
20B	23B	4·5	86·1	−·017	−·074	394·075
23B	24B	4·5	90·6	+·022	−·052	189·781
24B	25B	2·0	92·6	+·003	−·049	142·014
25B	26B	0·5	93·1	+·004	−·045	197·885
26B	27B	....	93·1	+·003	−·042	186.200
26B	28B	2·3	95·4	−·010	−·055	149·367
28B	29B	4·0	99·4	+·016	−·039	132·082
29B	30B	4·0	103·4	−·020	−·059	143·431

RESULTS OF PRECISE LEVELLING FROM ST. STEPHEN, N.B., TO RIVIERE-DU-LOUP, QUE.—*Continued.*

Bench Marks.		Distance between successive bench marks.	Distance from bench mark 1 B.	Discrepancy.		Elevation above mean sea level.
From.	To.			Partial.	Total.	
		Miles.	Miles.	Feet	Feet.	Feet.
30B	31B	2·8	106·2	+·018	−·041	158·366
31B	32B	6 0	112·2	+·015	−·026	172·021
32B	33B	3·0	115·2	−·015	−·041	181·791
33B	34B	4·5	119·7	+·013	− 028	200·344
34B	35B	3·5	123·2	−·018	−·046	202·812
35B	36B	4·5	127·7	−·019	−·065	213·799
36B	37B	6·0	133·7	−·004	−·069	237·576
37B	38B	6·7	140.4	−·031	−·100	285·937
38B	39B	1·5	141·9	−·001	−·101	257·296
39B	40B	0.3	142·2	−·002	−·103	261·503
40B	41B	5·5	147·7	+·002	−·101	279·292
41B	42B	4·7	152·4	−·002	−·103	373·065
41B	43B	4·5	152·2	+·020	−·081	407·970
43B	44B	3·7	155·9	−·010	− 091	334 720
44B	45B	5·0	160·9	+·002	−·089	287·758
45B	46B	5·5	166·4	−·017	−·106	513 117
46B	47B	1·5	167·9	+·002	−·104	467·698
47B	48B	4·2	172·1	+·001	−·103	497·302
48B	49B	4·5	176 6	+·031	−·072	442·633
49B	50B	5·0	181 6	−·014	−·086	449·126
50B	51B	2·5	184·1	+·015	−·071	451·834
51B	52B	3·0	187·1	+·019	−·052	439·205
52B	53B	4·0	191 1	+·002	−·050	459·917
53B	54B	3·5	194·6	+·021	−·029	457·010
54B	55B	3·8	198·4	+·015	−·014	478·167
55B	56B	1·8	200 2	−·013	−·027	475·713
56B	57B	3 0	203·2	+·006	−·021	511·944
57B	60B	2·0	205·2	−·014	−·035	482·942
60B	58B	0·5	205·7	+·003	−·032	473·642
58B	59B	....	205·7	+·004	−·028	461·816
60B	61B	2·5	207·7	+·009	−·026	485·214
61B	62B	18·7	226·4	−·019	−·045	531·111
62B	63B	3·3	229·7	+·021	−·024	513·118
63B	64B	4·2	233·9	−·024	−·048	521·975
64B	65B	3·0	236·9	+·002	−·046	512·770
65B	66B	4·3	241·2	+·013	−·033	514·376
66B	67B	6·2	247·4	−·027	−·060	709 814
67B	68B	4·5	251·9	+·014	−·046	987·119
68B	69B	4 0	255·9	−·006	−·052	1,118·094
69B	70B	4·5	260·4	+·009	−·043	1,295·992
70B	71B	4·5	264·9	−·007	−·050	1,165·164
71B	72B	2·5	267·4	−·022	−·072	1,081·000
72B	73B	5·5	272·9	+·021	−·051	846·736
73B	74B	5·5	278·4	−·024	−·075	653·057
74B	75B	5·5	283·9	+·032	−·043	338·673
75B	76B	2·5	286·4	+·023	−·020	307·535
76B	77B	1·0	287·4	+·013	−·033	313·608
77B	78B	0·2	287·6	−·001	−·034	412·589

RESULTS OF PRECISE LEVELLING FROM ST. STEPHEN, N.B., TO ST. JOHN, N.B.

Bench Marks.		Distance between successive bench marks.	Distance from bench mark 1B.	Discrepancy.		Elevation above mean sea level.
From	To			Partial.	Total.	
		Miles.	Miles.	Feet.	Feet.	Feet.
....	1B	....	....	....	....	53·578
1B	2B	1·0	1·0	+ ·005	+ ·005	26·064
2B	3B	....	1·0	+ ·001	+ ·006	23·239
3B	4B	5·3	6·3	+ ·011	+ ·017	82·584
4B	5B	4·7	11·0	+ ·013	+ ·030	135·118
5B	6B	4·7	15·7	+ ·008	+ ·038	275·905
6B	79B	4·7	20·4	+ ·028	+ ·066	127·400
79B	80B	3·0	23·4	+ ·018	+ ·084	159·387
80B	81B	5·5	28·9	− ·024	+ ·060	98·941
81B	82B	3·0	31·9	− ·019	+ ·041	68·744
82B	83B	4·5	36·4	+ ·021	+ ·062	38·274
83B	84B	3·0	39·4	− ·021	+ ·041	128·680
84B	85B	4·8	44·2	+ ·028	+ ·069	262·279
85B	86B	4·5	48·7	+ ·013	+ ·082	236·010
86B	87B	4·5	53·2	− ·004	+ ·078	168·028
87B	88B	3·3	56·5	− ·006	+ ·072	179·420
88B	89B	3·5	60·0	− ·005	+ ·067	60·782
89B	90B	3·0	63·0	+ ·021	+ ·088	86·890
90B	91B	3·3	66·3	− ·020	+ ·068	33·126
91B	92B	2·3	68·6	− ·020	+ ·048	15·928
92B	93B	4·7	73·3	− ·004	+ ·044	204·967
93B	94B	3·0	76·3	− ·026	+ ·018	204·662
94B	95B	5·0	81·3	+ ·002	+ ·020	68·498
95B	96B	2·5	83·8	− ·026	− ·006	86·440
96B	97B	1·7	85·5	+ ·008	+ ·002	21·776
97B	98B	0·5	86·0	− ·008	− ·006	20·770
98B	99B	0·3	86·3	− ·007	− ·013	42·722
96B	100B	1·8	85·6	− ·008	− ·014	20·352

RESULTS OF PRECISE LEVELLING FROM ROUSE POINT, N.Y., TO SHERBROOKE, QUE.

Bench Marks. From	Bench Marks. To	Distance between successive bench marks.	Distance from bench mark ⊕	Discrepancy. Partial.	Discrepancy. Total.	Elevation above mean sea level.
		Miles.	Miles.	Feet.	Feet.	Feet.
....	⊕	....	....	....	....	107·950
⊕	81	3·3	3·3	−·022	−·022	111·595
81	79	7·2	10·5	+·016	−·006	156·371
79	78	6·0	16·5	−·059	−·065	140·678
78	77	5·0	21·5	+·023	−·042	121·014
77	76	1·5	23·0	+·015	−·027	122·124
76	75	0·3	23·3	−·005	−·032	123·885
76	74	0·5	23·5	−·008	−·035	103·856
74	72	6·3	29·8	+·013	−·022	182·229
72	71	2·3	32·1	−·008	−·030	159·204
71	62	4·4	36·5	−·008	−·038	195·121
62	61	3·0	39·5	+·012	−·026	225·117
61	60	2·3	41·8	+·016	− 010	264·818
60	59	4·8	46·6	−·034	−·044	377·565
59	58	3·9	50·5	+·005	−·039	357·644
58	57	4·8	55·3	·000	−·039	432·236
57	56	4·2	59·5	− 042	−·081	589 078
56	47	3·5	63·0	+·051	−·030	703·135
47	46	1·9	64·9	+·011	−·019	731·218
46	45	3·5	68·4	+·007	−·012	859·930
45	44	2·7	71·1	+·012	·000	914·749
44	43	4·4	75·5	−·005	−·005	934·811
43	42	3·3	78·8	+·015	+·010	814 758
42	41	3·0	81·8	−.037	−·027	689·780
41	41A	0·5	82·3	−·002	−·029	707·298
41	40	0·1	81·9	−·001	−·028	689·123
40	39	1·4	83·3	+·002	−·026	676·635
39	38	6·2	89·5	−·030	−·056	651 376
38	37	4·7	94·2	−·055	−·111	660·471
37	36	5·0	99·2	−·051	−·162	595·667
36	35	1·2	100·4	−·011	− 173	611·198
35	1	0·5	100 9	−·004	− 177	541·862

⊕ United States bench mark on Chapman Building, Rouse Point, N.Y.

RESULTS OF PRECISE LEVELLING FROM FARNHAM TO INTERNATIONAL BOUNDARY NEAR ST. ARMAND, QUE.

Bench Marks.		Distance between successive bench marks.	Distance from bench mark 62.	Discrepancy.		Elevation above mean sea level.
From	To			Partial.	Total.	
		Miles	Miles	Feet	Feet	Feet
....	62	....	....	....	....	195·121
62	63	0·2	0·2	−·002	−·002	193·031
63	64	0·1	0·3	−·003	−·005	192·787
62	65	9·3	9·3	+·001	+·001	186·334
65	66	2·4	11·7	+·020	+·021	178·185
66	67	2·6	14·3	−·006	+·015	167·611
67	68	6·4	20·7	+·010	+·025	123·626
68	69	0·6	21·3	+·003	+·028	107·323
69	70	0·7	22·0	+·003	+·031	108·161

RESULTS OF PRECISE LEVELLING FROM FOSTER TO INTERNATIONAL BOUNDARY NEAR ABERCORN, QUE.

Bench Marks.		Distance between successive bench marks.	Distance from bench mark 47.	Discrepancy.		Elevation above mean sea level.
From	To			Partial.	Total.	
		Miles	Miles	Feet	Feet	Feet
....	47	....	....	....	....	703·135
47	48	3·2	3·2	−·033	−·033	666·742
48	49	1·2	4·4	−·038	−·071	690·592
49	50	4·4	8·8	−·025	−·096	679·176
50	51	3·7	12·5	+ 015	−·081	554·849
51	52	3·1	15·6	+·010	−·071	591·272
52	53	4·0	19·6	+·002	−·069	492·870
53	54	1·2	20·8	+·014	−·055	485·656
54	55	1·1	21·9	+·013	−·042	492 526

RESULTS OF PRECISE LEVELLING FROM SHERBROOKE, QUE., TO INTERNATIONAL BOUNDARY AT NORTON MILLS, VERMONT.

Bench Marks.		Distance between successive bench marks.	Distance from bench mark 1.	Discrepancy.		Elevation above mean sea level.
From.	To			Partial.	Total.	
		Miles.	Miles.	Feet.	Feet.	Feet.
....	1	....	....	....	....	541·862
1	2	....	0·0	−·001	−.001	533·543
2	3	0·2	0·2	−·007	−·008	484·318
3	4	1·3	1·5	+·008	·000	498·756
4	5	0·8	2·3	−·003	−·003	488·547
5	6	1·4	3·7	+·003	·000	495·522
6	7	1·2	4·9	+·010	+·010	495·050
7	8	3·5	8·4	−·056	−·046	597·624
8	9	1·4	9·8	+ 008	−·038	643·148
9	10	3·0	12·8	+·018	−·020	707·196
10	11	1·9	14·7	+·015	−·005	747·534
11	13	1·8	16·5	+·029	+·024	829·940
13	14	4·9	21·4	+·036	+·060	1005·416
14	15	0·4	21·8	+·017	+·077	963·679
15	16	....	21·8	·000	+·077	963·015
14	17	0·8	22·2	+·018	+·078	1040·109
17	18	1·4	23·6	+·022	+·100	1069·878
18	19	1·4	25·0	+·007	+·107	1101·157
19	21	3·3	28·3	+·025	+·132	1166·804
21	22	0·5	28·8	−·009	+·123	1187·171
22	23	2·8	31·6	+·008	+·131	1247·750
23	24	....	31·6	·000	+·131	1213·468
24	25	....	31·6	·000	+·131	1212·040

RESULTS OF PRECISE LEVELLING FROM ROUSE POINT, N.Y., TO COLBORNE, ONTARIO.

Bench Marks.		Distance between successive bench marks.	Distance from bench mark. ⊕	Discrepancy.		Elevation above mean sea level.
From	To			Partial.	Total.	
		Miles.	Miles.	Feet.	Feet.	Feet.
....	⊕	....	....	....	....	107·950
⊕	81	3·3	3·3	− ·022	− ·022	111·595
81	83	5·9	9·2	− ·024	− ·046	192·365
83	85	11·2	20·4	+ ·062	+ ·016	200·904
85	86	8·2	28·6	− ·010	+ ·006	132·917
86	87	3 6	32·2	− ·006	·000	125·239
87	88	6·2	38·4	+ ·007	+ ·007	130·729
88	89	8·8	47·2	− ·004	+ ·003	162·081
89	90	5·3	52·5	− ·011	− ·008	157·040
90	91	2·0	54·5	− ·013	− ·021	162 816
91	92	4·0	58·5	− ·008	− ·029	136·360
92	93	1·2	59·7	− ·017	− ·046	193·504
93	94	3·0	62·7	+ ·021	− ·025	213 997
94	95	2·3	65·0	− ·006	− ·031	226·446
95	96	2·7	67·7	+ ·005	− ·026	263·469
96	97	4·0	71·7	+ ·001	− ·025	268 499
97	98	3·8	75·5	− ·023	− ·048	277 283
98	99	3·0	78·5	+ ·013	− ·035	271·914
99	100	2·5	81·0	− ·020	− ·055	286·115
100	101	2·5	83·5	+ ·009	− ·046	317·830
101	102	3·5	87·0	− ·012	− ·058	335·602
102	103	5 0	92·0	·000	− ·058	327·566
103	104	1·8	93·8	− ·001	− ·059	297·254
104	105	4·2	98·0	− ·032	− ·091	275·786
105	106	3·2	101·2	+ ·007	− ·084	247·071
106	107	4·3	105·5	− ·025	− ·109	242·401
107	108	3·3	108·8	− ·005	− ·114	268·870
108	109	2·7	111·5	− ·018	− ·132	250·268
109	110	3·5	115·0	− ·026	− ·158	258·740
110	111	4·2	119·2	+ ·010	− ·148	270·325
111	112	5·0	124·2	+ ·011	− ·137	329·122
112	113	2·0	126·2	− ·002	− ·139	337·269
113	114	3·0	129·2	+ ·001	− ·138	335·400
114	115	4·0	133·2	− ·009	− ·147	338·808
115	116	3·2	136·4	+ ·034	− ·113	335·573
116	117	4·5	140·9	− ·022	− ·135	300·295
117	118	5·3	146·2	− ·029	− ·164	288·676
118	119	1·8	148·0	− ·022	− ·186	313·837
119	120	3·2	151·2	− ·008	− ·194	284·563
120	121	2·5	153·7	− ·002	− ·196	302·944
121	122	3·0	156·7	− ·009	− ·205	323·077
122	123	2·5	159·2	+ ·013	− ·192	295·634
123	124	2·0	161·2	+ ·011	− ·181	284·149
124	125	2·0	163·2	+ ·009	− ·172	286·823
125	126	2·8	166·0	− ·021	− ·193	321·389
126	127	3·5	169·5	− ·017	− ·210	290·107
127	128	3·0	172·5	+ ·018	− ·192	320·552
128	129	2·7	175·2	− ·024	− ·216	316·413
129	130	4·2	179·4	− ·017	− ·233	325·846
130	131	0·8	180·2	+ ·001	− ·232	376·174
131	132	4·0	184·2	− ·032	− ·264	314·225
132	133	2·2	186·4	− ·016	− ·280	325·320
133	134	4·0	190·4	+ ·009	− ·271	293·687
134	135	3·0	193·4	− ·022	− ·293	343·482
135	136	3·3	196·7	+ ·024	− ·269	351·746
136	137	3·0	199·7	+ ·013	− ·256	315·551
137	138	4·2	203·9	− ·038	− ·294	310·785
138	139	3·7	207·6	− ·003	− ·297	277·940

RESULTS OF PRECISE LEVELLING FROM ROUSE POINT, N.Y., TO COLBORNE, ONT.—*Concluded.*

Bench Marks.		Distance between successive bench marks.	Distance from bench mark ⊕	Discrepancy.		Elevation above mean sea level.
From	To			Partial.	Total.	
		Miles.	Miles.	Feet.	Feet.	Feet.
139	141	2·3	209·9	−·036	−·333	264·699
141	141A	....	209·9	+·003	−·330	276·986
141	142	....	209·9	·000	−·333	259·688
139	140	3·0	210·6	−·018	−·315	255·646
140	143	2·8	213·4	+·003	−·312	265·945
143	144	2·0	215·4	+·002	−·310	272·991
144	145	2·7	218·1	−·001	−·311	315·191
145	146	4·2	222·3	−·030	−·341	327·440
146	147	4·0	226·3	−·023	−·364	340·144
147	148	4·0	230·3	+·016	−·348	296·034
148	149	2·5	232·8	+·016	−·332	314·333
149	150	0·5	233·3	−·006	−·338	316·141
150	151	3·5	236·8	−·008	−·346	290·623
151	152	4·2	241·0	+·024	−·322	338·579
152	153	5·3	246·3	−·008	−·330	284·481
153	154	1·5	247·8	+·007	−·323	337·466
154	155	3·0	250·8	−·024	−·347	317·206
155	156	4·2	255·0	+·009	−·338	288·567
156	157	1·5	256·5	−·001	−·339	257·005
156	158	3·0	258·0	+·012	−·326	307·205
158	159	2·5	260·5	+·023	−·303	306·755
159	160	3·0	263·5	+·001	−·302	306·251
160	161	3·8	267·3	−·035	−·337	283·887
161	162	4·5	271·8	−·023	−·360	314·101
162	163	3·7	275·5	+·003	−·357	306·996
163	164	2·3	277·8	+·003	−·354	310·872
164	165	3·0	280·8	+·003	−·351	283·401
165	166	3·0	283·8	+·007	−·344	298·946

⊕ United States bench mark on Chapman building, Rouse Point, N.Y.

TABLE III.

RAIL ELEVATIONS AT STATIONS, ST. STEPHEN, N.B., TO RIVIERE-DU-LOUP, QUEBEC.

		Feet.
Canadian Pacific Railway	St. Stephen	15·1
" " "	Watt Junction	312·3
" " "	McAdam	458·6
" " "	Canterbury	563·1
" " "	Benton	415·6
" " "	Debec Junction	551·3
" " "	International Boundary (on Houlton branch)	525·9
" " "	Woodstock (yard station)	148·3
" " "	Upper Woodstock	158·7
" " "	Hartland	169·1
" " "	Florenceville	191·5
" " "	Bristol	206·1
" " "	Bath	218·0
" " "	Kilburn	286·0
" " "	Perth	257·8
" " "	Andover	268·6
" " "	Aroostook Junction	276·0
" " "	International Boundary (on Aroostook branch)	372·9
" " "	Grand Falls	504·8
" " "	St. Leonard	509·4
" " "	Green River	485·6
" " "	Edmundston	478·9
Témiscouata Railway	Edmundston	478·4
" "	Ste. Rose	505·8
" "	Notre-Dame-du-Lac	529·9
" "	Cabano	563·1
" "	Vauban	1,058·0
" "	St. Honoré	1,302·0
" "	Whitworth	879·2
" "	Ste. Modéste	547·6
Intercolonial Railway	Rivière-du-Loup	315·7

RAIL ELEVATIONS AT STATIONS, ST. STEPHEN, N.B., TO ST. JOHN, N.B.

New Brunswick Southern Railway	St. Stephen	15·1
" " "	Oak Bay	72·5
" " "	Brunswick Junction	279·6
" " "	Dyer	104·1
" " "	Bonny River	72·4
" " "	St. George	89·4
" " "	Utopia	112·0
" " "	Pennfield	226·5
" " "	Pocologan	203·8
" " "	New River	172·5
" " "	Lepreau	78·2
" " "	Musquash	16·6
" " "	Prince of Wales	118·2
" " "	Allan Cot	208·0
" " "	Spruce Lake	205·6
" " "	Duck Cove	68·6
Intercolonial Railway	St. John	20·6

RAIL ELEVATIONS AT STATIONS, ST. JOHNS, QUE., TO SHERBROOKE, QUE.

Railway	Station	Feet.
Canadian Pacific Railway	Iberville	109·3
" " "	Iberville Junction	114·9
" " "	Versailles	186·5
" " "	Mystic (Branch)	180·8
" " "	Bedford (Branch)	179·0
Central Vermont Railway	St. Armand (Branch)	122·0
Canadian Pacific Railway	Brigham Junction	267·7
" " "	Adamsville	376·0
" " "	West Shefford	428·0
" " "	Fulford	584·3
" " "	Foster	696·4
" " "	Knowlton (Branch)	680·2
" " "	Brome (Branch)	676·9
" " "	Drummondville Jct. (Branch)	557·8
" " "	Sutton (Branch)	581·2
" " "	Abercorn (Branch)	485·7
" " "	South Stukely	837·0
" " "	Eastman Junction	910·2
" " "	Magog	688·7
" " "	Lake Park	647·7
" " "	Rock Forest	700·5

RAIL ELEVATIONS AT STATIONS, SHERBROOKE, QUE., TO NORTON MILLS, VERMONT.

Railway	Station	Feet.
Grand Trunk Railway	Sherbrooke	485·0
" " "	Lennoxville	498·6
" " "	Waterville	645·0
" " "	Compton	733·0
" " "	Hillhurst	818·7
" " "	Coaticook	1,006·2
" " "	Dixville	1,126·8

RAIL ELEVATIONS AT STATIONS, COTEAU JUNCTION, QUE., TO COLBORNE, ONT.

Railway	Station	Feet.
Grand Trunk Railway	Coteau Junction	160·1
" " "	St. Polycarpe	176·0
Canadian Pacific Railway	St. Polycarpe Junction	194·0
" " "	St. Télesphore	213·7
" " "	Dalhousie Mills	226·5
" " "	Glen Norman	253·0
" " "	Green Valley	281·5
" " "	Apple Hill	301·5
" " "	Monckland	330·8
" " "	Avonmore	327·0
" " "	Finch	274·9
" " "	Chesterville	240·1
" " "	Winchester	249·9
" " "	Inkerman	267·1
" " "	Mountain	272·5
" " "	Kempton (diamond crossing)	332·8
" " "	Oxford	354·5
" " "	Spencerville	318·5
Grand Trunk Railway	Prescott	310·9
" " "	Maitland	329·7
" " "	Brockville	283·6
" " "	Lyn	283·4
" " "	Yonge Mills	302·9
" " "	Lansdowne	337·6
" " "	Thousand Islands Junction	346·6
" " "	Findley	368·7
" " "	Rideau	306·2
" " "	Kingston Junction	275·5

RAIL ELEVATIONS AT STATIONS, COTEAU JUNCTION, QUE., TO COLBORNE, ONT.—*Continued.*

		Feet.
Grand Trunk Railway	Kingston & Pembroke Railway (diamond crossing)	288·3
" " "	Collins Bay	284·8
" " "	Ernestown	325·0
" " "	Fredericksburg	308·2
" " "	Napanee	314·3
" " "	Bay of Quinté Railway (diamond crossing)	326·5
" " "	Marysville	335·8
" " "	Shannonville	334·8
" " "	Belleville	286·0
" " "	Trenton	285·3
" " "	Brighton	303·7
" " "	Colborne	321·8

DEPARTMENT OF THE INTERIOR

ANNUAL REPORT

OF THE

TOPOGRAPHICAL SURVEYS BRANCH

1909-1910

PRINTED BY ORDER OF PARLIAMENT

OTTAWA
PRINTED BY C. H. PARMELEE, PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1911

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REPORT

OF THE

SURVEYOR GENERAL OF DOMINION LANDS

1909-1910

Department of the Interior,
Topographical Surveys Branch,
Ottawa, August 27, 1910.

The Deputy Minister of the Interior,
Ottawa.

Sir,—I have the honour to submit the following report of the Topographical Surveys Branch for the year ended March 31, 1910.

Surveys under the Dominion Lands system are carried on by survey parties under three classes of surveyors,—(1) those employed by the day, (2) those paid at contract rates, and (3) those engaged under yearly salary. The parties under daily paid surveyors are engaged on the survey of initial meridians and base lines, on townsite and settlement surveys and on resurveys, restoration, correction and other miscellaneous work.

The survey of initial meridians and base lines is the most important work, for upon its accuracy depends the perfection of the subsequent subdivision. As a matter of course these lines are situated in outlying portions of the country, far from settlement and railway facilities and one of the greatest difficulties is that of transportation. This is in some measure obviated by having supplies freighted during the winter to depots selected in advance, thereby ensuring transportation during the course of the survey for shorter distances and with lighter loads.

Some idea of the isolation of a survey party engaged in these surveys may be obtained from the reports of one of the surveyors in charge, who states that his transport outfit required three weeks to make the round trip between his survey camp and his depot of supplies and that this depot was fifty miles from the nearest Hudson's Bay post, one hundred and twenty miles from the nearest post-office and one hundred and fifty miles from a railway station. Yet he goes on to say:—

> 'It is remarkable in how short a time settlement may follow after surveys are made. Places in other parts of Alberta where a few years ago, while surveying the preliminary lines, I used to wonder how I could keep the party from starvation, are now dotted with settlements, while houses, post-offices, stores and hotels cover the country where there was no sign of human life within a hundred miles of our camp.'

Surveyors engaged on this pioneer work have peculiar advantages for gathering valuable information as to the topographical features and natural resources of large tracts of territory which, in many cases, are practically unexplored. So important a part of the surveyors' duties has this become that a leveller and an explorer are now attached to each party and they are enabled to supply data for a complete chain of levels and to furnish a report on the nature and resources of the country for a considerable distance on either side of the surveyed line. These additional duties in no way interfere with the progress of the survey and the value of the information thus gained amply justifies the comparatively slight additional cost involved.

Subdivision surveys in the Peace river district and in western and southern Alberta were carried out by parties working under daily pay, while resurveys, restoration and correction surveys under the provisions of sections 57 and 58 of the Dominion Lands Surveys Act, were continued in the more settled districts. Several parties under similar organization were engaged in the survey of timber berths, settlements and townsites and in other miscellaneous surveys of Dominion Lands throughout the four western provinces.

Parties in charge of surveyors working under contract were employed exclusively upon the subdivision of townships into sections and quarter sections. A contract surveyor is paid at certain rates per mile of line surveyed, varying according to the difficulties of the work, from about $7.50 per mile in level prairie to about $31 per mile in heavily timbered country. From the rates allowed by the Department the contractors are required to meet all the expenses of survey. Twenty-six contracts were allotted during 1909, the average value of a contract being about $12,000.

The year 1909 is memorable as witnessing the completion of the survey of the western prairies, the subdivision of the tract of land lying immediately north of the international boundary in Saskatchewan and Alberta having been completed during the year. This tract, formerly known as the semi-arid district, comprised one hundred and sixty-nine townships, and was the last piece of unsurveyed open prairie. The subdivided townships extend now in an unbroken tract from the international boundary to a considerable distance north of the Saskatchewan river and the lands not yet surveyed are all more or less wooded.

Surveys under contract were also carried on northeast and northwest of Edmonton, southeast of Prince Albert and in northern and eastern Manitoba. At Grand Prairie in the Peace river district about thirty townships were subdivided and are now open for entry.

Five inspectors of surveys are employed under yearly salary as permanent officials of the Department. It is their duty to visit the townships subdivided under contract, to examine and report upon the character of the contractors' work and to recommend its acceptance or rejection.

SURVEYS FOR THE YEAR ENDED MARCH 31, 1910.

The unusually late spring of 1909 was a help rather than a hindrance to the majority of the surveyors as it enabled them to reach their respective districts before roads and trails became impassable for heavy transport. Mr. Geo. McMillan, D.L.S., states that not in the recollection of the oldest resident had the ice remained strong in the Peace river so late in the season. It was solid until May 4, and he crossed on it at Dunvegan on May 2. Mr. A. Saint Cyr, D.L.S., who worked about one hundred miles northwest of Prince Albert reports that the spring was the most backward experienced in that locality for thirty years. Mr. E. W. Hubbell, D.L.S., with his party crossed the Saskatchewan river below Prince Albert on the ice on May 9. Mr. H. W. Selby, D.L.S., traversed the Athabaska river near the fifth meridian on the ice on May 5.

The weather generally throughout the season was unusually favourable for field operations and the amount of work accomplished compares well with that of other years. Perhaps the best basis of comparison is that of the average number of miles surveyed per party which for the last four survey seasons is as follows:—

1909	412 miles.
1908	366 "
1907	364 "
1906	305 "

Two hundred and seventy-eight whole townships and twenty-five fractional townships were completely subdivided and a partial subdivision made of three hundred and five others. A complete resurvey or retracement was made of forty whole and three fractional townships as well as a partial resurvey in one hundred and ninety-eight others.

Sixty-four survey parties were employed, fifty-nine on township surveys and five on miscellaneous work. Of these, thirty-three were paid by the day, twenty-six worked under contract and five were engaged on the inspection of contract surveys. Four other surveyors were employed for short periods on small miscellaneous surveys. Two of the parties under daily pay worked in Manitoba, nine in Saskatchewan, fourteen in Alberta and six in British Columbia, while seven worked part of the time in one province and part of the time in another.

The parties working under contract were distributed as follows:—Three in Manitoba, eleven in Saskatchewan, eleven in Alberta and one partly in Saskatchewan and partly in Alberta.

The reports of the inspectors of surveys and of the surveyors employed under daily pay are given as appendices Nos. 11 to 45.

SURVEYS OF BLOCK OUTLINES.

Eight surveyors were employed in establishing base lines and initial meridians. Owing to the difficulties of transportation and the nature of the country through which these lines run, the progress of the work is slow and the cost is very great. The figures which are given in Appendix No. 2 show that it varies from $88 to $309 per mile, and averages $167.

Mr. A. Saint Cyr, D.L.S., continued the survey of the third meridian northerly from the north boundary of township 52 to the north boundary of township 60. He then established the sixteenth base westerly from the third to the fourth meridian. In this district valuable timber, not included in leased berths, is found in limited quantities and in widely distributed areas separated by large tracts of country which were overrun by fires years ago and where the second growth is still too small to be of any commercial value. Along the sixteenth base are many tracts of good agricultural land fit for immediate settlement. There are considerable areas of partly open and prairie land suitable for stock raising, where quantities of upland hay could be procured and where good water is found in numerous small streams.

Mr. Wm. Christie, D.L.S., established the fifteenth base easterly from the fourth to the third meridian. Sufficient governing lines between these two meridians have now been established to enable the Department to continue the subdivision of townships as far north as township 61, when a demand for these lands arises.

Mr. A. W. Ponton, D.L.S., continued the production of the fifth meridian northerly. His instructions were to extend it from township 107, where he left off in 1908, to township 117, and to run the thirtieth base westerly as far as necessary for the subdivision of the best agricultural lands in the Vermilion district. By an accident on Peace river a large part of his supplies was lost and he was compelled to return to Athabaska Landing for additional stores. Owing to the great distance from settlement and the infrequent mail service no report of his progress has yet been received.

Mr. Geo. McMillan, D.L.S., ran the eighteenth base west of the sixth meridian from the east boundary of range 9 to the British Columbia boundary. He also retraced the north boundary of township 64, range 27, west of the fifth meridian and established the seventeenth base westerly from the sixth meridian to the northeast corner of section 33, range 9. Considerable areas of this district have been devastated by forest fires and survey operations on the seventeenth base were greatly impeded by brulé and windfall.

Mr. A. H. Hawkins, D.L.S., continued the fifteenth base west of the fifth meridian from the east boundary of range 25 to the sixth meridian. He also established this base west of the sixth meridian as far as the east boundary of range 9 and the sixteenth base as far as the east boundary of range 5. This district at one time was thickly covered with forests of jackpine but these are now nearly burnt off and there remains either dry standing timber or windfall. Mr. Hawkins states that the distance from market alone stands in the way of making the Muskeg and Grande Cache valleys on the fifteenth base a most admirable horse or cattle range.

Mr. B. J. Saunders, D.L.S., established the ninth base west of the fifth meridian across ranges 8, 9 and 10, and the tenth base across ranges 8, 9, 10 and 11. In township 37, range 8, a number of settlers have already located on Prairie creek where a considerable area of good hay land is found.

Mr. J. N. Wallace, D.L.S., surveyed the fourth meridian from the northeast corner of section 12, township 63, to the north boundary of township 80. Within thirty miles of his starting point the meridian crosses Primrose lake, a body of water about forty miles long and covering an area of about one hundred and ten thousand acres. The fact that this lake had not previously been shown on any map indicates the general lack of knowledge which exists regarding the topographical features of this northern country and shows the need for the exploratory work now being carried on in connection with outline surveys.

Mr. W. A. Ducker, D.L.S., was employed during the past winter in establishing the eleventh base from the east boundary of range 27, west of the principal meridian, westerly to the second meridian. This base runs through the Porcupine forest reserve and its survey was necessary in order that the limits of the reserve might be definitely marked out later on.

TOWNSHIP SUBDIVISION SURVEYS.

In addition to the township subdivision surveys executed under contract, several parties under daily pay were employed exclusively on subdivision in districts where contract rates would not apply.

Mr. A. McFee, D.L.S., subdivided portions of townships on the Brazeau river in which coal claims are located. The district is very mountainous and Mr. McFee was unable to complete all the surveys required.

Mr. J. B. McFarlane, D.L.S., was engaged in projecting township subdivision westerly along the line of the Grand Trunk Pacific railway from range 24, west of the fifth meridian to the Yellowhead Pass.

Mr. J. B. Saint Cyr, D.L.S., continued the subdivision of townships in the Peace river district near Dunvegan. He reports that the climate is good, with no early summer frosts and that the greater portion of the land is suitable for farming and ranching purposes. Timber for general farm use and for lumbering purposes is plentiful.

Mr. H. W. Selby, D.L.S., subdivided land east and west of Lesser Slave lake. He states that the townships lying west of Winagami lake contain as fine land as can be found within the unsurveyed portion of Dominion lands.

Messrs. W. H. Young, D.L.S., W. A. Scott, D.L.S., and Jas. Warren, D.L.S., carried on subdivision in the foothills of the Rocky mountains between Calgary and the international boundary. Some of these lands were applied for as coal and oil lands, but there is also a considerable demand from farmers and ranchers. Owing to the mountainous character of the country the progress of these surveys is very slow.

CORRECTION, RESTORATION AND MISCELLANEOUS SURVEYS.

Owing to the advance of settlement in recent years, townships subdivided twenty-five or thirty years ago have been largely taken up as homesteads. The wooden posts formerly used as survey monuments have disappeared, the mounds and pits have been destroyed and settlers are not able to locate definitely their parcels of land. As a result, farm and local improvements are delayed, friction arises between neighbours and unless restoration surveys are promptly carried out the progress of the settlement is seriously retarded.

Some of the early surveys were carelessly executed and the plans do not show the boundaries of sections as they are on the ground. In such cases where the monuments still exist and where lands affected have been patented the lines are retraced for the purpose of obtaining accurate information as to areas, bearings and distances. Had these discrepancies been discovered a few years ago, before the tide of immigration set in, the effect would not have been so serious as then the survey could have been corrected. Sometimes where the original work indicates general care and accuracy in execution a serious error has been made in the location of a survey monument. A correction is made in such cases if it can be done under the provisions of the Dominion Lands Surveys Act.

Mr. C. F. Aylsworth, D.L.S., continued resurvey work in southeastern Manitoba.

Mr. W. J. Deans, D.L.S., worked in the district between lake Manitoba and the western boundary of the province. His reports show the great necessity for restoration surveys in some localities. In one township where the original monuments were lost a settler had six acres of crop and a newly erected house on another homesteader's quarter section. In another township where extensive improvements had been made in the way of buildings two settlers were found to be on the wrong quarter sections and one was on the road allowance.

Mr. John Francis, D.L.S., was employed on resurveys in the vicinity of Yorkton, Saskatchewan. In many cases the original surveys were found to be very irregular, but settlements, roads and improvements often stood in the way of satisfactory correction.

Mr. O. Rolfson, D.L.S., carried on resurveys in southeastern Saskatchewan and in southwestern Manitoba.

Messrs. A. L. McNaughton, D.L.S., and W. R. Reilly, D.L.S., were employed in resurveying townships in the Prince Albert district, Saskatchewan.

Mr. H. S. Holcroft, D.L.S., in the early part of the season was engaged in the resurvey of townships southeast and east of Edmonton. Later he made surveys required in townships 57 and 58, ranges 9 and 10, west of the fourth meridian, which comprise what was formerly known as the St. Paul de Metis half-breed reserve. The various parcels of land allotted to half-breed claimants were marked out to enable the Department to dispose of the remainder of the old reserve to homesteaders.

The demand for small miscellaneous surveys has grown so greatly in recent years that it has been found advisable to make special provision for them. For this purpose a surveyor is employed who travels with an assistant and engages labourers and local transportation when required. This provides an expeditious and economical method of completing small surveys scattered over a wide territory, without interfering with the more extensive work being carried on by the fully organized parties. Mr. Thos. Fawcett, D.T.S., was engaged on this work and during the past season completed over forty separate surveys in Manitoba and Saskatchewan. These included the correction of errors in the original subdivision, the reestablishment of lost corners, the traverse of water areas and investigations as to the necessity for resurveys applied for.

One of the surveys carried out by Mr. Fawcett was the subdivision into sections of the land formerly covered by the waters of Reed lake along the main line of the Canadian Pacific railway west of Moosejaw. In 1883, when the adjoining land was subdivided, this lake covered an area of over eight thousand acres and the water was seven or eight feet deep. Within recent years the lake has dried up and the greater part of the land formerly covered by it is now fit for cultivation. The fertility of the soil is shown by the fact that a portion of the old lake bed produced last year over one hundred bushels of oats to the acre. The demands for new surveys are frequently the result of similar changes in the topographical features of the western provinces.

Mr. C. C. Fairchild, D.L.S., accompanied the commission appointed to look into the claims of Doukhobor settlers. He laid out fifty-seven village sites in Saskatchewan for these people, involving the survey of about one hundred and twenty-five miles of line.

Mr. L. R. Orde, D.L.S., made a micrometer traverse of lac LaRonge, Saskatchewan, the object of this survey being to furnish a plan for recording the mining claims located there.

Mr. W. Thibaudeau, C.E., was engaged on a reconnaissance of the head waters of the Bow river, of the Waterton river in the vicinity of Waterton lakes, of Cypress lakes and of the southern slope of the Cypress hills, with a view to locating suitable sites for the construction of storage reservoirs for irrigation and other purposes.

Messrs. Joseph Doupe, D.L.S., A. C. Garner, D.L.S., and E. W. Walker, D.L.S., were employed for short periods on resurveys in Manitoba and Saskatchewan.

BRITISH COLUMBIA SURVEYS.

The subdivision of Dominion lands in the railway belt, British Columbia, was carried on by four parties under Messrs. J. E. Ross, A. W. Johnson, E. W. Robinson and T. H. Plunkett, Dominion Land Surveyors. The parties were so distributed as to be available for urgent surveys wherever required.

Part of the time of Messrs. Plunkett and Robinson was taken up in surveying agricultural lands in the Columbia valley, above and below Revelstoke, which were considered to be of such value that it was deemed advisable to lay them out in parcels smaller than quarter sections. For this purpose monuments were erected as far as practicable at legal subdivision corners and in the centre of legal subdivision boundaries along the regular surveyed lines so that the land may be disposed of in parcels of such size as may be desired.

Mr. Ross was employed in the Kamloops district and Mr. Johnson in the New Westminster district. One of the surveys carried out by the latter was the subdivision into lots of a parcel of land on Bedwell bay on the north arm of Burrard inlet. This locality is easily accessible from Vancouver and New Westminster and provides exceptional advantages as a summer resort.

Messrs. S. S. McDiarmid, D.L.S., and J. H. Brownlee, D.L.S., were employed in the railway belt for short periods on work that could not be done conveniently by the regular parties.

Mr. P. A. Carson, D.L.S., continued the triangulation survey through the Selkirk mountains. An important part of his work of last year was the measurement of a base line along the Columbia river about twenty-one miles southeast of Golden. This base controls the complete network of the triangulation survey from the summit of the main range of the Rocky mountains westward to the Cascade range.

The examination and classification of the vacant lands in the valleys of the railway belt was resumed in 1909. This work was in charge of Mr. A. O. Wheeler, D.L.S. He had under his direction three sub-parties under Messrs. M. P. Bridgland, A. J. Campbell and R. D. McCaw, Dominion Land Surveyors. The country examined was classified either as fruit, farming, grazing, timber, or worthless land.

INSPECTION SURVEYS.

Five parties were engaged for the greater part of the time on the inspection of surveys performed under contract.

Mr. E. W. Hubbell, D.L.S., worked in the Prince Albert district. In addition to his inspection work he resurveyed five townships near Elbow, Saskatchewan. He speaks in very favourable terms of the district in the vicinity of Lost river, classifying it, in his opinion, as the finest section of country that is open for settlement in Saskatchewan.

Mr. P. R. A. Belanger, D.L.S., carried on inspection work in Manitoba and completed several miscellaneous resurveys.

Mr. C. F. Miles, D.L.S., inspected the contract work in the prairie section adjoining the international boundary and resurveyed several townships north of Swift Current.

Mr. G. J. Lonergan, D.L.S., completed the inspection surveys required in the district east of Edmonton. Among the other surveys executed by him the most important was the resurvey of St. Albert settlement.

Mr. L. E. Fontaine, D.L.S., inspected the contract surveys west of Edmonton.

STATEMENT OF MILEAGE SURVEYED.

The following table gives a comparison of the mileage surveyed since 1907:—

——	April 1, 1909, to March 31, 1910.	April 1, 1908, to March 31, 1909.	April 1, 1907, to March 31, 1908.
	Miles.	Miles.	Miles.
Township outlines	2,089	2,019	1,674
Section lines	16,326	16,985	13,710
Traverse	2,413	3,323	3,193
Resurvey	3,876	2,175	2,917
Total for season	24,704	24,502	21,494
Number of parties	60	67	59
Average miles per party	412	366	364

The following tables show the mileage surveyed by the parties under daily pay and by the parties under contract:—

WORK OF PARTIES UNDER DAILY PAY.

——	April 1, 1909, to March 31, 1910.	April 1, 1908, to March 31, 1909.	April 1, 1907, to March 31, 1908.
	Miles.	Miles.	Miles.
Township outlines	861	512	542
Section lines	1,066	1,004	975
Traverse	1,324	1,158	1,313
Resurvey	3,808	2,175	2,782
Total for season	7,059	4,849	5,612
Number of parties	34	36	29
Average miles per party	208	135	194

WORK OF PARTIES UNDER CONTRACT.

—	April 1, 1909, to March 31, 1910.	April 1, 1908, to March 31, 1909.	April 1, 1907, to March 31, 1908.
	Miles.	Miles.	Miles.
Township outlines	1,228	1,507	1,132
Section lines	15,260	15,981	12,735
Traverse	1,089	2,165	1,880
Resurvey	68	....	135
Total for season	17,645	19,653	15,882
Number of parties	26	31	30
Average miles per party	679	634	529

NOTE.—Owing to the nature of their work the parties under Messrs. P. A. Carson, L. E. Fontaine, A. C. Garner, S. S. McDiarmid, W. Thibaudeau, E. W. Walker and A. O. Wheeler are not included in the statement of mileage for the year ended March 31, 1910. As no returns have been received from Mr. A. W. Ponton, his party is also omitted.

COST OF SURVEYS.

The following statement shows the average cost per mile of surveys executed by surveyors under daily pay and by surveyors under contract:—

—	Surveys under daily pay.	Surveys under contract.
Total mileage surveyed	7,059	17,645
Total cost	$348,208.00	$317,083.51
Average cost per mile	$49.33	$17.97

The low average cost of contract work, $17.97 per mile, is due to the subdivision of 169 townships in the open prairie in southern Saskatchewan and Alberta, while nearly all the surveys under daily pay were in the woods. The average cost of daily paid surveys is raised by the base lines and initial meridians, which are very expensive. With the present organization, it is estimated that the surveys which are now being executed under contract would cost little, if any more, if they were made by parties under daily pay.

DESCRIPTIONS OF TOWNSHIPS.

Descriptions of the townships subdivided during the year have been compiled from the surveyors' reports and will be published in a separate volume. Hitherto these descriptions have been an important feature of the Annual Report, but it was becoming so lengthy that it was deemed advisable to omit them. The information which they contain, although especially valuable to land seekers and intending settlers, is of little interest to the general public and a small edition will be sufficient to meet the requirements.

The subdivision surveys performed prior to March 31, 1909, those made between that date and March 31, 1910, and the resurveys executed during the same period are shown in different colours upon the map which accompanies this report.

RATE OF PAYMENT FOR TRAVERSE SURVEYS.

In order to remove doubts and causes of disagreement between survey contractors and the Department respecting the amount to be paid for traverse surveys, clause 14 of the schedule of rates of the Order in Council of May 12, 1908, was cancelled by Order in Council of December 6, 1909, and the following substituted:—

14. Traverses of lakes and rivers and connecting traverses shall be paid for at the rate of eleven dollars per mile. For traverses of lakes and rivers, the distance to be paid for shall be measured along the bank of the lake or river from every point fixed by the survey in a straight line to the next point. When both banks of a river are located from a single traverse line, the full traverse rate of eleven dollars per mile shall be paid for one bank only and the additional work for locating the other bank shall be paid for at the rate of four dollars per mile. Nothing shall be paid for offsets, but one dollar shall be deducted for every offset short of the number required by the Manual of Survey.

MANUAL OF SURVEY.

The seventh edition of the Manual of Survey referred to in the report of last year is now in the hands of the printers and is expected to be ready soon.

SURVEY OF TIMBER BERTHS.

Formerly timber berths were not surveyed until they had been disposed of by license. The licensee had to make his own arrangements for the survey of the berth. Last year a new method was adopted; the berths are now surveyed prior to being offered to the public. The practice is to call for tenders for the survey from surveyors in the vicinity and if the price is satisfactory instructions are issued by the Surveyor General. After the confirmation of the survey the berth is leased to the highest bidder. Instructions were issued during the year for the survey of thirteen berths.

IRON POSTS.

Beginning in 1908, iron posts were substituted for wooden ones in marking quarter section corners. During the past year about 43,000 small iron posts were purchased for marking section and quarter section corners; large posts are used at township corners. For the convenience of surveyors posts were kept in stock at Winnipeg, Saskatoon, Edmonton, Revelstoke, Kamloops and New Westminster.

VISIT TO DAWSON, Y.T.

The surveys in the Yukon territory are of two kinds. There are the surveys of lots and quartz mining claims for which patents are to be issued, and the surveys of placer claims, hydraulic leases, etc., which are for leases renewable from year to year. The surveys of the first kind are made under the instructions of the Surveyor General and the returns are recorded in the Department of the Interior at Ottawa. The surveys of the second kind are placed by law under the control of the Commissioner of the Yukon Territory; the returns are filed in the surveys office at Dawson and there are no duplicates anywhere else. The lack of information on these surveys was inconvenient when dealing with Yukon affairs at Ottawa; moreover, the danger of destruction by fire of that single set of records was great and the consequences would have been disastrous. I was accordingly directed to proceed to Dawson with two draughtsmen to examine the records of the surveys office carefully, and to make copies of such part of the records as it would be useful to have at Ottawa. This work has been successfully accomplished.

While at Dawson I devoted considerable attention to the arrangements in force for the surveys in the Territory and on my return submitted various recommendations for the improvement of the service.

CORRESPONDENCE.

The correspondence of this Branch consisted of:—

Letters received	15,368
Letters sent	14,130

ACCOUNTS.

The Accountant's record shows:—

Number of accounts dealt with	764
Amount of accounts	$898,536
Number of cheques forwarded	3,584

OFFICE STAFF.

Under the new organization of the Department of the Interior, the Geographer's and Survey Records' offices, which formerly were part of the Topographical Surveys Branch, are now separate branches: they have accordingly been omitted from the list of employees in Appendix No. 9.

The office staff of the Topographical Surveys Branch proper consists of one hundred and twenty-seven employees. There are fourteen vacancies.

Messrs. J. B. Lepage and M. J. McLaughlin resigned during the year. Mr. C. R. Binks was transferred to the Accounts Branch, Mr. M. B. Bonnell to the Department of Agriculture, Mr. T. H. G. Clunn to the Dominion Astronomical Observatory and Mr. R. S. Stronach to the Railway and Swamp Lands Branch.

Two members of the staff died, Messrs. Wm. Elwell and W. T. Green. Mr. Elwell was a graduate of the School of Practical Science, Toronto, and Mr. Green an honour graduate of the University of Toronto and a Dominion Land Surveyor. Both were possessed of a high order of ability and by their untimely deaths the public service suffered a serious loss.

The following new members were appointed:—J. F. Blanchard, J. D. Bradley, D. E. Chartrand, B.Sc., J. A. Cote, A. Cousineau, L. O. R. Dozois, J. F. Fredette, C. M. Hoar, B.Sc., W. J. Lytle and C. E. Marchand. Mr. H. M. Easton was engaged as a printer and Mr. E. H. Hare was employed temporarily as assistant photographer.

CHIEF DRAUGHTSMAN'S OFFICE.

(P. B. Symes, Chief Draughtsman.)

The chief feature of the past twelve months in the office has been the steady increase in the amount of business to be attended to and the increasing difficulty in handling it with a staff diminished in numbers and impaired in efficiency by the loss of experienced men. Not only has there been an increase in almost every item, as may be seen from statements below, but new lines of work have been added, such as levelling and magnetic observations, which necessarily occupy some of the available force in the office.

The new section of the draughting office established chiefly to deal with these and other scientific matters, such as astronomical tables, &c., was put into working order during the year and has now a staff of eight.

The demand for maps and plans and other printed matter is becoming greater every year and probably it will not be long before some better provision must be made for this distribution work.

CHIEF DRAUGHTSMAN'S OFFICE—FIRST SECTION—SURVEY INSTRUCTIONS AND GENERAL INFORMATION.

(T. E. Brown, Chief of Section.)

The work of this section has increased steadily during the year, whereas the strength of the staff has been reduced from twenty-one to nineteen. For this reason the general report of survey operations mentioned in last year's report, as well as the history of photo-topographical survey operations in the Rocky mountains have had to be laid aside and are not yet ready for publication.

One hundred and ninety-two drafts of instructions to surveyors for the execution of surveys were prepared. These instructions were accompanied in each case with all the information available as to the nature of the country, the previous surveys of Dominion lands, Indian reserves, trails, &c.; 1,274 sketches and 103 maps and tracings were compiled and furnished for this purpose.

Entries in the office registers show that 1,214 progress sketches were received from surveyors, together with 547 books of field notes for township surveys, 132 books and 568 plans, sketches, &c., for miscellaneous surveys, 451 timber reports, 383 statutory declarations of settlers and returns for 1,037 magnetic observations and for 128 separate blocks of timber berths. General reports on their survey operations were received from thirty-five surveyors.

Their examination having been completed, 725 books of field notes were placed on record, together with 430 plans of miscellaneous surveys and 383 statutory declarations of settlers.

Plans of 705 townships, 5 settlements or townsites, 54 sectional maps and 113 miscellaneous plans were received from the lithographic office, entered in the registers and distributed.

Preliminary plans were issued for 424 townships.

Fifteen hundred and five communications from settlers and others on various subjects, and inquiries from other branches were received and dealt with; they required the preparation of 1,250 sketches, 153 maps and tracings and the copying of 288 pages of field notes. Twelve descriptions of parcels of land were drafted.

The compilation of a set of maps to illustrate discrepancies in the surveys and to show closings of township surveys has been continued. Fourteen new sheets have been made and twenty-two revised and brought up to date.

Considerable time was devoted to proof-reading the new edition of the Manual of Instructions for the Survey of Dominion Lands, the Annual Report of the Branch, a pamphlet on 'Descriptions for Deeds' and other reports, forms, &c., printed during the year.

Two thousand, one hundred and ninety-one files were received from the Correspondence Branch and used in connection with the work of this office. Four thousand five hundred and five draft letters and memoranda were written.

CHIEF DRAUGHTSMAN'S OFFICE—SECOND SECTION—SURVEYS IN MANITOBA, SASKATCHEWAN AND ALBERTA.

(T. S. Nash—Chief of Section.)

The staff of this section is much smaller than previously. At the time of reorganization in September, 1908, twenty-eight employees were considered necessary for the work of the section. At the beginning of the year the staff was three men short. During the year five men were removed and one was added. The average shortage for the year has been six employees.

As stated in previous reports, all the returns of surveys of Dominion Lands in the provinces of Manitoba, Saskatchewan and Alberta are examined in this section and plans of the surveys compiled.

Sketches sent in by surveyors in the field showing the progress of the work are examined to see that all the surveys are correctly executed within the limits of error allowed by the Manual and that all areas made fractional by water are shown. These sketches are the basis for the advances to contractors. During the year 404 progress sketches from surveyors employed by the day, 441 from contractors and 203 from inspectors were received and examined, making a total of 1,048.

Immediately upon being received, the final returns are given a cursory examination, the purpose of which is to detect any serious omissions or discrepancies, and if necessary, they are returned to the surveyor for correction. After this the returns of all previous surveys in the township or settlement are collected and the compiling of the plan is proceeded with. During the year 378 subdivision surveys, 247 township outline surveys and 144 miscellaneous surveys were examined and the compiled plans of 660 townships were sent to the draughtsmen to be drawn for reproduction. This number includes the first edition of plans of 388 townships which shows the extent of new country being opened up for settlement. Compiled plans of 12 miscellaneous surveys were also sent to the draughtsmen. While compiling, a very careful examination is made of the returns of the new survey and a memorandum of any discrepancies or omissions is sent to the surveyor. Five hundred and twenty such memoranda were sent while 450 replies to memoranda were received and the necessary corrections made in the field books; 1,150 letters in connection with the work were drafted.

The field notes of the inspectors of surveys in examining survey contracts also are examined and their reports dealt with in this section.

The survey contracts given out each year are examined by five surveyors who are employed throughout the year by the Department. Each inspector has to examine a number of contracts situated in the same section of the country. It is his duty to survey a few miles of line in each of several townships in each survey contract as soon as possible after the contractor has completed his work and to send to the Department the same information in connection with the survey of the lines examined which the contractor is expected to furnish. He further makes a report on the general appearance of the survey and recommends to the Surveyor General the acceptance or the rejection of the contractor's work.

The inspector's notes are examined and compared with the contractor's. If this comparison reveals a close agreement between the two and if the inspector's general report is favourable the contractor's work is accepted by the Department and he is paid in full. If the inspector's field notes or report show that the survey, or any part of it, has been too imperfectly performed to be accepted, the contractor is required to correct his work. If the defects discovered show that the survey was not performed strictly in accordance with the terms of the contract, but the defects are not of such a nature as to cause the rejection of the work, the contract is accepted subject to deductions recommended by the inspector or provided for by the Manual of Surveys. In all such cases, however, the contractor is given the option of either accepting the deduction in his account or of correcting his work.

This system of inspection of contract surveys which has been in use for the past six years has resulted in a much higher standard of work by the survey contractors than was formerly obtained. Also it prevents the occurrence of large errors and thus obviates the necessity for making corrections at some later date. During the year the inspectors' reports on thirty-four contracts were received and dealt with and thirty-eight contract accounts were closed.

One hundred and forty-seven requests for information concerning surveys were received from other branches of the Department involving the calculation of 710 areas: 265 plans of road diversions made by the provincial governments of Saskatchewan and Alberta were examined.

In this section also were examined the plans and field notes for sixty-four timber berths consisting of 212 blocks; and thirty-four plans of right of way of railways were examined, the mileage of which amounted to 794·09. Many of the right of way plans being in duplicate or in triplicate, the gross mileage of plans examined was 1,889·25.

CHIEF DRAUGHTSMAN'S OFFICE—THIRD SECTION—DRAWING FOR REPRODUCTION.

(C. Engler, Chief of Section.)

The nominal strength of the staff in this section is thirteen, but this has not been maintained except during the latter part of March, when the vacancy recorded in the last annual report was filled by the appointment of Mr. C. E. Marchand.

The staff still occupy part of the second floor of the Imperial building, Queen street. These quarters have been found very comfortable and well suited for draughting, but on account of their situation, are not very convenient. It frequently happens that in planning the publication of a map details as to photographing have to be discussed with the photographer, and as to printing with the lithographers or pressmen. The photographer is on the top floor of the Topographical Surveys building, the pressmen and some of the lithographers are in the basement of the same building, while others are in the basement of the Imperial building. Time is therefore lost in going from one to another. The arrangement is also bad for the expeditious reading of proofs.

The hand printing press used in this section was originally intended for printing titles, names, &c., for pasting on plans to be photo-zincographed. Very frequently the office work of the other divisions requires the printing of forms for office use, circular letters to surveyors, amendments to the Manual of Surveys, &c. Many of these are printed on the hand press, for as a rule only a limited number is required and the amount of typesetting is small. As hinted at in the last report, the work of printing has become more than one man can do; accordingly a pressman from the lithographic office has been employed to operate the press. As time goes on the number of ways in which type can be adapted for use in making plans increases until now some of the most complicated plans are made altogether from type and a comparison of them with plans drawn in the ordinary way shows an improvement in most cases. It might be remarked that type lends itself to use in plans especially where straight lines predominate as, for example, in plans of townsites, while on the other hand where letters are to be arranged in curves it is hard to make type letters look well.

The number of township plans prepared for printing during the year was 713, an increase of about 16 per cent over the number prepared last year. These plans represent an area considerably larger than the combined areas of Nova Scotia and Prince Edward Island.

The number of other plans, drawings and miscellaneous jobs amounted to 182. Some of the more important are the plans of the town of Churchill and specimen plans for the revised Manual of Surveys. Considerable work has also been done on profiles of base lines to be published later, and on the maps and plans to accompany the Annual Report of this Branch.

CHIEF DRAUGHTSMAN'S OFFICE—FOURTH SECTION—BRITISH COLUMBIA SURVEYS.

(E. L. Rowan-Legg, Chief of Section.)

In this section the usual work of examination of surveyors' field notes has been carried on, and township plans have been compiled. In the case of townships in which the amount of information required to be shown is very great it becomes necessary to compile quarter township plans on a larger scale, so that the details may be clearly seen.

Besides township plans, a plan of the townsite of Golden (South) was compiled and issued.

Plans of the townsites of Yale and Golden have also been compiled, but have not yet been issued.

The compilation of the plan of Golden was delayed for a considerable length of time on account of the difficulty experienced in the field in finding a suitable road connection between the town and its extension, but this was at last satisfactorily arranged.

A large number of plans and field notes of the survey of timber berths has been examined for the Timber, Grazing and Irrigation Branch, in order that the berths may be dealt with as soon as possible. This work entails not only the examination of the returns, but also their reexamination when sent back by the surveyor after the corrections are made. Two of the members of the staff were engaged on this work.

Considerable time was spent by several members of the staff in copying maps for the Department in connection with the surveys to be made of agricultural lands about Shuswap lake and in the Columbia valley.

The work of this section consisted of:—

Preliminary plans issued	43
Township plans compiled	119
Townsite plans compiled	3
Plans and sketches made	344
Returns of township subdivision examined—books	40
" " " " —plots	57
Returns of timber berths examined	101
Returns of miscellaneous surveys examined	4
Returns of mineral claims examined	7
Odd jobs and requests for various information dealt with	722
Draft letters and memoranda written	1,067

CHIEF DRAUGHTSMAN'S OFFICE—FIFTH SECTION—MAPPING.

(J. Smith, Chief of Section.)

Since the last report the staff of the section has been reduced from eleven to nine, Mr. Genest having been transferred temporarily to Dawson and Mr. Lepage having resigned.

The routine work on the sectional maps has been continued, eleven of the maps on a scale of three miles to an inch and thirty-nine of those on a scale of six miles to an inch being revised and re-issued. In addition to the above, sixty-eight of the larger maps were revised and the work copied on the smaller maps for the Railway Lands Branch.

In connection with the work on the sectional maps, the following documents were used, viz.:—seventy-five plans of timber berths, three plans of Indian reserves, four hundred and twenty-six plans of surveyed roads, sixty-eight plans of railways and five hundred and twelve field books; the names and positions of one thousand and fifty-eight post-offices, mostly new ones, were obtained from the Post-Office Department and put on the maps, one hundred and forty-seven sectional maps were examined and three hundred and fifty-six letters and memoranda written.

The work on the Yukon surveys is falling in arrears because the staff is insufficient for the work; of the ninety-nine returns of surveys received, only thirty-eight have been examined and thirty-one plans reduced and plotted on the group plans. More assistance is urgently needed in this work.

CHIEF DRAUGHTSMAN'S OFFICE—SIXTH SECTION—SCIENTIFIC AND TOPOGRAPHICAL WORK.

(G. Blanchard Dodge, Chief of Section.)

The staff of this section consists at present of six technical men and one non-technical, but as some appointments have only recently been made the staff practically has consisted of only four men for the past year. There are still five vacancies.

This section takes entire charge of the level and magnetic work.

The instructions for levels are prepared, level notes checked and profiles plotted. The total number of miles of levels (spirit and trigonometric) run to date is 854; checked and profiles plotted, 506. Reduced profiles of some of the base lines, of part of the Yukon-British Columbia boundary and of the streets of Churchill are appended. The relief of the country is already an important matter in southern Alberta and as the country develops and becomes more thickly settled, will engage attention throughout the whole west. Large areas of swamp now regarded as practically useless may be drained and prove fine agricultural land. One surveyor writes: 'The taking of levels has shown the fallacy of thinking there would be much difficulty in drainage. We have crossed large areas of swamp fifty or a hundred feet higher than streams within a couple of miles. It is not want of fall, but want of outlet, that causes nearly all swamps and bogs.'

In 1907, Mr. A. Saint Cyr, D.L.S., was requested to take frequent aneroid readings during the course of his survey, the object being to see what reliability could be placed on elevations derived from aneroid readings carefully taken. The barometer reading at sea-level for the place of observation is taken from the daily isobar maps published by the Meteorological Service and the altitudes calculated. At the time it was thought that accuracy could not be hoped for and that the resulting elevations would be too unreliable to be made use of. On the contrary, the results have been very encouraging, so much so that this year (1910) as a further experiment, surveyors running levels have been requested to take frequent aneroid readings conjointly with the levels. If these prove equally satisfactory, they will furnish us with close approximations of the true elevations for the different level lines until opportunity offers to connect with railway surveys.

Instructions are prepared for magnetic observations, compasses of surveyors' transits examined, tested and the index correction determined, the returns of observations checked, the information compiled and prepared in form to be of practical use. The number of observations for magnetic declination received for the past year is 1,037. Observations were taken by 27 surveyors.

Eighty-seven letters of instructions to surveyors were prepared, 232 other letters drafted and 174 letters received.

The testing of surveyors' instruments comes under this section. This work is at present much handicapped by want of proper accommodation and proper facilities. Three of the new block survey transits were examined, tested and their constants determined. The telescopes of these transits are exceptionally good, the definition being very fine. No difficulty was experienced in getting good pointings on stars listed in star catalogues as 6·7 and 6·8 magnitudes. A latitude determination by Talcott's method gave a probable error of $0''{\cdot}20$ from 29 pairs of stars. This is considered remarkably good with an instrument of the size. Other instruments were also tested.

Whenever time permits, the surveyors' watches sent in to be cleaned and rated are sent to the makers, but sometimes there is not sufficient time for that and surveyors leave their watches to be rated here. Eight watches were rated for the past year.

This section has charge of all the instruments owned by the Branch and the repairs to instruments.

During the past year the chapter on 'Block and Base line Surveys' and the appendices on 'The Determination of the Astronomical Meridian,' 'The Determination of the Magnetic Meridian' and 'Instruments' for the new edition of the Manual of Surveys and a new book for 'Record of Azimuth Observations' were revised or prepared.

The Astronomical Field Tables for twelve months and a projection for a new map of Canada were computed. Numerous other miscellaneous computations required were also made.

Twenty-five township plans were compiled.

Under this section comes the plotting and putting into shape for publication the topographical information supplied by surveyors. The present staff is only about sufficient to handle the level, magnetic and other work enumerated above, and if anything worth while is to be done in that line all five of the existing vacancies will require to be filled.

PHOTOGRAPHIC OFFICE.

A new frame for hanging the copying camera and copying board has been installed; it is perfectly rigid and provided with means of adjustment both for the copying board and for the camera. A new graduation has been made for setting the focus to enlarge or reduce to any scale: it is very accurate.

Photo-zincographs in colours are now made from a single negative from which as many zinc transfers are made as there are colours to be printed. For each transfer, all the lines which must not show are painted out on the negative and after the transfer is made, the paint is washed off. The process is repeated for each colour. All the transfers being made from one negative, perfect registration is obtained.

There were 196 wet plate negatives and 118 photo-zinc transfers more than last year.

It is of interest to calculate the value of the work of the Process Photographer on a commercial basis. The photo-zinc transfers made during the year amounted to 190,080 square inches; the current rate being six cents per inch, this represents a value of $11,404.80. Wet plate negatives made for purposes other than lithography have a value of about $800. The total value is $12,204.80. The cost in salaries, chemicals, electric current, graining of plates, interest on plant and rent was $5,351.40, leaving a net profit on the operations of $6,853.40. The process photographer is unfortunately at a great disadvantage for lack of room: the copying camera can take plates 24″ x 32″, but the dark rooms are so small and crowded that it is next to impossible to handle plates of that size.

The work of the Chief Photographer has also steadily increased, especially in Vandyke printing, of which the quantity has nearly trebled. Of lantern transparencies, twice as many were made as in the previous year. These slides are for lecturing in Europe in connection with the immigration business of the Department. and they are made chiefly from the Chief Photographer's negatives, who visited for that purpose, during the summer, the Pacific Coast, the Okanagan valley in British Columbia, and the great wheat and ranching districts of Manitoba, Saskatchewan and Alberta. He brought back about 250 excellent negatives illustrating the salmon fisheries, the great orchards of British Columbia, the harvesting operations and other subjects of interest.

BOARD OF EXAMINERS FOR DOMINION LAND SURVEYORS.

(*F. D. Henderson—Secretary.*)

The Board of Examiners for Dominion Land Surveyors had two meetings. The first one was a special meeting lasting from April 30 to May 31 (inclusive) 1909, during which examinations were held at Ottawa, Montreal, Toronto, Winnipeg, Calgary and Edmonton. The second one was the regular annual meeting called for by Section 9 of the Dominion Lands Surveys Act. It began on "the second Monday" in February, (February 14, 1910) and lasted until March 31, 1910 (inclusive). During this meeting examinations were held at Ottawa, Halifax, Montreal, Kingston, Toronto, Winnipeg, Calgary, Edmonton and Vancouver.

At the special meeting of the Board in April and May, 1909, 111 candidates presented themselves for the full preliminary examination, 15 for the limited preliminary, and 30 for the final, a total of 156 candidates.

At the regular annual meeting in February and March, 1910, there were 145 candidates for the full preliminary examination, 18 for the limited preliminary, 42 for the final and one for a certificate as Dominion Topographical Surveyor.

Out of the 289 preliminary candidates, 97 or one-third, were admitted: of the 72 candidates at the final examination, 37, or one-half were successful and were granted commissions as Dominion Land Surveyors. The total number of candidates examined was 362, against 279 in 1908-09, and 161 in 1907-08.

The successful candidates were as follows:—

PRELIMINARY EXAMINATION.

Allwood, Frank Harold, Spanish Town, Jamaica.
Barton, Harold Maill, Ottawa, Ont.
Bastien, L. A., Ottawa, Ont.
Bartley, Thomas H., Toronto, Ont.
Bate, Charles Benjamin, Ottawa, Ont.
Brennan, Martin John, Ottawa, Ont.
Brown, Milton, Kitscoty, Alta.
Carthew, John Trewalla, Edmonton, Alta.
Chartrand, Lonat Emile, Ottawa, Ont.
Clarke, Alfred Carleton, Regina, Sask.
Clerke, Alexander Wilberforce, Toronto, Ont.
Collinson, John Gordon, St. Thomas, Ont.
Colquhoun, G. Allan, Vankleek Hill, Ont.
Cook, Arnold Blair, Taber, Alta.
Côté, Joseph Martial, Ottawa, Ont.
Coumans, Oliver, Chepstow, Ont.
Davidson, Douglas, Port Rowan, Ont.
Dodd, George Saville, Kingston, Ont.
Doze, Joseph Wilbert, Fort Saskatchewan, Alta.
Dozois, Leo Oswald Ross, Ottawa, Ont.
Draper, Walter Harold, Edmonton, Alta.
Earle, Wallace Sinclair, Picton, Ont.
Edwards, William Muir, Strathcona, Alta.
Ellis, Douglas Stewart, Kingston, Ont.
Ewan, Hedley Jenkins, Yarmouth, N.S.
Ewing, Ernest Olliphant, Toronto, Ont.
Ferguson, John Binning, Kenora, Ont.
Fife, Walter Maxwell, Edmonton, Alta.
Fletcher, Arthur William, Thornton, Ont.
Fox, Charles Harry, Winnipeg, Man.
Galletly, James Simpson, Brooklin, Ont.
Gemmill, John Alexander Ogilvie, Ottawa, Ont.
Gorman, Arthur O., Buckingham, Que.
Grant, Alexander Macdonald, Ottawa, Ont.
Greene, Gerald Elliott Denbigh, Toronto, Ont.
Harper, Clarence J., Orangeville, Ont.
Harris, Ley Edwards, Midnapore, Alta.
Harrison, Edward W., Ottawa, Ont.
Hicks, C. J., Edmonton, Alta.
Humbert, Adrien, Innisfail, Alta.
Hunter, A. Ernest, Wiarton, Ont.
Hunter, Alexander Neil, Toronto, Ont.
Johnston, Charles Ernest, Toronto, Ontario.
Johnston, Harold Chapman, Toronto, Ont.
Johnston, Charles, Parry Sound, Ontario.
Johnston, William James, St. Catharines, Ont.
Johnston, James Homer, Cottam, Ont.
Jones, Louis Elgin, Toronto, Ont.
Kendall, Leslie Evans, Ottawa, Ont.
Keys, Herbert J. E., Sault Ste. Marie, Ont.
Kingstone, George Alexander, Toronto, Ont.
Lamb, Frederick Carlyle, Walkerton, Ont.
Lindsay, James Herbert, Hornby, Ont.
Logan, Robert Archibald, Middle Musquodoboit, N.S.
Macdonald, Colin Stone, Ottawa, Ont.
Macdonald, James Atwood, Ridgetown, Ont.
Macdonald, Jeremiah James, Vernon River, P.E.I.
Mackay, Ernest George, Hamilton, Ont.
MacLennan, George Gordon, Toronto, Ont.
MacRostie, Norman Barry, Metcalfe, Ont.
McArthur, Alexander Stanley, Toronto, Ont.
McElhanney, Thomas Andrew, Toronto, Ont.
McEwan, Duncan Findlay, Vancouver, B.C.
McLaren, Arthur Anthony, Mitchell, Ont.
McLennan, R. A., Toronto, Ont.
Manson, A. Brock, Fairview, Ont.
Markle, Gower Ambrose, Kingston, Ont.
Marr, Norman, London, Ont.
Mowbray, F. E. H., Hamilton, Ont.
Moyer, John Curtis, St. Catharines, Ont.
Nesham, Edward Williams, Ottawa, Ont.
Novion, Lucien, Edmonton, Alta.
Openshaw, John Edward, Montreal, Que.

PRELIMINARY EXAMINATION—*Continued.*

Pae, Arthur Wilson, Barrie, Ont.
Parry, Harry, Westmount, Que.
Patterson, John Herbert, Kinosota, Man.
Pearson, Hugh Edwards, Edmonton, Alta.
Pierce, Clifford Benjamin, Kingston, Ont.
Pinder, George Zouch, Edmonton, Alta.
Pye, David E., Arnprior, Ont.
Raley, George Simpson, Lethbridge, Alta.
Reid, John, Winnipeg, Man.
Robertson, John Alexander Thompson, St. Catharines, Ont.
Roe, Allan John Forbes, Ottawa, Ont.
Segre, Beresford Henry, Winnipeg, Man.
Slater, Nicholas James, Ottawa, Ont.
Smith, Leonard Ross, Calgary, Alta.
Sproule, Stanley Macquana, Montreal, Que.
Staveley, Walter Darley, Montreal, Que.
Steers, Frank P., Ottawa, Ont.
Stitt, Ormand Montgomery, Ottawa, Ont.
Thornley, J. Harry, London, Ont.
Tipper, George Adrian, Brantford, Ont.
Toms, Charles Godfrey, Toronto, Ontario.
Webb, Christopher Everest, Toronto, Ont.
Willis, George Christopher, Toronto, Ont.
Wright, Alfred Esten, Golden, B.C.

FINAL EXAMINATION.

Akins, James Robert, Ottawa, Ont.
Allison, Calvin Bruce, South Woodslee, Ont.
Begg, William Arthur, Hamilton, Ont.
Belyea, Albert Palmer Corey, Edmonton, Alta.
Blanchet, Guy Houghton, Ottawa, Ont.
Brenot, Lucien, Ottawa, Ont.
Broughton, George Henry, Vancouver, B.C.
Brown, Charles Dudley, Winnipeg, Man.
Brown, Thomas Wood, Edmonton, Alta.
Carthew, William Morden, Edmonton, Alta.
Clarke, Charles Wentworth, Regina, Sask.
Cokely, Leroy S., Coaldale, Alta.
De la Condamine, Oscar Charles, High River, Alta.
Edwards, William Milton, Iroquois, Ont.
Ferguson, George Hendry, Toronto, Ont.
Graham, John Robertson, Ottawa, Ont.
Greene, Philip Weston, Toronto, Ont.
Hamilton, James Frederick, Lethbridge, Alta.
Hannon, Robert Maitland, deceased.
Harrison, Edward, Belleville, Ontario.
Heaman, John Andrew, Winnipeg, Man.
Herriot, George Henry, Kingston, Ont.
Heuperman, Frederick Justinus, Edmonton, Alta.
Lighthall, Abram, Vankleek Hill, Ont.
McGeorge, William Graham, Chatham, Ont.
Peters, Frederick Hatheway, Ottawa, Ont.
Phillips, Harold Geoffrey, Saskatoon, Sask.
Pierce, John Wesley, Kingston, Ont.
Purser, Ralph Clinton, Windsor, Ont.
Reid, Frederick Blair, Ottawa, Ont.
Robertson, Donald Fraser, Ottawa, Ont.
Sheppard, Albert Campbell Tremain, Ottawa, Ont.
Smith, Donald Alpine, Claude, Ont.
Stewart, Lionel Douglas Noble, Collingwood, Ont.
Stewart, Alexander George, Ottawa, Ont.
Street, Paul Bishop, Toronto, Ont.
Stock, James Joseph, Ottawa, Ont.

Besides the reading of the candidates' answers to the examination papers, the Board had to investigate the services of pupils under articles as shown by the affidavits, their diplomas from universities or technical colleges, the commissions of Provincial Land Surveyors and other evidence submitted by candidates as to their eligibility for examination. Full sets of examination papers were prepared at both meetings.

At the meeting of May, 1909, it was decided to allow candidates who have passed the final examination as Ontario Land Surveyors, but whose commissions as such are being withheld pending the completion of their service as Ontario pupils under articles, the privilege already granted to Dominion pupils of coming up for final examination if their time of service is within three weeks of completion.

Oaths of office and allegiance and bonds for the sum of one thousand dollars each as required by section 25 of the Act, were received from, and commissions as Dominion Land Surveyors issued to thirty-three surveyors.

Every Dominion Land Surveyor is required to be in possession of a subsidiary standard of length (D.L.S. Act. section 35). Seventeen new standards were issued by the Secretary, and one was re-tested. A list of the surveyors who have been furnished with standard measures up to March 31, 1910, will be found in Appendix No. 10.

The correspondence of the Board was as follows:—

Letters received	1,701
Letters sent	931
Circular letters, pamphlets and parcels sent	1,371

APPENDICES.

The following schedules and statements are appended:—

No. 1. Schedule of surveyors employed and work executed by them from April 1, 1909, to March 31, 1910.

No. 2. Schedule showing for each surveyor employed from April 1, 1909, to March 31, 1910, the number of miles surveyed, of township section lines, township outlines, traverses of lakes and rivers and resurvey; also the cost of the same.

No. 3. List of lots in the Yukon Territory, surveys of which have been received from April 1, 1909, to March 31, 1910.

No. 4. List of miscellaneous surveys in the Yukon Territory returns of which have been received from April 1, 1909, to March 31, 1910.

No. 5. Statement of work executed in the office of the chief draughtsman.

No. 6. List of new editions of sectional maps issued from April 1, 1909, to March 31, 1910.

No. 7. Statement of work executed in the photographic office from April 1, 1909, to March 31, 1910.

No. 8. Statement of work executed in the lithographic office from April 1, 1909, to March 31, 1910.

No. 9. List of employees of the Topographical Surveys Branch at Ottawa, giving the name, classification, duties of office and salary of each.

No. 10. List of Dominion Land Surveyors who have been supplied with standard measures.

Nos. 11 to 45. Reports of surveyors employed.

MAPS AND PROFILES.

The following maps and profiles accompany this report:—

Map showing subdivision surveys and resurveys made from April 1, 1909, to March 31, 1910.

Maps to accompany reports of surveyors:

Profile of streets and avenues of Fort Churchill.

Profiles of certain base lines.

Profile of part of the British Columbia-Yukon Territory boundary.

I have the honour to be, sir,

Your obedient servant,

E. DEVILLE,

Surveyor General.

TOPOGRAPHICAL SURVEYS BRANCH

SCHEDULES AND STATEMENTS.

APPENDIX No. 1.

SCHEDULE of Surveyors employed and work executed by them from April 1, 1909, to March 31, 1910.

Surveyor.	Address.	Description of Work.
Aylsworth, C. F.	Madoc, Ont.	Investigation of dispute in township 12, range 7, east of the principal meridian; resurvey of township 15, range 3, township 9, range 10, and township 8, range 13, west of the principal meridian; traverse of Assiniboine river through townships 9, ranges 10 and 11, townships 8 and 9, range 13, and township 8, range 14, west of the principal meridian.
Baker, J. C.	Vermilion, Alta.	Contract No. 25 of 1909. Subdivision of the southerly two-thirds of townships 54, ranges 17, 18, 19 and 20, west of the fifth meridian.
Bélanger, P. R. A.	Ottawa, Ont.	Destruction of monuments along the Colonization road in townships 18, 19 and 20, range 1; subdivision in township 31, range 17, townships 32 and 35, range 18, and township 33, range 19; all west of the principal meridian. Survey of villa lots and resurvey at Grand Marais point in township 18, range 7, east of the principal meridian and retracement in Fairford and Pine Creek settlements. Traverse of Winnipeg river in township 18, range 11, east of the principal meridian. Inspection of contracts Nos. 33 of 1907, 5, 24, 29 and 30 of 1908, and Nos. 6 and 12 of 1909; re-inspection of contracts Nos. 32 of 1907 and 17 of 1908; inspection of mounding in contract No. 9 of 1906.
Bolton, L.	Listowel, Ont.	Contract No. 13 of 1909. Subdivision of townships 42 and 43, ranges 7 and 8, west of the second meridian.
Brownlee, J. H.	Vancouver, B.C.	Subdivision and resurvey in townships 12 and 15, east of the coast meridian.
Carson, P. A.	Ottawa, Ont.	Triangulation surveys in British Columbia in connection with the Trigonometrical Section of the Topographical Survey of Canada.
Cautley, R. H.	Edmonton, Alta.	Contract No. 7 of 1909. Subdivision of townships 1, 2, 3 and 4, ranges 14 and 15, and townships 1, 2 and 3, ranges 16, 17, 18, 19 and 20; part resurvey of township 4, range 18, all west of the third meridian.

APPENDIX No. 1—*Continued.*

SCHEDULE of Surveyors employed, and work executed by them, from April 1, 1909, to March 31, 1910—*Continued.*

Surveyor.	Address.	Description of Work.
Chilver, C. A.	Walkerville, Ont.	Contract No. 11 of 1909. Subdivision of townships 1, 2, 3 and 4, ranges 5, 6, 7, 8, 9 and 10, all west of the third meridian.
Christie, W.	Prince Albert, Sask.	Survey of the fifteenth base line from the third to the fourth meridian.
Cote, J. L.	Edmonton, Alta.	Contract No. 15 of 1909. Subdivision of townships 1, ranges 7, 8, 9, 10, 11, 14, 17, 18, 19 and 20, townships 3, 4, 5, 6, 7 and 8, ranges 10 and 11, and township 4, range 12, all west of the fourth meridian.
Davies, T. A.	Edmonton, Alta.	Contract No. 2 of 1909. Subdivision of townships 56, 57 and 58, ranges 1 and 2, and townships 57 and 58, ranges 3 and 4, all west of the fourth meridian.
Deans, W. J.	Brandon, Man.	Resurvey of township 16, range 9; correction survey in township 24, range 30; retracement of township 20, range 12; retracement and restoration survey in township 16, range 8, township 17, range 10, and in township 20, range 13, all west of the principal meridian
Doupe, Jos.	(Deceased).	Resurvey in township 13, range 6, townships 13 and 14, range 7 and township 14, range 8, west of the principal meridian.
Ducker, W. A.	Winnipeg, Man.	Survey of the eleventh base line from the northeast corner of township 40, range 26, west of the principal meridian to the second meridian.
Edwards, Geo.	Ponoka, Alta.	Contract No. 16 of 1909. Subdivision of township 47, range 5, and townships 47 and 48, range 6 and township 48, range 7, all west of the fifth meridian.
Fairchild, C. C.	Brantford, Ont.	Survey of fifty-seven Doukhobor villages in the province of Saskatchewan; miscellaneous surveys in townships 44 and 45, range 5, township 44, range 6, townships 42 and 44, range 7, townships 39 and 44, range 8, and township 39, range 9, all west of the third meridian.
Farncomb, A. E.	Lacombe, Alta.	Contract No. 23 of 1909. Subdivision of townships 37 and 38, ranges 8 and 9, and township 39, range 8; survey of the east outlines of township 40, range 9, and townships 39 and 40, range 10, all west of the fifth meridian.
Fawcett, Thos.	Niagara Falls, Ont.	Miscellaneous surveys in township 19, range 21, township 20, range 23, townships 25, ranges 27 and 28, townships 17 and 20, range 29, and townships 17 and 18, range 30, all west of the principal meridian. Miscellaneous surveys in townships 20 and 21, ranges 3 and 4, townships 21 and 28, range 5, townships 22 and 28, range 6, township 20, range 7, townships 19, 20 and 21, range 8, townships 23, 32 and 33, range 9, township

APPENDIX No. 1—*Continued.*

SCHEDULE of Surveyors employed, and work executed by them, from April 1, 1909, to March 31, 1910—*Continued.*

Surveyor.	Address.	Description of Work.
		24, range 12, townships 29, ranges 15 and 16, township 30, range 17, township 23, range 18, township 48, range 19, township 11, range 22, township 46, range 23, township 7, range 24, and townships 31, ranges 28 and 29, all west of the second meridian. Miscellaneous surveys in townships 6 and 11, range 1, township 6, range 2, township 34, range 3, townships 33 and 34, range 6, township 32, range 7, townships 16 and 17, ranges 8 and 9, township 13, range 12, and township 41, range 18, all west of the third meridian. Traverse in township 16, range 18, township 18, range 21, and township 20, range 25, all west of the principal meridian. Traverse in township 27, range 14, townships 30 and 31, range 16, townships 31 and 40, range 17, township 39, range 24, townships 39 and 40, ranges 25 and 26, and township 38, range 28, all west of the second meridian. Traverse in township 34, range 6, west of the third meridian.
Fontaine, L. E..	Lévis, Que..	Inspection of contracts Nos. 12, 22, 25 and 28 of 1908; partial inspection of contract No 22 of 1909; re-inspection of contracts Nos. 24, 31 and part of 2 of 1907; completion of inspection of contracts Nos. 7 and 27 and inspection of addition to contract No. 18 of 1908.
Francis, Jno..	Portage la Prairie, Man..	Restoration and retracement survey of townships 18 and 19, range 15, and townships 25 and 29, range 32; retracement in township 25, range 30 and townships 31 and 32, range 32, all west of the principal meridian. Retracement of township 24, range 4, and township 23, range 12; correction survey in townships 27, ranges 4 and 5, and retracement in township 25, range 4, township 26, range 6, and township 29, range 17, all west of the second meridian.
Garner, A. C..	South Qu'Appelle, Sask.	Correction survey in township 19, range 14, west of the second meridian.
Green, T. D...	Ottawa, Ont..	Contract No. 17 of 1909. Subdivision of township 44, ranges 2, 3 and 4, and townships 43 and 44, range 5, all west of the second meridian.
Hawkins, A. H...	Listowel. Ont..	Survey of the fifteenth base line from the east side of range 25 west of the fifth meridian to the west side of range 8 west of the sixth meridian, and the sixteenth base across ranges 1 to 4 inclusive west of the sixth meridian.
Heathcott, R. V..	Edmonton, Alta..	Contract No. 9 of 1909. Subdivision of townships 59 and 60, ranges 7, 8 and 9, west of the fifth meridian.

APPENDIX No. 1—*Continued.*

SCHEDULE of Surveyors employed, and work executed by them, from April 1, 1909, to March 31, 1910—*Continued.*

Surveyor.	Address.	Description of Work.
Holcroft, H. S...	Toronto, Ont..	Subdivision in township 57, range 12; correction survey in township 47, range 14; resurvey in townships 57 and 58, ranges 9 and 10; retracement in township 41, range 11, townships 43, ranges 16 and 17, township 45, range 18, townships 43 and 44, range 20; traverse of Battle river in townships 41, 42 and 43, range 17, townships 43 and 44, range 18, and township 44, range 19; traverse of lake in township 38, range 16, and in townships 43 and 44, range 19; all west of the fourth meridian.
Hopkins, M. W..	Edmonton, Alta..	Contract No. 26 of 1909. Subdivision of townships 63 and 64, ranges 3, 4, 5, 6, 7, 8, 9 and 10, all west of the fourth meridian.
Hubbell, E. W...	Ottawa, Ont...	Resurvey of townships 21, 22, 23 and 24, range 11, and township 23, range 12, west of the third meridian. Inspection of contracts Nos. 4 and 26 of 1908, and contracts Nos. 4 and 18 of 1909.
Johnson, A. W..	Kamloops, B.C...	Subdivision in townships 6 and 7, range 26, townships 2 and 3, range 28, townships 2, 3 and 7, range 29, and township 3, range 30, all west of the sixth meridian; in townships 3 and 4, range 4, and township 3, range 5, west of the seventh meridian; and in township 38 west of the coast meridian. Resurvey in townships 6 and 7, range 26, township 3, range 28, townships 2, 3 and 7, range 29, west of the sixth meridian, in township 24, east of the coast meridian; in township 38 and in the fractional township west of township 39, west of the coast meridian; traverse in townships 6 and 7, range 26, townships 3 and 7, range 29, township 3, range 30, west of the sixth meridian, in township 24, east of the coast meridian, and in township 38, west of the coast meridian, and in the fractional township west of township 39, west of the coast meridian.
Kimpe, M...	Edmonton, Alta..	Contract No. 8 of 1909. Subdivision of townships 1, 2, 3 and 4, range 28, townships 1, ranges 29 and 30, west of the third meridian, townships 3, ranges 2, 3 and 4, townships 1, 2 and 3, range 5, townships 3, 4, 5 and 6, range 6, townships 6 and 7, range 7, townships 6, 7 and 8, ranges 8 and 9, west of the fourth meridian.
Knight, R. H...	Edmonton, Alta..	Contract No. 21 of 1909. Subdivision of townships 54, 55 and 56, ranges 25 and 26, and townships 55 and 56, range 27, west of the third meridian.
Laurie, R. C...	Battleford, Sask..	Resurvey in township 47, range 23, west of the third meridian. Contract No. 20 of 1909. Subdivision of township 54, range 23, and townships 54, 55 and 56, range 24, west of the third meridian.

APPENDIX No. 1—*Continued.*

SCHEDULE of Surveyors employed, and work executed by them, from April 1, 1909, to March 31, 1910—*Continued.*

Surveyor.	Address.	Description of Work.
Lonergan, G. J..	Buckingham, Que... ..	Resurvey in townships 53 and 54, ranges 25 and 26 and in township 53, range 27, west of the fourth meridian; traverse in townships 53 and 54, range 27, west of the third meridian; retracement of St. Albert settlement. Inspection of contracts Nos. 19 of 1908; 2, 20, 21, 22 and 24 of 1909; completion of inspection of contract No. 23 of 1908.
Miles, C. F...	Toronto, Ont..	Resurvey of township 23, range 5, townships 21 and 22, range 10, townships 25 and 26, ranges 17 and 18, west of the third meridian; correction survey in township 11, range 25, west of the second meridian; resurvey in townships 12 and 15, range 20, west of the second meridian; retracement in township 25, range 28 and townships 19 and 21, range 29, west of the second meridian and in township 15, range 24, and township 18, range 14, west of the third meridian; subdivision and traverse in township 5, range 8, west of the fourth meridian. Survey of timber berth No. 1596 in township 17, range 12, east of the principal meridian. Inspection of contracts Nos. 3, 5, 7, 8, 11, 14 and 15 of 1909; completion of inspection of contract No. 8 of 1908.
Molloy, John..	Winnipeg, Man..	Contract No. 19 of 1909. Subdivision of townships 11, ranges 13 and 14, townships 1, 2, 3, 4, 5, 6, 7 and 8, range 16, townships 1, 2, 3, 4, 6, 9, 10 and part of 5, range 17, and townships 2, 3 and 4, range 18, all east of the principal meridian.
Montgomery, R. H.. ..	Prince Albert, Sask....	Contract No. 18 of 1909. Subdivision of townships 44, 46, 47, 48, 49 and north third of 45, range 12, and township 42, range 13, all west of the second meridian.
Morrier, J. E..	Ottawa, Ont...	Contract No. 4 of 1909. Subdivision of townships 37 and 38, ranges 7 and 8; survey of the east outlines of townships 39 and 40, range 8, townships 38 and 39, range 9, and the north outline of township 38, range 9; traverse in township 37, range 9, all west of the second meridian.
McDiarmid, S. S... ...	Vancouver, B.C..	Subdivision and resurvey in township 4, range 3, west of the seventh meridian, and in townships 15 and 18, east of the coast meridion; traverse in township 4, range 2, and townships 3 and 4, range 3, west of the seventh meridian, and in townships 15 and 18, east of the coast meridian.
McFarlane, J. B... ...	Toronto, Ont..	Subdivision in townships 51, ranges 24 and 25, townships 50 and 51, range 26, townships 49 and 50, range 27, township 48, range 28, west of the fifth meridian, and in townships 45, 46 and 47, range 1, and townships 45, ranges 2, 3 and 4, west of the sixth meridian.

APPENDIX No. 1—*Continued.*

SCHEDULE of Surveyors employed, and work executed by them, from April 1, 1909, to March 31, 1910—*Continued.*

Surveyor.	Address.	Description of Work.
McFarlane, W. G....	Toronto, Ont..	Contract No. 1 of 1909. Subdivision of townships 72 and 73, range 3, township 72, range 4, townships 72 and 73, range 5, township 73, range 6, townships 72 and 73, ranges 7, 8 and 9, townships 71, 72 and 73, range 10, townships, 71, 72, 73 and 74, range 11, the north two-thirds of townships 71, ranges 3, 4, 5, 7, 8 and 9, the south two-thirds of township 74, ranges 4 and 5, the north third of townships 70, ranges 10 and 11, the south third of townships 74, ranges 3, 6, 7, 8, 9 and 10, the west third of township 71, range 6, and the east half of township 72, range 6; survey of the east outlines of townships 69 and 70, range 10, and townships 69, 70, 75 and 76, ranges 11 and 12, all west of the sixth meridian.
McFee, A...	Red Deer, Alta..	Subdivision in township 40, range 18, and townships 41 and 42, range 19; survey of north outline of township 39, range 17, and part east outline of township 40, range 17, and township 39, range 18, all west of the fifth meridian.
McGrandle, H...	Wetaskiwin, Alta... ..	Contract No. 10 of 1909. Subdivision of townships 52, ranges 10, 11 and 12, west of the fifth meridian.
McMillan, Geo..	Ottawa, Ont...	Survey of the seventeenth base line from the east boundary of range 27, west of the fifth meridian to the middle of range 9, west of the sixth meridian; and of the eighteenth base line from the east boundary of range 9 to the west boundary of range 14 west of the sixth meridian. Inspection of contract No. 1 of 1909.
McNaughton, A. L.. ..	Cornwall, Ont..	Retracement of township 47, range 3; resurvey of townships 44 and 46, range 3, townships 46 and 47, range 4, and the east outline of township 48, range 3; traverse in township 46, range 3 and townships 46 and 47 range 4, west of the third meridian.
Ord, L. R...	Hamilton, Ont..	Stadia traverse of part of lac LaRonge.
Plunkett, T. H...	Toronto, Ont..	Subdivision in townships 24 and 25, ranges 19 and 20, townships 28, ranges 22 and 23. township 29, range 25, townships 20 and 21, range 29, west of the fifth meridian, and in townships 21 and 22, range 1, townships 22 and 23, range 2, township 20, range 9, townships 18, 19 and 20, range 10, townships 18 and 19, range 11, township 14, range 23. township 16, range 26 and townships 17, ranges 27 and 28, west of the sixth meridian: traverse in townships 28, ranges 22 and 23, west of the fifth meridian, and also in townships 13 and 14, range 23, township 16, range 26, township 17, range 27, and townships 17 and 18, range 28, west of the sixth meridian; resurvey in township 24, range 19, townships 25, ranges 20 and 21, township 28, range 22, townships 20 and 21,

APPENDIX No. 1—*Continued.*

SCHEDULE of Surveyors employed, and work executed by them, from April 1, 1909, to March 31, 1910—*Continued.*

Surveyor.	Address.	Description of Work.
		range 29, west of the fifth meridian, also in townships 21 and 22, range 1, township 23, range 2, township 20, range 9, and townships 18, 19 and 20, range 10, west of the sixth meridian.
Ponton, A. W.	Edmonton, Alta.	Survey of the fifth meridian north from township 107; no returns yet received.
Reilly, W. R.	Regina, Sask.	Retracement in townships 36 and 41, range 1, west of the third meridian; resurvey in township 49, range 21, townships 45, ranges 27 and 28, west of the second meridian, and in township 42A, range 1, township 41, range 2, and township 48, range 3, west of the third meridian; correction survey in township 31, range 9, and township 49, range 12, west of the third meridian.
Robinson, E. W.	Ottawa, Ont.	Subdivision in townships 23 and 24, range 1, townships 23, 24, 26 and 27, range 2, township 19, range 6, townships 18 and 19, range 7, townships 17, ranges 8 and 9, townships 25. ranges 10, 11 and 12, west of the sixth meridian; traverse in townships 23 and 24, range 1, townships 19, ranges 5, 6 and 7, township 17, range 9, and township 25, range 12, west of the sixth meridian; resurvey in township 24, range 1, and townships 23, 24 and 27, range 2, west of the sixth meridian.
Rolfson, O.	Walkerville, Ont.	Retracement of township 13, range 26, west of the principal meridian, and of township 12, range 5 and township 14, range 7, west of the second meridian; correction survey of township 13, range 7, township 7, range 8, township 2, range 11, townships 1 and 2, range 12, and part of townships 14 and 15, range 9, west of the second meridian.
Ross, J. E.	Kamloops, B.C.	Subdivision in township 21, range 7, townships 19 and 21, range 8, township 21, range 9, townships 21 and 22, range 10, townships 17, 22 and 23, range 11, townships 17, 21, 22 and 23, range 12. townships 16, 17, 18, 20, 21, 22 and 23, range 13, townships 16, 17, 18, 20 and 21, range 14, townships 18, 20 and 23, range 15, and township 18, range 16, west of the sixth meridian. Resurvey in township 19, range 8, townships 22 and 23, range 12, townships 17, range 13, township 23, range 15, township 19, range 17, and townships 18 and 19, range 18, west of the sixth meridian; traverse in townships 19 and 22, range 8, townships 21, ranges 9 and 10, townships 21, 22 and 23, range 12, townships 16, 20, 21 and 23, range 13, township 16, range 14 and townships 16, 18 and 23, range 15, west of the sixth meridian.
Roy, G. P.	Quebec, Que.	Contract No. 22 of 1909. Subdivision of townships 57 and 58, range 12, and townships 57, 58 and 59, range 13; survey of the east outline of township 60, range 14, west of the fifth meridian.

APPENDIX No. 1—*Continued.*

SCHEDULE of Surveyors employed, and work executed by them, from April 1, 1909, to March 31, 1910—*Continued.*

Surveyor.	Address.	Description of Work.
Saint Cyr, A.	Ottawa, Ont.	Survey of the third meridian from the fourteenth to the sixteenth base line, and the sixteenth base line from the third to the fourth meridian.
Saint Cyr, J. B.	Montreal, Que.	Subdivision of townships 77, 78 and 79, range 5; part subdivision of townships 77 and 78, range 6; survey of the east outline of township 80, range 6; traverse in township 77, range 4, west of the sixth meridian. Miscellaneous surveys in Dunvegan, Peace River Crossing, and Shaftsbury settlements.
Saunders, B. J.	Edmonton, Alta.	Survey of the ninth and tenth base lines across ranges 8, 9 and 10 and the tenth base line across range 11, west of the fifth meridian.
Scott, W. A.	Galt, Ont.	Subdivision in townships 13, ranges 1 and 2, townships 9, 10 and 13, range 3, and townships 8, 9 and 10, range 4, west of the fifth meridian.
Selby, H. W.	Toronto, Ont.	Subdivision of township 77, range 20, townships 77 and 78, range 21; part subdivision of townships 71 and 72, range 1, townships 72, ranges 2 and 3, and townships 77 and 78, range 22; survey of the east outlines of townships 79 and 80, ranges 21 and 22, west of the fifth meridian.
Seymour, H. L.	Edmonton, Alta.	Contract No. 5 of 1909. Subdivision of townships, 1, 2, 3 and 4, ranges 21, 22 and 23, townships 1, 2, 3, 4 and 5, ranges 24 and 25, and township 5, range 26, west of the third meridian.
Steele, I. J.	Ottawa, Ont.	Contract No. 3 of 1909. Subdivision of townships 1, ranges 23, 24, 25. 26 and 27, townships 1 and 2, range 28, townships 1, 2, and 3, ranges 29 and 30, west of the second meridian, also townships 1, 2 and 3, ranges 1, 2 and 3, and townships, 1, 2, 3 and 4, range 4, west of the third meridian.
Teasdale, C. M.	Concord, Ont.	Contract No. 6 of 1909. Subdivision of townships 26 and 27, range 6, townships 27, ranges 7 and 8, and townships 27 and 28, range 9; survey of the east outline of townships 28, ranges 6, 7 and 8, west of the principal meridian.
Thibaudeau, W.	Montreal, Que.	Reconnaissance survey of the headwaters of Bow river, of Waterton river in the vicinity of Waterton lakes and of Cypress lakes and the southern slope of the Cypress hills with a view to locating suitable sites for the construction of storage reservoirs for irrigation and other purposes.
Tyrrell, J. W.	Hamilton, Ont.	Contract No. 12 of 1909. Subdivision of townships 26 and 27, ranges 3, 4 and 5; survey of the east outlines of townships 28 ranges 4 and 5, west of the principal meridian.

APPENDIX No. 1—*Continued.*

SCHEDULE of Surveyors employed, and work executed by them, from April 1, 1909, to March 31, 1910—*Continued.*

Surveyor.	Address.	Description of Work.
Waddell, W. H..	Edmonton, Alta..	Contract No. 24 of 1909. Subdivision of townships 62 and 63, ranges 25 and 26, and township 62, range 27; survey of the east outlines of townships 64, ranges 26 and 27, west of the fourth meridian.
Waldron, J..	Moosejaw, Sask..	Contract No. 14 of 1909. Subdivision of townships 5 and 6, ranges 9 and 10, townships 1, 2, 3, 4. 5 and 6, ranges 11 and 12, townships 4, 5 and 6, range 13, townships 5 and 6, ranges 14 and 15, townships 6, ranges 16 and 17, and the south third of townships 7, ranges 13, 14 and 15, west of the third meridian.
Walker, E. W..	Disley, Sask..	Partial resurvey of township 11, range 22, west of the second meridian.
Wallace, J. N..	Calgary, Alta..	Survey of the fourth meridian from the north boundary of section 12, township 63 to the north boundary of township 80.
Warren, Jas..	Walkerton, Ont..	Part subdivision of township 14, range 2, township 20, range 4, and township 23, range 9; survey of the sixth base line across ranges 5, 6 and part of 7, and part of the east outline of township 15, range 3; survey of villa lots in township 24, range 1, west of the fifth meridian.
Wheeler, A. O...	Calgary, Alta..	Examination of land below Golden, between Revelstoke and Shuswap lake, and in Shuswap district for purposes of classification into fruit land, farming land, grazing land, timber land and worthless land.
Young, W. H..	Lethbridge, Alta.. ...	Retracement in townships 6 and 7, range 17 west of the fourth meridian; retracement and restoration of township 7, range 1; subdivision in townships 6 and 7, range 4, west of the fifth meridian.

APPENDIX No. 2.

SCHEDULE showing for each surveyor employed from April 1, 1909, to March 31, 1910, the number of miles surveyed, of township section lines, township outlines, traverses of lakes and rivers and resurvey, also the cost of the same.

Surveyor.	Miles of section line.	Miles of outline.	Miles of traverse.	Miles of resurvey.	Total mileage.	Total cost.	Cost per mile.	By day work or by contract.
						$	$ cts.	
Aylsworth, C. F.			66	239	305	10,729	35 26	Day.
Baker, J. C.	129	16	4		149	4,550	30 55	Contract.
*Belanger, P. R. A.	1		13	31	45	3,934	87 42	Day.
Bolton, Lewis	218		6		224	6,752	30 14	Contract.
Brownlee, J. H.	6			5	11	1,175	106 81	Day.
Cautley, R. H	1,159	133	18	2	1,312	10,086	7 70	Contract.
Chilver, C. A.	1,197	139	4		1,340	11,476	8 56	"
Christie, Wm		162			162	14,300	88 27	Day.
Coté, J. L.	1,080	18	8		1,106	8,585	7 76	Contract.
Davies, T. A.	396	3	179	12	590	14,318	24 27	"
Deans, W. J.			11	307	318	7,611	23 93	Day.
Doupe, Jos.		6		41	47	638	13 58	"
Ducker, W. A.		34			34	6,000	176 47	"
Edwards, Geo.	193	6	20		219	6,343	29 05	Contract.
Fairchild, C. C.			98	27	125	5,868	46 94	Day.
Farncomb, A. E.	248	48	25		321	9,500	29 60	Contract.
Fawcett, Thos.			34	212	246	5,346	21 73	Day.
Francis, John			38	460	498	9,500	19 08	"
Green, T. D.	221	6	89		316	8,015	25 37	Contract.
Hawkins, A. H.		89			89	19,940	224 00	Day.
Heathcott, R. V.	266		70		336	9,293	27 66	Contract.
Holcroft, H. S.	5		108	161	274	7,540	27 52	Day.
Hopkins, M. W.	764		109		873	26,091	29 88	Contract.
*Hubbell, E. W.			22	294	316	4,343	13 74	Day.
Johnson, A. W.	10		45	11	66	15,500	234 85	"
Kimpe, M.	1,179				1,179	8,912	7 56	Contract.
Knight, R. H.	364	21	127		512	12,526	24 46	"
Laurie, R. C.	234	37	47		318	7,386	23 23	"
*Lonergan, G. J.			186	102	288	7,319	25 41	Day.
*Miles, C. F.	34		29	520	583	5,960	10 22	"
Molloy, John	1,156	111	147	18	1,435	40,049	27 90	Contract.
Morrier, J. E.	200	36	44		280	7,791	27 83	"
Montgomery, R. H.	299	20	26		345	10,118	29 33	"
McFarlane, J. B.	149	7	4	1	161	15,686	97 43	Day.
McFarlane, W. G.	1,090	245			1,335	38,886	29 13	Contract.
McFee, A.				61	61	7,996	131 08	Day.
McGrandle, H.	145	18			163	4,700	28 84	Contract.
McMillan, Geo.		85			85	22,385	263 35	Day.
McNaughton, A. L.			127	298	425	11,500	27 06	"
Ord, L. R.			235		235	3,551	15 11	"
Plunkett, T. H.	99		27	10	136	10,700	78 68	"
Reilly, W. R.			85	345	430	9,500	22 10	"
Robinson, E. W.	58		13	4	75	12,223	162 98	"
Rolfson, O.			57	508	565	10,216	18 08	"
Ross, J. E.	112		40	13	165	9,203	55 77	"
Roy, G. P.	236	24	61		321	9,466	29 48	Contract.
Saint Cyr, A.		208			208	28,300	136 06	Day.
Saint Cyr, J. B.	214	36	41		291	12,557	43 15	"
Saunders, B. J.		42			42	13,000	309 52	"
Scott, W. A.	80	12		4	96	9,504	99 00	"
Selby, H. W.	218	60	42		320	12,434	38 86	"
Seymour, H. L.	1,124	97	2	6	1,229	9,278	7 55	Contract.
Steele, I. J.	1,236	90	36	18	1,380	11,832	8 57	"
Teasdale, C. M.	310	30	12	12	364	10,963	30 12	"
Tyrrell, J. W.	334	31	12		377	11,008	29 19	"
Waddell, W. H.	217	32	38		287	8,141	28 71	"
Waldron, Jno.	1,265	64	5		1,334	11,018	8 26	"
Wallace, J. N.		106			106	17,600	166 64	Day.
Warren, Jas.	46	12	3	6	67	7,750	115 67	"
Young, W. H.	34	2		148	184	8,400	45 65	"
	16,326	2,089	2,413	3,876	24,704	665,291		

* Inspector of contract surveys; the total cost includes only the proportional part of the whole cost of the party for the season, determined from the time occupied on miscellaneous surveys.

APPENDIX No. 3.

List of lots in the Yukon Territory, survey returns of which have been received from April 1, 1909, to March 31, 1910.

GROUP No. 1.

Lot No.	Area in Acres.	Surveyor.	Year of Survey.	Date of Approval.	Claimant.	Remarks.
41	40·61	C. S. W. Barwell	1908	July 27, 1909..	A. P. Schultze.	Surface.

GROUP No. 2.

Lot No.	Area in Acres.	Surveyor.	Year of Survey.	Date of Approval.	Claimant.	Remarks.
365	51·65	T. D. Green	1909	*..	Mrs. L. D. Schmidt.	Aulas, M. C.
388	0·79	C. W. MacPherson.	1909	*...... . ..	The White Channel Gold Hill Hydraulic Co.	Right of way for flume.
K24	1·82	" " ..	1909	*.	" " " .	" "
404	50·5	C. S. W. Barwell	1908	*.	Mrs. L. Schmidt...	Au Curd, M. C.
408	43·2	" "	1909	April 4, 1909..	Wm. Catto, F. A. Chute and the Stewart estate.	New Bonanza, M. C.
409	5·5	" "	1909	*...............	" " " .	Niobe, M. C.
410	41·2	" "	1909	*......	" " " .	Lone Star, M. C.
411	33·4	" "	1909	*.....	" " " .	Zulu Chief, M. C.
412	10·9	" "	1909	April 19, 1909..	William Austell............	Surface rights.
413	34·6	" "	1909	*.....	Margaret J. Mitchell.... ..	Little Minnie, M. C.
414	44·7	" "	1909	*...............	" "	Mastodon, M. C.
417	347·17	" "	1909	*..............	Northern Light, Power and Coal Co.	Right of way for power transmission line.
420	35·23	Jas. Gibbon	1909	*...............	Frank J. McDougal *et al.* .	Ottawa, M. C.
421	11·27	"	1909	Aug. 10, 1909..	William Williams..........	Lillias, M. C.
422	51·65	"	1909	Feb. 15, 1910..	Frank J. McDougal *et al.* ..	Regina, M. C.
423	34·6	" ...	1909	*...	Mrs. Jennie Balton.........	Francette, M. C.
424	51.5	"	1909	Aug. 10, 1909..	Jas. Cameron and Jas. Lester	New Bonanza, M. C.
431	48.63	"	1909	*....	Robert A. Lawther.........	Iron King, M. C.
432	44·61	" ..	1909	*.	"	Silver King, M. C.
433	51·65	"	1909	*..............	Lizzie Olivia Craig, Geo. A. Hunter and W. J. Elliott.	American, M. C.
434	46·8	" ...	1909	*.	" " " .	Canadian, M. C.
435	51·65	"	1909	*...............	Geo. A. Hunter, J. H. Thorne, R. H. S. Creswell, J. Pickering and W. J. Elliott.	White Rose, M. C.
436	51·65	"	1909	*.	" " " .	Yukon Star, M. C.
437	51·65	"	1909	*....	" " " .	Nero, M. C.
438	49·10	"	1909	*...............	Mary Rebecca Knorr, per J. J. Hartman.	Stratton, M. C.
443	36·34	"	1909	*.	Dome Lode Development Co.	Colorado, M. C.
446	41·8	"	1909	*...............	Lillie E. Sturtevant........	Lone Star, M. C.
451	44·26	"	1909	*...............	Jno. F. Patterson and Lizzie O. Craig.	Georgie, M. C.
452	51·65	"	1909	*.	" " " .	Cissie, M. C.
456	48·24	Jas. Gibbon ...	1909	*.......	Malvine Brosseau & Joseph Fournier.	Alexander, M.C.
457	38·66	"	1909	*	Joseph Fournier	Clara, M.C.
458	40·13	"	1909	*.	Malvine Brosseau & Joseph Fournier.	Cestrian, M.C.
464	14·72	"	1909	*......	Malcom Nicholson & A. W. Complin.	Helena, M.C.
468	25·54	"	1909	*...	Joseph Fournier..	Congdon, M.C.
469	10·00	"	1909	*..	"	Surface rights.
470	10·00	"	1909	*.	"	"
472	640·00	C. S. W. Barwell	1909	*.	F. W. Morrison....	Coal claim.
473	640·00	" ..	1909	*.	"	"
474	640·00	" ..	1909	*....	"	"
475	640·00	" ..	1909	*....	"	"
501	45·42	N. A. Burwash..	1909	*......	James Lloyd & R. B. Segbers	Cousin Jack, M.C.
502	51·09	" ..	1909	*.	M. R. Knorr, J. L. Lloyd & R. B. Segbers.	Blueberry, M.C.

* Not yet approved.

APPENDIX No. 3—*Continued.*

List of lots in the Yukon Territory, survey returns of which have been received from April 1, 1909 to March 31 1910—*Continued.*

GROUP No. 2—*Continued.*

Lot No.	Area in Acres.	Surveyor.	Year of Survey.	Date of Approval.	Claimant.	Remarks.
520	25·03	N. A. Burwash..	1909	*.	Joseph Fournier	Belle Chasse, M.C.
570	5·73	C. W. MacPherson.	1909	*.....	Yukon Gold Co............	Surface, intake and flume.
571	4·51	" ..	1909	*..............	"	Surface power house, &c.

GROUP No. 5.

Lot No.	Area in Acres.	Surveyor.	Year of Survey.	Date of Approval.	Claimant.	Remarks.
114	17·60	H. G. Dickson.	1907	June 9, 1909..	Miss Maggie LaRose.......	Little Chief No. 2, M.C.
116	39·06	" ..	1907	Feb. 15, 1910..	A B. Palmer.........	Palmer No. 2, M.C.
117	65·77	" ..	1907	" 15, 1910..	"	Dawson, M.C.
118	132·19	" ..	1907	" 15, 1910..	"	Bonanza, M.C.
119	152·45	" ..	1907	Mar. 7, 1910..	"	Eldorado, M.C.
120	152·45	" ..	1907	" 7, 1910..	"	Henderson, M.C.
151	105·80	" ..	1907	" 7, 1910	"	Arthur, M.C.
152	86·20	" ..	1907	" 7, 1910..	"	Russell, M.C.
153	111·16	"	1907	Feb. 15, 1910..	"	Claude, M.C.
158	48·89	" ..	1909	June 9, 1909..	Roland Ryder......... ..	Bingo, M.C.
159	51·51	" ..	1909	" 9, 1909..	"	Annie, M.C.
160	51·65	" ..	1909	" 16, 1909..	Père August Nelson.... ...	Portland, M.C.
161	27·17	" ..	1909	*	A. B. Palmer.....	Elmira, M.C.
182	39·97	N. A. Burwash..	1909	Dec. 16, 1909 .	E. Johnson	Surprise, M.C.
183	3·88	" ..	1909	Nov. 24, 1909..	"	Big Bear (Frac.), M.C
185	41·99	" ..	1908	" 24, 1909..	K. Weik...........	Centre, M.C.
186	142·43	" ..	1909	*..............	J. L. Shroeder.......	Buccaneer No. 1, M.C.
187	145·95	" ..	1909	*..............	"	" No. 2, M.C.
188	9·63	" ..	1909	Feb. 15, 1910..	H. Chambers	Surface.
190	156·94	" ..	1909	Aug. 10, 1909..	The Public Administrater *et al.*	Bornite, M. C.
191	151·85	" ..	1909	" 10, 1909..	" " ..	Boston, M.C.
192	80·00	" ..	1909	Dec. 22, 1909..	E. A. Pelletier..	Surface.
193	51·65	" ..	1909	*..	A Thompson.............	Golgonda, M.C.
194	51·45	" ..	1909	*..............	"	Florence M., M.C.
195	50·47	" ..	1909	*..............	P. Campbell................	Concord.
196	51·60	" ..	1909	*......	"	Mohawk, M.C.

GROUP No. 6.

Lot No.	Area in Acres.	Surveyor.	Year of Survey.	Date of Approval.	Claimant.	Remarks.
20	50·44	H. G. Dickson..	1907	*.....	J. H. Conrad.............	Venus, M.C.
21	51·13	" ..	1907	*......	"	Venus No. 2, M.C.
22	11·12	" ..	1907	*..............	"	Venus Fraction, M.C.
24	3·52	" ..	1907	*.	"	Mars, M.C.
25	51·08	" ..	1907	*..............	"	M. & M., M.C.
26	21·48	" .	1907	*..............	"	Vault, M.C.
76	34·69	" ..	1907	*.......... ...	"	Annex, M.C.
79	5·00	" ..	1908	Feb 15, 1910..	A. B. Palmer.......	Surface.
80	35·80	" .	1908	*..............	R. H. Chadwick	Ruby Silver Extension, M.C.
151	9·70	N. A. Burwash..	1908	*..	A. B. Palmer	Allin, M.C.
152	38·10	" ..	1908	*..............	"	Celtic, M.C.
153	17·17	" ..	1908	*.....	"	Iron Mask, M.C.
154	44·82	" ..	1908	*..............	"	A. D., M.C.
155	12·86	" ..	1908	*......	"	First Chance, M.C.
156	33·41	" ..	1908	*..............	"	Iron Cap, M.C.
157	38·37	" ..	1908	*.	"	Douglas, M.C.
158	0·005	" ..	1908	*..............	"	Russell (Fraction), M.C.

*Not yet approved.

APPENDIX No. 3—*Continued.*

List of lots in the Yukon Territory, survey returns of which have been received from April 1, 1909, to March 31, 1910—*Continued.*

GROUP No. 15.

Lot No.	Area in Acres.	Surveyor.	Year of Survey.	Date of Approval.	Claimant.	Remarks.
1	100 00	H. G. Dickson..	1904	July 24, 1909..	Harry Chambers............	Surface.
2	26·18	" ..	1904	" 24, 1909..	"	"

APPENDIX No. 4.

List of miscellaneous surveys in the Yukon Territory, returns of which have been received, from April 1, 1909, to March 31, 1910.

Year.	Surveyor.	Description of Survey.
1908	H. G. Dickson	Wheaton river reference traverse.
1908	Jas. Gibbon	Base lines and side lines on Black Hills creek.
1909	H. G. Dickson	Continuation of Wheaton river reference traverse.
1909	C. W. MacPherson	Base lines on Examiner, Dion and Falconer gulches.
1909	Jas. Gibbon	Base lines on Clear creek and Barney creek.
1909	Jas. Gibbon	Base lines on Clear creek and Eldorado creek.
1909	C. W. MacPherson	Base lines on Little Blanch creek and right and left forks.
1909	C. W. MacPherson	Base line on Miller creek.

APPENDIX No. 5.

STATEMENT of work executed in the office of the Chief Draughtsman:—

Letters of instructions to surveyors	279
Progress sketches received and filed	1,214
Declarations of settlers received and filed	383
Returns of separate blocks of timber berths received	128
Plans received from surveyors	568
Field books received from surveyors	679
Timber reports received	451
Observations for magnetic declination received	567
Preliminary township plans prepared	467
Sketches made	3,028
Maps and tracings made	256
Plans of Yukon lots received	91
Plans of miscellaneous Yukon surveys received	8
Yukon lots reduced to 40 chains to 1 inch and plotted on group plans	31
Returns of surveys examined—	
Township subdivision	475
Township outline	247
Road plans	265
Railway plans	34
Mineral claims	7
Timber berths	165
Correction and other miscellaneous surveys	148
Township plans compiled	779
Townsite, settlement and other plans compiled	15
Proofs of plans examined	96
Township plans printed	705
Townsite and settlement plans printed	5
Descriptions written	12
Pages of field notes copied	288
Applications for various information dealt with	2,374
Files received and returned	2,191
Letters and memoranda drafted	7,917
Books received from Record Office and used in connection with office work	5,093
Books returned to Record Office	5,301
Plans other than printed township plans received from Record Office and used in connection with office work	631
Plans returned to the Record Office	813
Volumes of plans received from Record Office and used in connection with office work	70
Volumes of plans returned to Record Office	88
Books sent to Record Office to be placed on record	725
Plans other than township plans sent to Record Office to be placed on record	430
Sectional maps (3 miles to 1 inch)—	
Revised	60
Reprinted	11
Sectional maps (6 miles to 1 inch)—	
Reprinted	39
Revised for Railway Lands Branch	68

APPENDIX No. 6.

LIST of new editions of sectional maps issued from April 1, 1909, to March 31, 1910.

(Scale 3 miles to one inch.)

No.	Name.	No.	Name.	No.	Name.	No.	Name.
14	Pincer Creek........	68	Swift Current.......	165	Rosebud..........	266	Ribstone Creek.
22	Dufferin	74	Cross Lake..........	216	Sullivan L..........	316	Vermilion.
65	Macleod......	120	Qu'Appelle.........	264	Brazeau............		

(Scale 6 miles to one inch.)

No.	Name.	No.	Name.	No.	Name.	No.	Name.
18	Wood Mountain....	71	Brandon............	122	Manitoba House....	221	Swan River.
19	Willowbunch. . ..	72	Portage la Prairie...	123	Ft. Alexander.....	268	Carlton.
20	Souris.............	74	Cross Lake.	166	Sounding Cr........	269	Prince Albert S.
21	Turtle Mountain....	114	Calgary	167	Bad Hills.	270	Pasquia.
23	Emerson..	115	Blackfoot........ .	169	Touchwood.........	271	Mossy Portage.
24	Lake of the Woods..	116	Rainy Hills.........	170	Yorkton....	317	Fort Pitt.
64	Porcupine	117	Red Deer Forks.....	214	Rocky Mt. House...	318	Shell River.
65	Macleod......... .	118	Rush Lake..........	218	Saskatoon	319	Prince Albert N.
69	Moosejaw	119	Regina.	219	Humboldt..........	365	Victoria.
70	Moose Mountain.	121	Riding Mountain....	220	Nut Mountain......		

APPENDIX No. 7.

STATEMENT of work executed in the photographic office from April 1, 1909, to March 31, 1910.

—	3¼ x 3¼	4 x 5	5 x 7	8 x 10	10 x 12	11 x 14	16 x 18	18 x 20	20 x 24	24 x 30	30 x 36	36 x 42	42 x 48	Total.
Dry plate negatives	......	510	744	......	......	......	......	......	......	......	......	......	......	1,254
Bromide prints	......	314	36	82	1	46	277	96	......	64	33	44	6	999
Silver prints	......	2,320	4,412	34	2	6	......	......	......	......	......	......	......	6,774
Vandyke prints	......	......	14	47	15	205	497	312	......	201	58	112	28	1,489
Blue prints	......	......	......	......	......	5	20	7	......	138	6	1	......	177
Lantern transparencies	620	......	......	......	......	......	......	......	......	......	......	......	......	620
Photographs mounted	......	......	296	......	......	......	166	......	......	......	......	......	......	462
Wet plate negatives	......	......	57	101	......	136	1,003	138	22	......	......	......	......	1,457
Photo-litho plates	......	......	......	......	......	......	......	990	......	......	......	......	......	990
	620	3,144	5,559	264	18	398	1,963	1,543	22	403	97	157	34	14,222

APPENDIX No. 8.

STATEMENT of work executed in the lithographic office from April 1, 1909, to March 31, 1910.

Month.	Maps.		Townships.		Forms, &c.	
	No.	Copies.	No.	Copies.	No.	Copies.
1909.						
April	2	19,400	76	15,200	16	10,500
May	6	30,600	83	16,600	3	1,150
June	1	500	91	18,200	6	7,580
July	5	5,600	12	2,400	1	225
August	....	....	76	15,200	2	1,150
September	45	18,850	71	14,200	3	15,500
October	1	200	....	....	3	1,100
November	2	19,100	....	....	8	7,945
December	2	575	129	25,800	4	2,400
1910.						
January	....	....	51	10,200	5	2,500
February	2	1,475	63	12,600	6	3,175
March	10	14,350	57	11,400	11	7,383
Total	76	110,650	709	141,800	68	60,608

—	No.	Copies.	Impressions.	Cost.
				$ cts.
Maps	76	110,650	275,200	3,065 50
Townships	709	141,800	150,600	5,266 20
Forms, &c	68	60,608	73,033	1,003 66
Grand total	853	313,058	498,833	9,335 36

APPENDIX No. 9.

LIST of employees of the Topographical Surveys Branch at Ottawa, giving the name, classification, duties of office and salary of each. (Metcalfe street, corner of Slater.)

Name.	Classification. Division	Classification. Sub-division.	Duties of Office.	Salary.
				$ cts.
Deville, E., D.T.S., LL.D	1	A	Surveyor General	3,450 00
	Correspondence			
Brady, M	1	B	Secretary	2,200 00
Cullen, M. J	3	A	Stenographer	1,200 00
Moran, J. F	3	B	Typewriter and clerk	800 00
Williams, E. R	3	B	Correspondence clerk	800 00
Lynch, F	3	B	Typewriter	800 00
Addison, W. G	3	B	Typewriter	700 00
Paquette, A	3	B	Clerk	800 00
Pegg, A	......	......	Messenger	800 00
	Accounts.			
Hunter, R. H	2	A	Accountant	2,000 00
Wilkinson, Percy	3	A	Asst. accountant	1,000 00

Chief Draughtsman's Office—General direction and supervision of the technical work.

Symes, P. B	1	B	Chief draughtsman	2,250 00
Shanks, T., B.A.Sc., D.L.S	1	B	Asst. chief draughtsman.	2,350 00

Chief Draughtsman's Office, First Section—Survey instructions and general information.

Name.	Classification. Division	Sub-division.	Duties of Office.	Salary.
				$ cts.
Brown, T. E., B.A	1	B	Chief of division	2,350 00
Umbach, J. E., Grad. S.P.S., D.L.S	2	A	Asst. chief of division	1,800 00
Barber, H. G., Grad. S.P.S	2	A	″ ″	1,800 00
Rice, F. W., Grad. School of Mining	2	A	″ ″	1,800 00
Belleau, J. A., D.L.S	2	A	″ ″	1,800 00
McRae, A. D., B.A., B. Sc	2	B	Draughtsman	1,300 00
Carroll, M. J., Grad. S.P.S	2	B	″	1,500 00
Grant, A. W., B.A	2	B	″	1,300 00
Peaker, W. J., Grad. S.P.S	2	B	″	1,200 00
Grant, A. M., B. Sc	2	B	″	1,200 00
Milliken, J. B., B.A., B. Sc	2	B	″	1,200 00
MacMillan, J. P., B.E	2	B	″	1,200 00
Cordukes, J. P., B. Sc	2	B	″	1,100 00
Wadlin, L. N., B. Sc	2	B	″	1,100 00
Hayward, H. E., B. Sc	2	B	″	1,200 00
Sylvain, J	2	B	″	1.600 00
Rochon, E. C	2	B	″	1,300 00
Holbrook, C. H	3	B	Clerk	800 00
Burkholder, E. L	3	B	″	800 00
Vacant	2	B		1,000 00
Vacant	2	B		1,000 00

Chief Draughtsman's Office, Second Section—Surveys in Manitoba, Saskatchewan and Alberta.

Nash, T. S., Grad. S.P.S., D.L.S	1	B	Chief of division	2,350 00
Henderson, F. D., Grad. S.P.S., D.L.S	2	A	Asst. chief of division	1,800 00
Burgess, E. L., Grad. S.P.S., D.L.S., O.L.S	2	A	″ ″	1,800 00
Dennis, E. M., B. Sc	2	A	″ ″	1,800 00
Elder, A. J., Grad. S.P.S., D.L.S	2	A	″ ″	1,800 00
Hill, S. N.. Grad. S.P.S	2	A	″ ″	1,800 00
Cumming, A. L., B. Sc., D.L.S	2	A	″ ″	1,800 00
Robertson, D. F., Grad. S.P.S	2	A	″ ″	1,600 00
Sutherland, H. E., B. Sc	2	B	Draughtsman	1,300 00
Kitto, F. H., D.L.S	2	B	″	1,400 00
Norrish, B. E., B. Sc	2	B	″	1,100 00
McClennan, W. D	2	B	″	1,550 00
Roger, A	2	B	″	1,550 00
Spreckley. R. O	2	B	″	1,400 00
Goodday, Leonard	2	B	″	1,300 00
Williamson, F. H. H	2	B	″	1,300 00
Webb, G. C	2	B	″	1,300 00
Bray, R. P	2	B	″	1,300 00
Harrison, E. W	2	B	″	1,200 00
Ault, H. W	2	B	″	1,200 00
d'Orsonnens, A	2	B	″	1,500 00
Macdonald, J. A	3	B	Clerk	800 00
Lytle, W. J	3	B	″	500 00
Vacant	2	B		1,000 00
Vacant	2	B		1,000 00
Vacant	2	B		1,000 00
Vacant	2	B		1,000 00
Vacant	2	B		1,000 00
Vacant	2	B		1,000 00

Chief Draughtsman's Office, Third Section—(Imperial Building, Queen street). Copying plans for reproduction.

Name.	Classification.		Duties of Office.	Salary.
	Division	Sub-division.		$ cts.
Engler, Carl, B.A., D.L.S.	2	A	Chief of division	1,950 00
May, J. E.	2	A	Asst. chief of division	1,800 00
O'Connell, J. R.	2	B	Draughtsman	1,600 00
Moule, W. J.	2	B	"	1,550 00
Helmer, J. D.	2	B	Clerk	1,000 00
Dawson, R. J.	2	B	"	1,000 00
Archambault, E.	2	B	"	1,000 00
Watters, James	3	A	Printer	1,200 00
Tremblay, A.	3	B	Clerk	800 00
Brown, A.	3	B	"	800 00
Ebbs, E. J.	3	B	"	700 00
Bradley, J. D.	3	B	"	500 00
Marchand, C. E.	3	B	Engrosser	500 00

Chief Draughtsman's Office, Fourth Section—(Metcalfe street, corner of Slater). British Columbia surveys.

Rowan-Legg, E. L.	2	A	Chief of division	1,950 00
Gillmore, E. T. B., Grad. R.M.C.	2	A	Asst. chief of division	1,900 00
Lawe, H., D.L.S.	2	A	" "	1,800 00
MacIlquham, W. L., B.Sc.	2	A	" "	1,800 00
Morley, R. W.	2	A	" "	1,800 00
Weld, W. E.	2	A	" "	1,800 00
Wilson, E. E. D.	2	B	Draughtsman	1,600 00
Osmond, H.	2	B	"	1,200 00
Harris, K. D.	2	B	"	1,200 00

Chief Draughtsman's Office, Fifth Section—(Imperial Building, Queen street). Mapping.

Smith, J.	1	B	Chief of division	2,350 00
Begin, P. A.	2	A	Asst. chief of division	1,850 00
Genest, P. F. X.	2	A	" "	1,800 00
Flindt, A. H.	2	A	"	1,600 00
Blanchet, A. E.	2	B	Draughtsman	1,600 00
Davies, T. E. S.	2	B	"	1,500 00
Perrin, V.	2	B	"	1,500 00
Davy, E.	2	B	"	1,300 00
Villeneuve, E.	2	B	"	1,000 00
Bergin, W.	2	B	"	1,000 00
Vacant	2	B	...	1,000 00

Chief Draughtsman's Office, Sixth Section—(Imperial Building, Queen street.)
Scientific and topographical work.

Name.	Classification. Division	Classification. Sub-division	Duties of Office.	Salaries.
				$ cts.
Dodge, G. B., D.L.S.	1	B	Chief of division	2,350 00
Blanchard, J. F.	2	B	Draughtsman	1,000 00
Chartrand, D. E., B.Sc.	2	B	"	1,000 00
Coté, J. A., Grad. R.M.C.	2	B	"	1,000 00
Cousineau, A.	2	B	"	1,000 00
Dozois, L. O. R., Grad. R.M.C.	2	B	"	1,000 00
Hoar, C. M., B.Sc.	2	B	"	1,000 00
Fredette, J. F.	3	B	Clerk	500 00
Vacant	3	B	"	500 00
"	3	B	"	500 00
"	3	B	"	500 00
"	3	B	"	500 00
"	3	B	"	500 00

Geographic Board (Woods Building, Slater street).

Whitcher, A. H., F.R.G.S., D.L.S.	2	A	Secretary	2,100 00

Photographic Office (Metcalfe street, corner Slater street).

Carruthers, H. K.	2	A	Process photographer	1,800 00
Woodruff, John	2	A	Chief "	1,800 00
Whitcomb, H. E.	3	A	Photographer	1,200 00
Morgan, W. E.	3	A	"	1,100 00
Kilmartin. A.	3	B	Asst. photographer	800 00
Devlin, A.	3	B	"	800 00
Ouimet, E. G.	3	B	"	800 00

Lithographic Office (unclassified) (Metcalfe street, corner Slater street).

Name.	Occupation.	Salaries.
Moody, A.	Foreman	$25 00 per week.
Burnett, E.	Lithographer	25 00 "
Thicke, C. R.	"	22 00 "
Deslauriers, J. H.	Transferrer	20 00 "
Bergin, J.	Printer	20 00 "
Thicke, H. S.	"	18 00 "
Boyle, S.	Stone polisher	14 00 "
Gagnon, J.	Press feeder	11 00 "
Kane, P.	"	7 00 "
Easton, H. M.	Printer	17 50 "

APPENDIX No. 10.

LIST of Dominion Land Surveyors who have been supplied with Standard Measures.

Name.	Address.	Date of Birth.	Date of Appointment or of Commission.	Remarks.
Austin, George Frederick	Not known		April 14, '72	
Aylen, John	North Bay, Ont		May 29, '85	
Aylsworth, Charles Fraser	Madoc, Ont	April 21, '62	" 13, '86	O. L. S.
Baker, James Clarence	Vermilion, Alta	May 12, '78	" 18, '06	
Baker, Mason Hermon	St. Thomas, Ont	July 9, '84	Aug. 6, '08	"
Barwell, Chas. Sedley Wm	Dawson, Y. T		April 21, '94	
Bayne, George A	Winnipeg, Man	Oct. 25, '50	" 14, '72	M. L. S.
Beatty, David	Parry Sound, Ont	Dec. 22, '42	" 14, '72	O. L. S.
Beatty, Walter	Delta, Ont		" 14, '72	"
Begg, William Arthur	Hamilton, Ont	July 15, '82	June 8, '09	
Belanger, Phidime Roch Arthur	Ottawa, Ont	Mar. 5, '53	May 17, '80	Inspector of Surveys, Topographical Surveys Branch, Dept. of the Interior.
Belleau, Joseph Alphonse	"	Sept. 30, '56	" 15, '83	Topographical Surveys Branch, Dept. of the Interior.
Bemister, George Bartlett	Winnipeg, Man		June 11, '78	M. L. S., Engineering Dept. C. N. R.
Bigger, Charles Albert	Ottawa, Ont	Aug. 15, '53	Mar. 30, '82	B. C. L. S., O. L. S., Assistant Superintendent Geodetic Survey.
Bingham, Edwin Ralph	Fort William, Ont	— '78	Oct. 25, '06	O. L, S.
Bolton, Lewis	Listowel, Ont	Jan. 4, '40	April 14, '72	"
Boswell, Elias John	Not known		Mar. 18, '03	" M. L. S.
Bourgeault, Armand	St. Jean Port Joli, Que	Feb. 23, '58	" 29, '83	Q. L. S.
Bourgault, Charles Eugene	" "	Sept. 6, '61	Feb. 21, '88	
Bourget, Charles Arthur	Lauzon, Que	Aug. 26, '51	May 14, '84	"
Bowman, Herbert Joseph	Berlin, Ont	June 18, '65	Feb. 16, '88	O. L. S.
Brabazon, Alfred James	Ottawa, Ont		May 13, '82	Boundary Survey, Dept. of the Interior.
Brady, James	Golden, B.C	Nov. 24, '40	April 14, '72	O. L. S., B. C. L. S.
Bray, Samuel	Ottawa, Ont	" 5, '46	Nov. 14, '83	O. L. S., Chief Surveyor, Dept. of Indian Affairs.
Bray, Lennox Thomson	Amherstburg, Ont	Mar. 14, '77	Feb. 18, '03	O. L. S.
Bridgland, Morrison Parsons	Calgary, Alta	Dec. 20, '78	Mar. 10, '05	
Broughton, George Henry	Penticton, B.C	Aug. 12, '86	June 3, '09	B. C. L. S.
Brown, Thomas Wood	Edmonton, Alta		" 21, '09	
Brownlee, James Harrison	Vancouver, B.C	Mar. 22, 56	April 15, '87	M. L. S., B. C. L. S.
Bucknill, Walter Birch	"	May 8, '73	Mar. 19, '08	B. C. L. S.
Burke, William Robert	Not known		May 13, '86	
Burnet, Hugh	Victoria, B.C		June 22, '85	O. L. S., B. C. L. S.
Burwash, Nathaniel Alfred	Whitehorse, Y.T	Sept. 28, '79	Mar. 6, '07	O. L. S.
Burwell, Herbert Mahlon	Vancouver, B.C	Oct. 23, '63	Feb. 17, '87	B. C. L. S.
Campbell, Alexander Stewart	Kingston, Ont	Mar. 7, '80	Mar. 6, '09	
Carbert, Joseph Alfred	Medicine Hat, Alta.	Feb. 4, '56	May 12, '80	O.L.S., District Engineer and Surveyor, Dept. of Public Works, Alberta.
Carpenter, Henry Stanley	Regina, Sask	" 8, '74	Feb. 20, '01	Dept. of Public Works, O. L. S.
Carroll, Cyrus	Prince Albert, Sask.	Dec. 6, '34	April 14, '72	O. L. S.
Carson, Percy Alexander	Ottawa, Ont	" 25, '77	Feb. 22, '06	Topographical Surveys Branch, Dept. of the Interior.
Cautley, Reginald Hutton	Edmonton, Alta	" 6, '79	May 1, '05	
Cautley, Richard William	"	Aug. 3, '73	Sept. 2, '96	
Cavana, Allan George	Orillia, Ont	Jan. 22, '58	Nov. 16, '76	O. L. S.
Charlesworth, Lionel Clare	Edmonton, Alta	Nov. 17, '73	Mar. 24, '03	O. L. S., Dept. of Public Works for Alberta.
Chilver, Charles Alonzo	Walkerville, Ont	Feb. 8, '83	Feb. 22, '07	
Christie, William	Prince Albert, Sask.	" 13, '76	Mar. 22, '06	
Cleveland, Ernest Albert	Vancouver, B.C	May 12, '74	June 27, '99	B. C. L. S.
Coates, Preston Charles	Golden, B.C	" 16, '81	April 19, 07	"
Cokely, Leroy S	Merritt, B.C	Nov. 23, '84	Mar. 22, '10	
Côté, Joseph Adelard	Prince Albert, Sask.	June 5, '64	May 14, '84	
Côté, Jean Léon	Edmonton, Alta	May 6, '67	Mar. 21, '90	
Cotton, Arthur Frederick	New Westminster, B.C	Aug. 8, '52	May 11, '80	O. L. S., B. C. L. S.

APPENDIX No. 10—*Continued.*

List of Dominion Land Surveyors who have been supplied with Standard Measures—*Continued.*

Name.	Address.	Date of Birth.	Date of Appointment or of Commission.	Remarks.
Craig, John Davidson	Ottawa, Ont	Jan. 30, '76	Feb. 24, '02	Boundary Surveys, Dept. of the Interior.
Cummings Alfred	Fernie, B.C.	July 3, '80	Mar. 3, '09	B. C. L. S.
Cummings, John George	Cranbrook, B.C.	Nov. 19, '73	Feb. 17, '04	"
Dalton, John Joseph	Weston, Ont.	June 12, '54	April 17, '79	O.L.S., D.T.S.
Davies, Thomas Attwood	Edmonton, Alta	....	Feb. 22, '06	
Deans, William James	Brandon, Man	May 4, '60	May 13, '86	O.L.S.
Dennis, John Stoughton	Calgary, Alta	Oct. 22, '56	Nov. 19, '77	D.T.S.
Denny, Herbert C	Not known	....	April 1, '82	
Dickson, Henry Godkin	Whitehorse, Y.T.	Mar. 29, '64	Mar. 19, '89	M.L.S.
Dickson, James	Fenelon Falls, Ont.	Oct. 30, '34	April 14, '72	O.L.S.
Dobie, James Samuel	Thessalon, Ont	Oct. 15, '73	Mar. 22, '06	O.L.S.
Doupe, Jacob Lonsdale	Winnipeg, Man.	Sept. 14, '67	Oct. 6, '88	M.L.S. Asst. Land Commissioner for C.P.R.
Drewry, William Stewart	Nelson, B.C	Jan. 20, '59	Nov. 14, '83	O.L.S., B.C.L.S.
Driscoll, Alfred	Edmonton, Alta	July 2, '65	Feb. 23, '87	B.C.L.S.
Drummond, Thomas	Montreal, P.Q	1856	June 24, '76	D.T.S.
Ducker, William A.	Winnipeg, Man.	April 4, '52	Mar. 30, '83	O.L.S., M.L.S.
Dumais, Paul Thomas Concorde	Hull, P.Q	Jan. 2, '47	" 29, '82	Q.L.S.
Edwards, George	Ponoka, Alta.	June 13, '42	April 14, '72	O.L.S.
Ellacott, Charles Herbert	Victoria, B.C.	Dec. 24, '66	Feb. 22, '99	B.C L.S.
Empey, John Morgan	Calgary, Alta	April 16, '74	" 23, '05	O.L.S.
Fairchild, Charles Courtland	Brantford, Ont.	Feb. 21, '67	" 20, '01	O.L.S.
Farncomb, Alfred Ernest	Lacombe, Alta	May 22, '73	Mar. 12, '02	O.L.S.
Fawcett, Thomas	Toronto, Ont.	Oct. 28, '48	Nov. 18, '76	O.L.S., D.T.S.
Fawcett, Adam	Gravenhurst, Ont.	....	Feb. 22, '93	
Ferguson, George Hendry	Toronto, Ont.	Jan. 20, '83	June 2, '09	
Findlay, Allan	Winnipeg, Man.	Oct. 15, '80	Mar. 21, '08	
Fontaine, Louis Elie	Levis, P.Q	" 3, '68	Nov. 30, '92	
Francis, John	Portage la Prairie, M	Dec. 22, '52	June 17, '75	M.L.S.
Garden, James Ford	Vancouver, B.C.	Feb. 19, '47	May 13, '80	B.C.L.S.
Garden, George H	Lethbridge, Alta	....	April 14, '72	Deputy Surveyor for N.B.
Garden, Charles	Not known	......	" 14, '72	" "
Garner, Albert Coleman	S. Qu Appelle, Sask.	Sept. 6, '78	May 27, '07	
Gauvreau, Louis Pierre	Not known	....	April 14, '72	
Gibbons, James	Dawson, Y.T.	June 25, '60	Feb. 12, '91	O.L.S.
Gordon, Maitland Lockhart	Vancouver, B.C.	....	" 18, '04	B.C.L.S.
Gordon, Robert John	Lethbridge, Alta	June 18, '69	Mar. 12, '02	
Gore, Thomas Sinclair	Victoria, B.C.	1852	April 19, '79	B.C.L.S.
Green, Alfred Harold	Nelson, B.C.	Jan. 20, '79	Feb. 23, '05	B.C.L.S.
Green, Thomas Daniel	Prescott, Ont.	Dec. 21, '57	May 19, '84	O.L.S.
Green, F. C	Nelson, B.C	....	....	B.C.L.S.
Grover, George Alexander	Norwood, Ont	....	Feb. 18, '04	
Hamilton, James Frederick	Lethbridge, Alta	....	June 2, '09	
Harris, John Walter	Winnipeg, Man.	Feb. 26, '45	April 14, '72	O.L.S., M.L.S., City Surveyor.
Harvey, Charles	Kelowna, B.C	May 5, '76	Feb. 17, '04	B.C.L.S.
Hawkins, Albert Howard	Listowel, Ont.	July 27, '62	Mar. 6, '06	
Heaman, John Andrew	Winnipeg, Man.	June 3, '75	July 15, '09	O.L.S.
Heathcott, Robert Vernon	Edmonton, Alta	July 7, '81	May 13, '07	
Henderson, Walter	Not known	....	Nov. 17, '83	
Holcroft, Herbert Spencer	Toronto, Ont.	Sept. 4, '77	Feb. 18, '03	O.L.S.
Hopkins, Marshall Willard	Edmonton, Alta	May 24, '61	" 20, '01	O.L.S.
Hubbell, Ernest Wilson	Ottawa, Ont.	Nov. 5, '62	May 19, '84	Inspector of Surveys, Topographical Surveys Branch, Dept. of Interior.
James, Silas	Toronto, Ont.	June 19, '34	April 14, '72	O.L.S.
Jephson, Richard Jermy	Brandon, Man.	Feb. 5, '54	May 12, '80	O.L.S., B.C.L.S.
Johnson, Alfred William	Kamloops, B.C.	" 23, '74	Mar. 12, '02	B.C.L.S.
Kimpe, Maurice	Edmonton, Alta	Jan. 17, '76	May 13, '07	
King, William Frederick	Dominion Observatory, Ottawa, Ont.	Feb. 19, '54	Nov. 21, '76	D.T.S., Chief Astronomer, Dept. of Interior.
Kirk, John Albert	Summerland, B.C.	Jan. 9, '54	May 11, '80	O.L.S., B.C.L.S.
Kitto' Franklin Hugo	Ottawa, Ont	Mar. 28, '80	Mar. 6, '08	Topographcail Surveys Bh., Dept. of Interior.

APPENDIX No. 10—*Continued.*

LIST of Dominion Land Surveyors who have been supplied with Standard Measures—*Continued.*

Name.	Address.	Date of Birth.	Date of Appointment or of Commission.	Remarks.
Klotz, Otto Julius	Dominion Observatory, Ottawa, Ont.	Mar. 31, '52	Nov. 19, '77	O.L.S., D.T.S., Astronomer, Dept. of Interior.
Knight, Richard H.	Edmonton. Alta	June 7, '77	Feb. 18, '04	
Latimer, Frank Herbert	Penticton, B.C	May 23, '60	Nov. 13, '85	
Laurie, Richard C.	Battleford, Sask	Jan. 31, '58	April 27, '83	
Lawe, Henry	Ottawa, Ont	Feb. 28, '38	" 14, '72	O.L.S., M.L.S. Topographical Surveys Branch, Dept. of Interior.
Lemoine, Charles Erel	Ville Montcalme, P.Q.	. . . . . .	Mar. 31, '82	Q.L.S.
Lendrum, Robert Watt	Strathcona, Alta	July 24, '34	May 15, '80	O.L.S.
Lighthall, Abram	Vankleek Hill, Ont.	Mar. 30, '78	Dec. 25, '09	
Lonergan, Gerald Joseph	Buckingham, P.Q.	Oct. 8, '71	Feb. 28, '01	Q.L.S. Inspector of Surveys, Dept of Interior.
Lumsden, Hugh David	Ottawa, Ont	Sept. 7, '44	Apr. 14, '72	O.L.S.
MacLennan, Alexander L.	Toronto, Ont	May. 10, '78	Feb. 23, '05	
MacPherson, Charles Wilfrid	Dawson, Y.T.	Sept. 6, '71	Mar. 7, '00	O.L.S. Director of Surveys, Y.T.
Magrath, Charles Alexander	Lethbridge, Alta	April 22, '60	Nov. 16, '81	B.A.Sc., O.L.S., B.C.L.S., D.T.S.
Meadows, William Walter	Maple Creek, Sask.	May 27, '73	Feb. 23, '05	O.L.S.
Miles, Charles Falconer	Toronto, Ont.	Jan. 30, '38	Apr. 14, '72	O.L.S. Inspector of Surveys, Dept. of Interior.
Moberly, Hardford Kenneth	Moosomin, Sask	—— '69	" 21, '03	
Molloy, John	Winnipeg, Man	Jan. 13, '40	" 14, '72	M.L.S.
Montgomery, Royal Harp.	Prince Albert, Sask.	May 20, '82	Feb. 23, '05	O.L.S.
Moore, Herbert Harrison	Calgary, Alta	Dec. 1, '69	" 17, '04	
Morrier, Joseph Eldedge	Ottawa, Ont	Aug. 29, '74	May 16, '07	
McArthur, James Joseph	Ottawa, Ont	May 9, '56	Apr. 17, '79	Boundary Survey, Dept. of Interior.
McColl, Gilbert Beebe	Winnipeg, Man	Oct. 3, '82	Mar. 20, '07	M.L.S., D.T.S.
McDiarmid, Stuart Stanley	Vancouver, B.C.	Aug. 4, '81	Feb. 23, '05	B.C.L.S.
McFadden, Moses	Vancouver, B.C.	Aug. 26, '26	Apr. 14, '72	O.L.S., M.L.S.
McFarlane, Walter Graham	Toronto, Ont	Sept. 28, '75	May 19, '05	
McFarlane, John Baird	Claremont, Ont	Feb. 25, '79	June 3, '08	
McFee, Angus	Red Deer, Alta	July 14, '46	Apr. 19, '79	
McGrandle, Hugh	Wetaskiwin, Alta	Mar. 12, '57	Mar. 30, '83	O.L.S.
McKenna, John Joseph	Dublin, Ont	. . . .	Apr. 14, '72	O.L.S.
McKenzie, John	New Westminster, B C.	Oct. 31, '47	Nov. 18, '87	
McLean, James Keachie	Ottawa, Ont	Dec. 19, '51	Apr. 1, '82	O.L.S. Dept. of Indian Affairs.
McMillan, George	Finch, Ont	Dec 9, '69	Feb. 22, '06	
McNaughton, Alexander L	Cornwall, Ont	Sept. 30, '8[illegible]	Feb. 23, '05	O.L.S., B.C.L.S.
McPherson, Archibald John	Regina, Sask	—— '70	Feb. 21, '01	
McPhillips, George	Winnipeg, Man	Apr. 26, '48	Jan. 17, '75	O.L.S., M.L.S.
McVittie, Archibald W.	Victoria, B.C	May 5, '58	Mar. 30, '82	B.C.L.S.
Nash, Thomas Sanford	Ottawa, Ont	July 2, '75	Feb. 18, '04	Topographical Surveys Branch, Dept. of Interior
Ogilvie, William	Ottawa, Ont	April 7, '46	Apr. 14, '72	O.L.S.
O'Hara, Walter Francis	Ottawa, Ont	. . . .	Feb 19, '95	O.L.S.
Ord, Lewis Redman	Hamilton, Ont	Oct. 17, '56	Apr. 1, '82	O.L.S.
Parsons, Johnstone Lindsay R.	Regina, Sask	Jan. 18, '76	Feb. 23, '05	O.L.S.
Patrick, Allan Poyntz	Calgary, Alta	July 18, '49	Nov. 19, '77	B.C.L.S., D.T.S.
Patten, Thaddeus James	Little Current, Ont.	Feb. 4. '59	Mar. 29, 83	O.L.S.
Pearce, William	Calgary, Alta	Feb. 1, '48	May 10, '80	O.L.S., B.C.L.S.
Peters, Frederic Hatheway	Calgary, Alta	Nov. 4, '83	March 4, '10	Hydrographic Surveys, Dept. of Interior.
Phillips, Edward Horace	Saskatoon, Sask.	Dec. 19, '78	Feb. 24, '02	
Plunkett, Thomas Hartley	Meaford, Ont	June 1, '78	Mar. 12, '08	
Ponton, Archibald William	Edmonton, Alta	Jan. 25, '59	May 18, '81	O.L.S.
Proudfoot, Hume Blake	Saskatoon, Sask	June 23, '58	Mar. 28, '82	O.L.S.
Rainboth, Edward Joseph	Ottawa, Ont	. . . .	May 19, '81	Q.L.S., O.L.S.
Rainboth, George Charles	Ottawa, Ont	Oct. 4, '46	Apr. 14, '72	Q.L.S., O.L.S. Boundary Surveys, Dept. of Interior
Reid, John Lestock	Prince Albert, Sask.	Sept. 12, '41	Apr. 14, '72	Dept. of Indian Affairs.
Reilly, William Robinson	Regina, Sask	Aug. 10, '57	Nov. 17, '81	O.L.S., M.L.S.

APPENDIX No. 10—*Concluded.*

List of Dominion Land Surveyors who have been supplied with Standard Measures—*Concluded.*

Name.	Address.	Date of Birth.	Date of Appointment or of Commission.	Remarks.
Richard, Joseph Francois	Ste Anne de la Pocatiere, P.Q.	....	May 13, '82	
Rinfret, Raoul	Montreal, P.Q	July 16, '56	Feb. 20, '00	Q.L.S.
Ritchie, Joseph Frederick	Prince Rupert, B.C.	May 23, '63	Jan. 7, '89	B.C.L.S.
Roberston, Henry H	N. Temiskaming, P.Q.	Sept. 13, '47	Apr. 14, '72	Q.L.S.
Roberts, Sydney Archibald	Victoria, B.C	April 10, '48	May 16, '85	B.C.L.S.
Roberts, Vaughan Maurice	Goderich, Ont	Mar. 22, '64	" 17, '86	
Robinson, Ernest Walter P	Ottawa, Ont	May 8, '80	" 1, '08	
Robinson, Franklin Joseph	Regina, Sask	Oct. 20, '70	Feb. 20, '00	
Rolfson, Orville	Walkerville, Ont	Feb. 26, '85	July 11, '08	
Rombough, Marshall Bedwell	Morden, Man	Oct. 14, '35	April 14, '72	M.L.S.
Rorke, Louis Valentine	Toronto, Ont	Feb. — '65	Aug. 13, '91	O.L.S. Inspector of Surveys for Ontario.
Ross, George	Welland, Ont	June 12, '53	Nov. 21, '82	O.L.S.
Ross, Joseph Edmund	Kamloops, B.C	Jan. 9, '61	Feb. 12, '91	O.L.S., B.C.L.S.
Roy, George Peter	Quebec, P.Q	Oct. 1, '52	Nov. 17, '81	Q.L.S.
Saint Cyr, Jean Baptiste	Montreal, P.Q	" 17, '66	Feb. 17, '87	Q.L.S.
Saint Cyr, Arthur	Ottawa, Ont	Nov. — '60	" 17, '87	
Saunders, Bryce Johnston	Edmonton, Alta	....	Nov. 16, '84	O.L.S.
Scott, Walter Alexander	Galt, Ont	Aug. 8, '85	Mar. 16, '09	
Seager, Edmund	Kenora, Ont	Nov. 22, '38	April 14, '72	O.L.S.
Selby, Henry Walter	Toronto, Ont	Aug. 24, '54	Nov. 15, '82	O.L.S.
Sewell, Henry DeQuincy	" "	April 18, '48	May 16, '85	O.L.S.
Seymour, Horace Llewellyn	Edmonton, Alta	June 11, '82	Feb. 22, '06	O.L.S.
Shaw, Charles Aeneas	Greenwood, B.C	Nov 16, '53	May 10, '80	O.L.S., B.C.L.S.
Sheply, Joseph Drummond	N. Battleford, Sask.	Sept. 13, '79	Mar. 12, '06	
Smith, Charles Campbell	Ottawa, Ont	Jan. 1, '73	Feb. 22, '06	O.L.S.
Speight, Thomas Bailey	Toronto, Ont	Feb. 8, '59	Nov. 16, '82	O.L.S.
Starkey, Samuel M	Codys, Queen's Co., N.B.	Sept. 4, '37	April 14, '72	
Steele, Ira John	Ottawa, Ont	April 6, '81	April 16, '08	
Stewart, Elihu	Collingwood, Ont	Nov. 17, '44	" 14, '72	O.L.S.
Stewart, Will Malcolm	Saskatoon, Sask	" 26, '84	June 6, '07	
Stewart, Louis Beaufort	Toronto, Ont	Jan. 27, '61	Nov. 22, '82	O.L.S., D.T.S.
Stewart, George Alexander	....	....	April 14, '72	O.L.S.
Stock, James Joseph	Ottawa, Ont	Aug. 16, '87	Mar. 2, '10	
Talbot, Albert Charles	Calgary, Alta	April 5, '56	May 13, '80	
Taylor, Alexander	Portage la Prairie, Man.	Aug. 6, '75	June 9, '04	M.L.S.
Teasdale, Charles Montgomery	Concord, Ont	Oct. 18, '79	Mar. 9, '06	
Thompson, William Thomas	Grenfell. Sask	Nov. 1, '53	Nov. 19, '77	D.T.S.
Tracy, Thomas Henry	Vancouver, B.C	June 25, '48	April 14, '72	O.L.S., B.C.L.S.
Tremblay, Alfred Joseph	Les Eboulements, P.Q.	....	Feb. 18, '90	
Turnbull, Thomas	Winnipeg, Man	May 26, '57	Mar. 29, '82	O.L.S.
Tyrrell, James William	Hamilton, Ont	" 10, '63	Feb. 16, '87	O.L.S.
Vaughan, Josephus Wyatt	Vancouver, B.C	Oct. 17, '45	June 11, '78	B.C.L.S.
Vicars, John Richard Odlum	Kamloops, B.C	April 16, '65	May 17, '86	O.L.S., B.C.L.S.
Waddell, William Henry	Edmonton, Alta	Mar. 23, '83	Mar. 25, '07	O.L.S.
Waldron John	Pine Grove, Ont	Aug. 1, '72	April 2, '07	
Walker Ernest Ward	Regina, Sask	Dec. 26, '75	Mar. 27, '07	
Wallace, James Nevin	Calgary, Alta	Aug. 21, '70	Feb. 20, '00	O.L.S.
Warren, James	Walkerton, Ont	Nov. 7, '37	April 14, '72	
Watt, George Herbert	Ottawa, Ont	Feb. 5, '76	Feb. 24, '02	
Weekes, Abel Seneca	Edmonton, Alta	" 17, '66	" 11, '92	
Weekes, Melville Bell	Regina, Sask	Nov. 28, '74	" 18, '03	O.L.S.
Wheeler, Arthur Oliver	Calgary, Alta	May 1, '60	Nov. 21, '82	O.L.S., B.C.L.S
White-Fraser, George W. R. M.	Ottawa, Ont	——— '61	Feb. 21, '88	D.T.S.
Wiggins, Thomas Henry	Saskatoon, Sask	Aug. 24, '63	" 18, '96	O.L.S.
Wilkins, Frederick W. B	Norwood. Ont	June 27, '54	May 18, '81	O.L.S., D.T.S.
Wilkinson, William Downing	Not known	....	Feb. 22, '93	
Williams, Guy Lorne	Enderby, B.C	Mar. 3, '79	June 24, '08	B.C.L.S.
Woods, Joseph Edward	Pincher Creek, Alta.	Oct. 13, '61	Nov. 14, '85	
Young, Walter Beatty	Winnipeg, Man	July 6, '80	Mar. 25, '05	M.L.S.
Young, William Howard	Lethbridge, Alta	June 8, '78	May 17, '07	

REPORTS OF SURVEYORS

GENERAL REPORTS OF SURVEYORS

1909-1910

APPENDIX No. 11.

EXTRACTS FROM THE REPORT OF C. F. AYLSWORTH, Jr., D.L.S.

RESURVEYS IN SOUTHERN MANITOBA.

On April 21, with my party, I left Winnipeg for St. Laurent, where my outfit had been wintered. St. Laurent has not grown much during the past ten years, but since it has secured railway facilities the people in the locality predict prosperity, especially as it is proving a very poplar summer resort for the citizens of Winnipeg.

We left St. Laurent with the outfit on April 26, for township 9, range 10, west of the principal meridian, where we arrived on May 1, with about nine inches of snow on the ground and the weather bitterly cold.

The original survey of this township was completed over thirty years ago, and the corners were marked by wooden posts. These posts gradually decayed or were burned making it almost impossible to locate parcels of land. The Canadian Northern railway runs across the north end of this township, but the business centre of the district is Treherne, on the Canadian Pacific railway, in township 8. The manager of the Bank of Commerce there informed me that the financial condition of the farmers in the vicinity was good. They raise good horses and cattle and have well-graded roads throughout the district.

The traverse of both banks of Assiniboine river through this township occupied nearly twenty days, and the resurvey was completed on July 29. The following day we moved to township 12, range 7, east of the principal meridian. The work in this township consisted of investigating the dispute over the boundaries of the quarter sections in section 35. This having been satisfactorily accomplished, we proceeded to township 15, range 3, west of the principal meridian, arriving there on August 19.

We reached township 8, range 13, west of the principal meridian on September 30 and completed the resurvey on December 6, having traversed both banks of Assiniboine river through it.

APPENDIX No. 12.

EXTRACTS FROM THE REPORT OF P. R. A. BELANGER, D.L.S.

MISCELLANEOUS RESURVEYS IN MANITOBA AND INSPECTION OF CONTRACTS.

I left home on March 16 for Winnipeg and on April 6 I started with the whole party for Sandy Lake village where I began inspection work. Sandy Lake is the name of a small village on the Rossburn section of the Canadian Northern railway; it is situated in the Riding mountains at the south end of the lake. It is claimed to be a fine summer resort and a few families are already in the habit of spending their holidays there under canvas during the warm season. The inhabitants of the surrounding settlement are mostly all foreigners who are progressing very favourably and appear contented with their lot.

From Sandy Lake I proceeded by rail to Makinak from where I continued inspection until May 11.

Early on the morning of May 11, I boarded the train at Makinak for Oak Point where I organized my transport outfit and left that place on the 17th for Fairford settlement.

At Fairford my work consisted of the retracement of part of the old settlement survey by Mr. Martin. This survey was found badly obliterated, and it was only by mere luck that I found blazing on a lot line which had been disputed in the past, and subsequently blazed. By reopening this line, between blazing and measuring from Fairford river the distance shown on the old plan for the length of the line, I located a stub of a post at the bottom of a very small marshy coulee, marking the intersection of the rear line of the settlement from this stub by turning the bearing of the rear line, and measuring one lot westerly I located another stub and with the help of these two marks I was enabled to resurvey the settlement and reestablish all the marks and lines which everywhere were found entirely obliterated; the only traces of lines I found were old stumps here and there, indicating that a line had probably been run there in the past.

All lots were laid out and surveyed according to the dimensions shown on the original plan, and almost everywhere the distances found on side lines of lots proved to be about the same as in the original survey. This would indicate that the old survey was accurately retraced notwithstanding the absence of old marks. All lines I retraced were thoroughly blazed and permanently marked by posts and mounds and all interested parties appeared satisfied. Principal among these was the Rev. Mr. Bruce who was rather under a false impression with regard to the position of the metes and bounds of his lot, which lot I surveyed for him according to the patent issued in his favour.

This settlement is nicely situated on both banks of Fairford river which is the great outlet of lakes Winnipegosis and Manitoba and the inlet of lake Winnipeg, after passing through lake St. Martin. It is mostly inhabited by half-breeds whose occupation is fishing and hunting; some of them also work at the gypsum mines which are situated a short distance north of the settlement. I am informed that the Oak Point branch of the Canadian Northern railway will pass through this place en route to Gypsumville. This railway would replace the boat service and help in developing the mines on a larger scale.

I performed the inspection of contracts in this vicinity which kept me busy until June 15, and the next day I took my outfit across Fairford river and started back to Oak Point where I arrived on the 21st, and after leaving my horses in pasture and the outfit in care of Mr. Seller of that place I boarded the train with the party for Winnipegosis which was reached on the 24th.

Here I organized a sailboat transport to examine contract surveys scattered along the shores of lakes Winnipegosis and Manitoba.

On July 1, everything being in readiness, I set sail from Winnipegosis for Pine Creek settlement, which I reached on the same evening at nine o'clock, after a safe voyage.

Before going on with inspection I attended to the retracement of the survey of Pine Creek settlement of which the post-office name is 'Camperville;' this is a small settlement situated on the west shore of lake Winnipegosis adjoining an Indian Reserve. It is inhabited by half-breeds who make their living by fishing, trapping, or in some other way; they do not care for farming. The only lot which has been partly cleared out belongs to the Roman Catholic mission which is already making use of the clearing by keeping in it a good herd of cows for their milk supply.

There is a fine boarding school here under the direction of the Rev. Oblats Fathers.

From Pine Creek settlement I sailed to different places on lake Winnipegosis such as Red Deer point, Salt point, Salt Springs, Devil's island, &c. All those places were visited for the purpose of carrying on inspection and to survey a few lines which had been omitted at the time of subdivision and also to establish the true location of the salt springs.

I sailed next day to Oak Point which I reached on August 24. Here again I secured my horses and outfit and left the next day for Selkirk and thence to Grandmarais point, where my work consisted of the survey of villa lots in township 18, range 7. east of the principal meridian, and the retracement of a few section lines in connection with that survey. These lots numbering about forty-five are all nicely situated on the east shore of lake Winnipeg; some of the lots lie on a peninsula formed by a bay which connects with the lake by a narrow channel about four chains wide and four feet deep at low water. This bay affords a splendid harbour for safe boat sailing at any time.

The large sandy beach extending in shallow water for some distance into the lake in front of these lots should make the place very attractive for a summer resort, and I have no doubt that the lots will sell as soon as they are placed on the market, principally those on section 33 which are situated along a bank or plateau rising from twelve to about sixty feet above the lake. Those on section 19 lie on the above mentioned peninsula formed by the drifted sand of the lake beach, and though their position is more picturesque, the annoyance caused on windy days by the drifting sand will hinder their sale; however, this inconvenience can be remedied by covering the ground with grass sod and planting trees specially adapted to such soil.

On September 21, having finished the survey of villa lots at Grandmarais point, I moved camp to Mitasa point and after spending four days at that place examining two townships, I proceeded to township 18, range 11, east of the principal meridian, where I completed the inspection.

While continuing inspection work I passed through Fort Alexander and the settlement of St. George which is situated along both banks of Winnipeg river a few miles from its mouth and adjoining the Indian reserve which extends southerly from the mouth of the river.

St. George is settled by French-Canadians who had the courage some twenty years ago to take the heavy timbered land they occupy, and by perseverance and hard work they succeeded in clearing and improving their land, and made a home where they live happy and contented. All they desire now is the building of a railway from Lac-du-Bonnet to Fort Alexander to give them access to the Winnipeg market at any time of the year. The only way to get out of this place in summer is by boat to Selkirk via Winnipeg river and lake Winnipeg, or up the river to Lac-du-Bonnet.

On October 9 I proceeded to Rennie for the inspection of contract surveys in that vicinity which kept me busy until November 3.

I next proceeded via Teulon to township 18, range 1, east of the principal meridian where I made an investigation with regard to the necessity of resurveying the township, and then continued my journey northerly along the colonization road, where I destroyed some mounds that were considered unnecessary.

I continued inspection of contract surveys until December 27, when I was compelled by deep snow to close operations for the season.

While at Winnipeg on my return home I inspected the iron posts made by the Manitoba Bridge and Iron Works, Ltd., and by the Vulcan Iron Works, for Messrs. Brown and Mitchell, of Brandon, contractors. Separate reports have been already submitted to you in connection with the inspection of these posts.

Detailed reports were also made during the season on the inspection of each contract, and I only wish to mention the fact that the rigid inspections made in the past have greatly benefitted both the Department and the contractors. The surveys have been improved to a great extent, and one contractor who was considered careless before, fulfilled his contract this year with such care and attention that I was highly pleased to recommend the acceptance of his survey without any restriction.

During my work along lake Winnipegosis I noticed that the salt claims which had been located and worked for a time had been abandoned. I was unable to state the reason for this action, but while at Pine Creek settlement I remarked that at the Roman Catholic mission they had bored two artesian wells and found the water so saline that it could not be used except for the purpose of preserving fish during the summer.

I did not meet with any mineral during the course of my operations.

The rivers and lakes noticed on my surveys still abound with fish furnishing employment and nourishment for the half-breeds, Indians and settlers in that vicinity, besides the great fishing which is done in winter by the large fish companies for exportation.

Feathered game appears to be decreasing, most likely due to the destruction by the 'nimrods' who become more numerous as population increases. Large game on the contrary appeared more abundant as I saw more moose and larger herds of elk than I ever saw before, and though I was provided with hunting licenses I was unable to secure any as the great depth of snow which fell at the open season prevented me as well as others from securing them in a legal way, the consequence being that very few were killed this year, though many were killed in an unlawful manner before the open season.

APPENDIX No. 13.

REPORT OF P. A. CARSON, D.L.S.

TRIANGULATION SURVEYS IN THE RAILWAY BELT OF BRITISH COLUMBIA.

OTTAWA, ONT., February 8, 1910

E. DEVILLE, Esq., LL.D.,
Surveyor General,
Ottawa.

SIR,—I have the honour to submit the following report of my field operations during the past season on the triangulation survey in the railway belt of British Columbia, in connection with the Trigonometrical section of the Topographical Survey of Canada.

I left Ottawa on June 8, for Golden, British Columbia, where I had stored my outfit the previous autumn, and after making up my party, I proceeded by rail to Revelstoke. Thence we went up Columbia river by trail to Carnes creek, a rapid mountain stream some twenty-five feet wide, flowing into the Columbia from the east about twenty-six miles above Revelstoke. The mouth of this creek is about a quarter of a mile north of the limit of the railway belt. Columbia river in this vicinity is very rapid, but is navigated by a wonderful flat-bottomed steamboat, which with enormous boilers and powerful machinery, manages to navigate the rapids and canyons. This boat plies from Revelstoke to Downie creek, a distance of forty-five miles, carrying supplies to the mines and lumber camps of that district. There is a wagon road from Revelstoke to Mosquito landing, a distance of six miles; then an old trail leads up the east side of the river to 'big bend' This trail is not much used now and is in a rather bad condition. There is some good timber, consisting of cedar, spruce, hemlock and fir, along both sides of the river, extending high up on the mountains. The low lands are suitable for fruit growing, but the clearing of it will be a herculean task on account of the heavy timber. The valley itself is rather narrow, with, however, some good bench lands higher up. The mountains on each side of the river are low, rising only to an elevation of six or seven thousand feet with higher peaks several miles back.

About four miles from its mouth Carnes creek divides into the north and south forks, the former coming from the direction of Standard basin and Downie creek, while the south fork, which lies wholly within the railway belt, heads from the same snow fields as Silver, Laforme and Clachnacudainn creeks. An old pack trail leads up to the north side of Carnes creek to the forks, crossing the northerly stream by a bridge and following the south fork for a distance of two miles to some undeveloped mining claims. A branch trail also ascends the west bank of the north fork towards Standard basin, while at the bridge a third trail climbs Rosebery mountain with numerous switchbacks to the old deserted Rosebery mine, at an elevation of six thousand feet.

I set two stations in this vicinity, one on Rosebery mountain (elevation 8,000 feet), and the other on Carnes mountain (elevation 8,000 feet), reading angles therefrom and taking photographs for mapping purposes.

A topographical map has been prepared of this mountainous district, extending northeasterly to connect with my map of the previous season.

From Carnes creek I returned to Revelstoke and moved to Twin Butte railway station, eleven miles east of Revelstoke. On account of the position of Albert peak, we were obliged to ascend to timber line with a light camping outfit, climbing from Twin Butte bridge up the ridge projecting between the railway and East Twin creek. If Lord Byron had made this trip through dirty windfall and burnt timber I am perfectly sure he would never have uttered that beautiful line 'There is a pleasure in the pathless woods.' From timber line we ascend North Albert peak, the summit of which on this date(July 9) was covered with deep snow. Station XXVII. was consequently placed on a projecting and adjoining creek slightly lower than the main summit at an elevation of 9,300 feet.

We next moved to Albert Canyon railway station and followed the trail leading up the north fork of Illecillewaet river. This trail is the remnants of the sometime wagon road, fearfully and wonderfully made, leading to the defunct Waverley and Tangier mines, whose unlaid ghosts still scare nervous capital from British Columbia. We advanced fifteen miles up the river to 'the farm,' from where we ascended Cornice mountain (elevation 9,000 feet) and occupied station XXVI. During the descent of this mountain we encountered four caribou, two black bears and a hugh grizzly within the space of half an hour.

From 'the farm' we proceeded for twelve miles up the old wagon road, which follows the east or left side of the river, until we reached a broad level pass (elevation 5,700 feet) between the heads of the north fork of Illecillewaet river and Downie creek. On the Downie slope, about a thousand feet below the pass, lay the old deserted buildings of the Waverley and Tangier mines, now frequented only by legions of porcupines.

On the summit of Sorcerer mountain (elevation 10,500 feet), which lies on the northeasterly side of the pass, I established station XXXI. This mountain is one of the most commanding peaks in this locality, and is rather difficult to scale. On account of the depth of snow on the summit, I was unable to cement the brass bolt in the rock, but I placed it temporarily in the centre of the cairn.

On the flat pass I ran a base line sixty-eight chains long, and by means of three secondary stations connected station XXXI. with one of the survey posts of the Tangier group, thus locating the position of these mines relative to the Dominion system of surveys and the north limit of the railway belt.

The return trip to Albert Canyon was made in two days, when we moved to Bear Creek railway station, and went up the Beaver river trail to Grand glacier, near the pass between Beaver and Duncan rivers. We ascended Grand glacier and established station XXIV. on Grand mountain, lying between the two forks of the glacier (elevation 10,000 feet) This station takes the place of the one placed on Sugarloaf mountain in 1907, which was unsuitable for a station on account of the great depth of snow. The ascent of Grand mountain (August 7) was very disagreeable, especially crossing the enormous crevasses of the upper glacier, it being necessary in some cases to descend a couple of hundred feet into ice tunnels and caves to attain the higher reaches of the glacier.

From our camp at Grand glacier we retraced our steps down the Beaver river trail for seven miles to a point opposite Bald mountain. Here we took horses up the steep face of Bald mountain, reaching the prairie-like summit in four hours, ascending over 3,000 feet at a fifty per cent slope. We nooned on the top of Bald mountain, and in the afternoon descended the easterly slope to the valley of the north fork of Spillimacheen river. By making this forced march over Bald mountain I was saved the hard trip up Grizzly creek, or the long journey *via* Carbonate Landing and the north fork trail.

We ascended to station XXII. and read angles there on two successive days, August 12 and 13. Forest fires by this time were raging in the mountainous districts, and the smoke therefrom was very dense, especially in the direction of Duncan river and the Arrow lakes.

I also established a station, No. XXII. A, in the valley of the north fork of Spillimacheen river, and marked the point with a wooden post and stone mound. This reference station should prove useful for commencing new surveys in this valley, there being no posts of the Dominion lands survey system in the vicinity. I also occupied and established the position of three of Mr. A. O. Wheeler's stations, viz.: XXII. B (Wheeler's Bald mountain cairn), XXII. C (Wheeler's Spillimacheen cairn), and XXII. D (Wheeler's Grand glacier station).

The return journey was made down Bald mountain to the Beaver valley and thence back to Bear Creek railway station, when a move was made to Flat Creek siding.

We ascended the trail up Flat creek some seven miles to the pass between that stream and Slick creek. Here we were laid up for several days with heavy rains, and when the weather cleared we took packs on our shoulders, went over Mt. Oliver, on the east side of the pass, and camped near the southerly base of Mt. Bonney. We then ascended to station XXV. (Mt. Bonney, elevation 10,200 feet) by the same route as in 1906. During the occupation of this station very cold winds prevailed, and the work was also retarded by smoke.

On moving to Six-mile Creek siding we ascended to timber line on the Esplanade range as in 1908, and camped at Sunbeam lake, at the head of Spinster creek. From this camp I occupied station XXX. (Cherub Mt.), station XXX. A (Cupola Mt.), Station XXX. B (Sentry Mt.), and station XXX. E.

We then returned to Six-mile Creek siding and moved to Beavermouth to visit station XXIII. Here we were delayed several days by bad weather. I connected station XXIII. with the Dominion system of surveys, by tying this station to the iron post marking the northeast corner of section 34, township 29, range 25, west of the fifth meridian.

At Beavermouth Mr. de la Condamine, who was assistant to Mr. T. H. Plunkett, D.L.S., this season, was transferred to my party to assist in the measuring of the Kootenay base with the invar apparatus. On completing the occupation of station XXIII. we moved to Golden on October 3, and there examined the base line apparatus. We then moved up the Columbia valley to the base to proceed with its measurement. This work occupied us from October 21 to November 8, a detailed account of the measurement and the use of the invar apparatus being given hereinafter. On account of only twenty-four metre wires being available for measuring purposes it was necessary to alter the position of one end of the base in order to make the line an integral number of twenty-four metre stretches. This alteration necessitated the reoccupation of stations A, C and D.

The mountain survey season of 1909 was moderately dry on the whole and the triangulation work was not retarded any more than usual by continuous rains. In the month of August, however, considerable delay was experienced from smoke. High winds prevailed during the entire season, which also interfered with the work and as well caused us great physical discomfort on the peaks.

During the latter half of June, in the vicinity of Columbia river, north of Revelstoke, we had rainy weather on eight days. In the month of July, in the Illecillewaet valleys, there were fifteen rainy days, fourteen fine and two cloudy. In August in the valleys of the Beaver and Incomappleux rivers there were nineteen fine days, ten rainy, and two cloudy, with dense smoke during the greater portion of the month. During September, in the vicinity of Beavermouth and Gold creeks, rain fell on eleven days, nine were fine and ten cloudy. In the upper Columbia valley the month of October was rather peculiar, nearly the entire month being cloudy in the day time, with rain at night. On the few fine days a dense fog filled the valley most of the day. On November 5 permanent snow fell in the Columbia valley.

THE MEASUREMENT OF KOOTENAY BASE WITH INVAR WIRES.

Kootenay base controls the complete network of the triangulation survey in the railway belt, British Columbia, from the summit of the main range of the Rocky mountains westward to the Cascade range. This base was laid out and its terminal points established in 1907, but no precise base measuring apparatus was available for its determination until 1909, when three twenty-four metre wires and the necessary auxiliary apparatus was finally received from the International Bureau of Weights and Measures.

The many parts of the apparatus were all repacked at Ottawa in strong trunks, specially designed, and the instrument shipped to British Columbia, where the measurements were taken in the month of October, after the climbing season had closed.

For the complete manual on the theory of invar and the description of the base line apparatus reference should be made to 'La Mesure Rapide des Bases Géodesiques' (4th edition) by J. René Benoit and Ch-Ed. Guillaume, of the International Bureau of Weights and Measures. It has been considered advisable, however, to give in connection with this report a brief discussion on the theory and peculiarities of that strange alloy of nickel and steel termed 'invar' together with a description of the salient features of the apparatus, and its application to the rapid and precise measurement of geodetic base lines.

In precise measuring the greatest source of error has always been the uncertainty in the temperature, and consequently of the length of the measuring unit; first because during changing temperatures the recording thermometers rarely measure the true temperature of the bar or tape, and secondly because the volumetric change in the metals generally lags behind the temperature change. The many compensating apparatus devised to obviate this source of error while theoretically perfect have been found faulty in practice and have been generally abandoned. Even such instruments as the Eimbeck Duplex apparatus and the U. S. Coast and Geodetic Survey Iced Bar apparatus have in recent years been replaced by steel tapes, which method has reached a high degree of perfection by taking great precautions for temperature changes, and making the measurements at night.

Some twenty years ago Mr. Edward Jaderin, of Stockholm, devised a most ingenious and exact method of measuring with steel and brass wires. He used wires twenty-five metres long stretched over portable tripods set in line. On the top of each tripod there was a fixed mark, and by means of a graduated scale at the forward end of his wire he measured the distance between successive tripods, the wire being kept at a constant tension with spring balances.

Several years ago M. Ch. Guillaume, Assistant Director of the International Bureau of Weights and Measures in making researches with alloys of nickel and steel discovered that an alloy of these two metals containing about thirty-six per cent of nickel possesses a very small coefficient of expansion and its use was immediately suggested for base measurement. To this alloy, which is made by a secret process, has been given the name 'invar' a word derived from the same root as the word 'invariable,' and having a similar meaning.

By the use of invar in the forming of wires, and the method of M. Jaderin somewhat modified and improved, we now have at our command a base measuring instrument capable of the same accuracy as the most refined bar apparatus, and at the same time much more convenient and economical. It has also many advantages over steel tapes in that the invar wires may be standardized at any Bureau of Standards instead of in the field, greater precision can be attained, the work may be done in daytime, and errors due to uncertain temperatures are almost entirely eliminated.

Properties and Manufacture of Invar.—Invar is more like nickel than steel in appearance. It is less easily oxidized, yet requires some care to keep it free from rust, especially in moist climates. This may be done by rubbing with a rag covered with vaseline, as the small spots of rust which sometimes appear on the surface do not adhere very closely, and may be easily removed in this manner. The alloy is very ductile, yet at the same time quite tenacious. It laminates and is made into wires very easily, but quickly wears out files and other hard tools. In the malleable state it will submit to great alterations in shape without rupture, while on the contrary, when it has been laminated or drawn into wires, it reaches a state of elasticity suitable for ordinary springs. The modulus of elasticity of invar in the form of cold-drawn and hammered wires is about 16,000 Kg.: mm^2, its tensile strength being about one-half of that of steel. One of the peculiar properties of invar is that its modulus of elasticity increases with an increase of temperature which is contrary to all other known metals.

Invar intended for geodetic purposes is made by certain steel manufactories in France, the usual additions of manganese, silicate, and carbon being reduced to a minimum. Specimens of each casting are then examined, and only those which possess the requisite small coefficient of expansion are accepted. These are then made into wires, being forged at very high temperatures, and cold-drawn and hammered at low temperatures. They are reduced to an average diameter of two millimetres by means of steel wire-machines, and then made to the definite diameter of 1.65 m.m. through ruby holes, which give a smooth surface and a uniform diameter.

Etuvage.—Invar wires so manufactured are, however, by no means ready for use, but must be carefully studied and examined in the laboratory. It has been observed that invar in the course of time shows a gradual permanent lengthening extending over a number of years, which lengthening approaches slowly towards a limit which seems definite. The value of this limit depends on the temperature and the progress is more rapid as the temperature is higher. This permanent lengthening is considerably minimized by a peculiar treatment of the alloy, termed 'étuvage.'

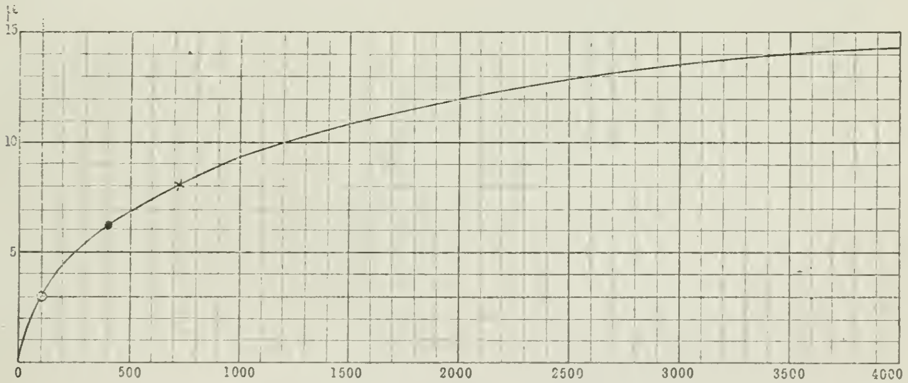

Fig. 1.

The wires are rolled on a spool-like cylindrical boiler of 50 c.m. diameter, forming a kind of drum. The boiler is filled with water, which is kept at boiling point (100° C) for several days. This temperature is then lowered gradually so as to reach 40° C or even 25° C in about three months, the alterations in temperature becoming slower as the temperature decreases. By submitting the wires to this process of 'étuvage,' they undergo the series of changes which would have taken a great number of years to accomplish at ordinary temperatures, and which changes will not now take place again. Even after the étuvage process is completed there is still for some time a gradual though small lengthening. This change is rather rapid at first, then becomes less and less and it is wise to keep the wires for some months before attempting to determine their absolute length.

The curve in Fig. 1 shows the gradual permanent lengthening, which takes place in the course of time, in an invar bar, one metre long, which has been treated by the étuvage operation, the temperature being reduced to 40° C, then at that of the laboratory (6° C to 22° C). The abscissae represent the number of days after étuvage and the ordinates the lengthening in microns per metre (a micron being the one-millionth part of a metre).

When the temperature of the étuvage is lowered to 25° C instead of 40° C, the origin of the curve is decreased by one hundred days and three microns, as shown by the dotted lines in the figure.

Record is kept of the dates of étuvage, and of the standardizing tests, and from the curve we can determine what alteration in length has taken place in the interim. When the wires are used for field measurements we must note the date and reckon the number of days since étuvage or test. By plotting off the correct distance along the abscissa the curve will show in microns per metre the gradual lengthening of the wire, and therefore we have the quantity which must be added to the value of the wire obtained in the standardization.

Invar wires Nos. 272 and 273, which belong to the casting, or coulée No. 1438, terminated their étuvage on February 15, 1908. Their equations of length were determined on December 15, 1908. The wires were used for measuring on October 21, 1909. Therefore by measuring off three hundred and ten days along the horizontal co-ordinate from the date of test, the curve shows an increase of 1·9 microns per metre over the length on December 15, 1908. Hence the length given in the certificate of the wires (q.v.) must be increased by 1·9 microns per metre, or 0·045 m.m. for twenty-four metres.

The corrections given by the curve ought to be considered at least for the first two years, only as an approximation to the millionth part.

Periodic and Daily Temperature Dilatation.—Although the expansion of invar due to temperature is very small, it is by no means negligible. When the temperature of invar is altered a change in length takes place. This change is of two kinds, termed daily and periodic, the first of which is by far the greater, and occurs simultaneously with the change in temperature. The periodic change, which is very small, follows the other slowly, and corresponds to the lag of other metals. When the new temperature is greater than the first, the periodic variation is a contraction and conversely. In order to apply this second correction for thermal variation we proceed as follows:—If we have an invar wire to be used in measuring a base line, we consider the mean temperature for the weeks which precede the measurements to be a temperature which is slowly reached, and the periodic variation will tend to approach the change corresponding to this mean temperature. The following formula of dilatation has been established by observations with the comparator:—

$$\Delta l = -0{\cdot}00325 \times 10^{-6} \times l\, t^2.$$

t being the temperature reckoned from zero.

The numerical coefficient of this formula is very small, consequently an error of five or six degrees does not affect the length of the wire one in a million.

To determine the periodic temperature dilatation of invar wires Nos. 272 and 273, which were used in the measurement of Kootenay base, the maximum and minimum temperatures of the wires were recorded each day for the fortnight preceding their use. The mean temperature for this period was 7° ·4 C, and is practically the same as the mean temperature of the wires during the measurements.

We therefore have from the above formula

$$\Delta\, l = 0{\cdot}00325 \times 10^{-6} \times (7{\cdot}4^2 - 15^2)\ 24^{m} = t\ 0{\cdot}^{mm}0133.$$

This quantity may be added once for all to the value of the wires for the measurements under consideration.

Daily Temperature Dilatation:—The ordinary changes in the temperature recorded during the actual measurements determine the daily thermal corrections, which are applied from the regular coefficient of expansion. For wires Nos. 272 and 273 this formula for the range of ordinary temperature is

$$\Delta\, l = (-0{\cdot}228 - 0{\cdot}00040\ t\ )\ 10^{-6}\ t\, l$$

and when expanded in a table for each degree from 0° C to say 30° C, gives the correction to be applied to the length of the wire for each recorded temperature.

The above formula is not the formula of absolute expansion but is the dilatation of the wires when under a tension of ten kgs. The elastic deformations decrease as the temperature increases, therefore this expansion of invar is slightly less than the free or absolute dilatation. It should be noted that this formula is negative, as the lengths of the wires decrease as the temperature rises.

Mechanical Treatment of Wires to assure permanence in length:—As geodetic wires must necessarily be rolled for transportation, it is important to note what effect the continual rolling and unrolling might have on the length of the wires. Numerous

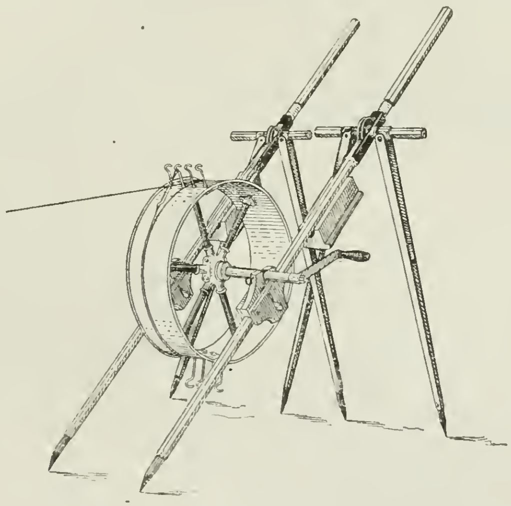

Fig. 2.

observations have shown that an invar wire, cold drawn and hammered, may be rolled in a diameter of fifty c.m. without suffering any alteration in length. Each wire before it leaves the Bureau is submitted to numerous rollings and unrollings for an extended period of time, and observations are made upon its length before and after until permanence is assured. Great care must be exercised that no portion of a wire shall be rolled in a diameter of less than fifty c.m., lest a degree of instability may be caused which will produce permanent changes of which the wire can rid itself only very slowly.

The wires for transportation are rolled on an aluminum drum of fifty c.m. diameter as shown in figure 2. The six spokes of the drum are of steel; the outer rim is of aluminum, is about sixteen c.m. wide, and will hold four twenty-four-metre wires. The ends of the wires are fixed to two pairs of hooks fastened to the rim of the drum so that the end scales are tangential to the circumference. For winding and unwinding, the drum is fixed to a steel axle with a handle, and the whole is attached to the two tension tripods placed side by side. When not in use the drum and wires are kept in a specially designed trunk. The wires should be rolled rather loosely on the drum so as to avoid dangerous tensions due to the difference in expansion of the drum and wires. When the wires were reeled and put away after the measurement of the Kootenay base, the temperature of the air was about 3° C. Consequently the drum was heated to about 20° to avoid subsequent excessive expansion.

The wires are also treated by another mechanical process, being a system of rythmic beating on the floor, which operation tends to produce a condition of stable equilibrium in the particles of the alloy and prevents unknown alterations in length from accidental disturbances such as might occur during long railway journeys and other rough usage.

Wires which are used under constant tension of say ten kg. are also tested by excessive tensions for long and short periods of time, and any danger of accidental lengthening from sudden shocks or prolonged forces thereby removed.

Standardizing Tests.—When the wires have been treated by the operations described above, and mounted at their extremities by graduated scales they are then ready for comparison to determine their absolute lengths. The graduated invar scales are of a special design which is very ingenious.

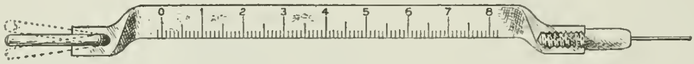

Fig. 3.

Figure 3 shows one of these scales, the graduated edge being hollowed so as to be in a direct line with the neutral axis of the wire. This form does away with errors in reading due to the terminal tangent to the curved wire not coinciding with the straight line joining the two extremities.

The standardization of the wires is made at the International Bureau, by exhaustive comparisons with the underground mural base, the wires being under conditions exactly similar to those under which they are used in field work.

The following certificate accompanied the wires received from the International Bureau of Weights and Measures by the Surveyor General of Dominion Lands.

Bureau international des poids et mesures.

Pavillon de Breteuil, Sèvres (S.-et-O.)
Le 15 janvier 1909.

Certificat de deux fils en invar nos 272, 273, construits par M. J. Carpentier, à Paris, appartenant à la Direction générale du Cadastre du Gouvernement du Canada.

Description.—Les fils, de 1,7mm de diamètre environ, portent, fixées aux deux extrémités, des réglettes en invar auxquelles ils sont reliés par l'intermédiaire d'un appendice goupillé dans lequel ils sont vissés et rivés.

Chacune des réglettes porte une division en millimètres, sur une longueur de 82mm. chiffrée en centimètres de 0 à 8, la chiffraison progressant dans le même sens à chaque extrémité. Les traits de la division aboutissent à une arête faisant suite à l'axe du fil. L'une des réglettes porte, gravée sur la face dorsale, l'inscription: J. Carpentier, Paris, et, chacune d'elles, sur la face divisée, respectivement les numéros 272 et 273.

Etude.—Les fils ont été soumis d'abord à une série d'opérations de nature à assurer la permanence de leur longueur. Puis ils ont été comparés, sous la tension de 10 kg. à la base murale du bureau. Il a été fait dix séries de comparaisons effectuées du 5 novembre 1908 au 4 janvier 1909.

Les comparaisons ont été ramenées à la température moyenne de 15° à l'aide de la formule de dilatation;

$$l_t = l_0(1-0.000000228t-0.0000000000040t^2)$$

déterminée sur un échantillon du même fil, soumis à la même tension de 10 kg.

On a trouvé pour la distance des traits homologues des réglettes, les valeurs suivantes:—

Valeur du fil à 15° sous une tention de 10 kg.
N° 272=24 m. + 1.05 mm.
N° 273=24 m. + 0.82 mm.

La détermination de la dilatation du fil a été faite par M. Ch. Ed. Guillaume, directeur-adjoint du Bureau International des Poids et Mesures; les comparaisons ont été effectuées par MM. Ch. Ed. Guillaume, L. Maudet et A. Carrade.

LE DIRECTEUR DU BUREAU.
(Signé) René Benoit.

The values of the wires as given by the above certificate must be modified slightly to obtain the absolute values for the measurement of the Kootenay base.

According to the certificate,
Wire No. 272=24001·05 mm.
Wire No. 273=24000·82 mm.
at the temperature 15° C, under a tension of ten kg., on December 15, 1908.

To these values must be added the small increment + 0.0456 mm. for the ' permanent elongation due to time,' as explained above. Also the quantity + 0·0133 mm. for ' periodic temperature dilatation ", determined above.

Consequently we have
Wire No. 272=24001·11 mm.
Wire No. 273=24000·88 mm.
at 15° C, under a tension of ten kg., on October 21, 1909.

These are the absolute values used in the measurements of the Kootenay base.

Principle of measuring.—The general principle followed in measuring is to find the number of times that a standard measure of length may be laid off along the line to be determined, marking the consecutive lengths as accurately as possible. The principle adopted by the International Bureau for measuring with invar wires, is the converse method, or in other words, to lay down courses having a certain approximate length, then to measure accurately the length of these courses. This latter method is obviously the more precise.

The apparatus used is a modification of that of M. Jäderin, and consists of twenty-four metre invar wires, having graduated end scales, a series of moveable tripods, clinometer accessories for reading the slopes of successive courses, and thermometers for recording temperature, besides such auxiliary instruments as pickets, level, levelling rods, aligning telescopes, plum-bobs, &c.

Moveable Tripods.—Figure 4 shows a moveable tripod, the wooden frame A, having in its top a circular opening through which passes a smaller cylindrical metallic tube, B, which is capable of a lateral displacement of several centimetres and may be fastened tightly to the wooden head by a thumb screw, C. The upper plate, D, bears three levelling screws held to the levelling plate by three springs. The datum mark, E, is also capable of a lateral motion by three horizontal screws, and carries a small level on its plate. The top of the datum mark is composed of a hard white alloy which will not oxidize. The cross forming the datum mark is of an ingenious design, having a bevelled edge, cut at the same angle as a cross-section of the end scales, and permits the graduations to coincide with the horizontal plane of the datum mark. A

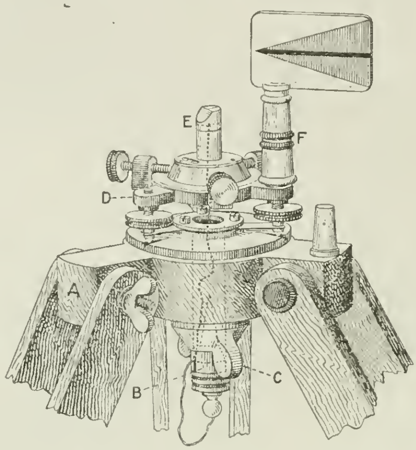

Fig. 4.

plumb-bob, when not in use, screws into the tube, B, as in the figure, and the string passes through the hollow tube to a point directly under the cross of the datum mark. By means of this plumb-bob a definite point on the ground can be quickly and accurately transferred to the moveable datum mark. In the measurements of the Kootenay, base, however, the transference was generally made by transit instrument.

The tripods, of which from six to eight are used, are set in position at approximately twenty-four metres apart, the alignment being made by small telescopes expressly intended for that purpose, or if hubs and tacks are set beforehand, the tripods can be fixed by means of the plumb-bobs.

A target, F, is placed on a vertical gudgeon beside the datum mark. On it readings of the slope are made with a small level, hereinafter described. The flag is coated with white enamel, and in the apparatus supplied by the International Bureau, the mark to be read upon was a horizontal black line six mm. wide. An improvement was made to these targets by painting a red triangle as in the figure. A better bisection can be made on the apex of the angle, and the red colour assists greatly in rapid and precise reading.

Slope.—The difference in slope between successive tripods is measured by means of a small level shown in figure 5. The level replaces the flag on the upright gudgeon, the centre of the telescope being at the same height as the apex of the red target. At the focus of the object glass for a distance of twenty-four metres is a photographic scale etched on glass, the graduations being so spaced that one division covers twenty-four mm. at a distance of twenty-four metres, that is, reads a slope of one-tenth of one per cent, or ·001 in terms of the tangent. Readings are estimated to one-tenth of a division, or ·0001. Forward and backward readings are taken at each portée, or course, thus eliminating error of collimation.

On the Kootenay base, slopes up to five per cent were read directly on the flags of the moveable tripods. Greater slopes than five per cent were measured with the assistance of a long auxiliary rod, which when reading an ascending, or positive grade, was hung on the forward tripod with its flag close to the ground. By means of this rod the readings of the slope were reduced three per cent, and only the aplanatic part of the lens used. In reading negative, or down grades, the auxiliary rod was placed above the low tripod, and the readings thus reduced five per cent. Wherever several slopes greater than five per cent were encountered, the heights of the end tripods above the hubs were measured with a tape, and by means of auxiliary levels with a transit the relative heights of the hubs were determined. The intermediate slopes read with the level were thus checked, and a close approximation obtained.

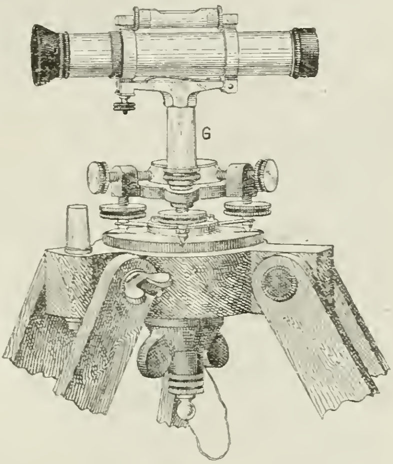

Fig. 5.

The level constants of the photographic scale were determined by sighting on a vertical rod placed at twenty-four metres. Red triangles were spaced at correct distances and the graduation errors read directly from the telescope. Numerous readings were taken under different weather conditions to allow for irregularity of light and refraction. The following corrections were obtained; they are all negative, that is, the slope read by the level is in each case to be decreased numerically by the quantities shown in the following table. The corrections for positive and negative divisions have been combined. Intermediate corrections may be determined by simple interpolation.

Level Constants.

Tangent.	Correction.
·005	0
·01	·00005
·015	·0001
·02	·00015
·025	·00015
·03	·0002
·035	·00025
·04	·0003
·045	·0004
·05	·00045
·055	·00052
·06	·00055
·065	·0006
·07	·00065
·075	·0007

The correction for slope is made up of two parts. One is dependent on the horizontal projection of the straight line joining the tops of the tripods; that is, l (1—cos. [illegible]). This correction is given in table IV. in terms of tangent [illegible] for a slant length of twenty-four m. The table has been elaborately constructed up to ten per cent and may be quickly applied. In the last column of the table is also given the value of l (1— [illegible]) for a length of one metre. When the distance between two successive tripods differs from twenty-four m. by an appreciable amount, such as from ten to fifty mm., the correction for slope as applied directly from table IV. must itself be modified by the small correction for the said excess or deficiency.

The second correction for slope (table V.) is due to the fact that when the ends of the wire are not at the same level the curve ceases to be symmetrical, or a true catenary. The correction for this deformation in the curve is a function of the slope and although very small, cannot be neglected as it is always in the same sense, that is, positive.

Tables IV. and V. are to be found in the appendix of 'La Mesure Rapide des Bases Géodésiques,' fourth edition.

In the first chapter of the same book may be found an exhaustive mathematical discussion on the theory of measuring with a stretched wire, with the alterations which take place in the catenary when the tension is changed by even a small amount, either by friction or by changes in terrestrial gravity.

The difference between the effects of terrestrial gravity at Sèvres, France, where the wires were standardized (latitude, 48°, 50′N.; elevation, 184 feet) and at the Kootenay base (latitude 51°, 04′ N.; elevation, 2,700 feet) is so small that the resulting change in tension of the ten kilogramme weight does not effect an appreciable alteration in the length of the wires.

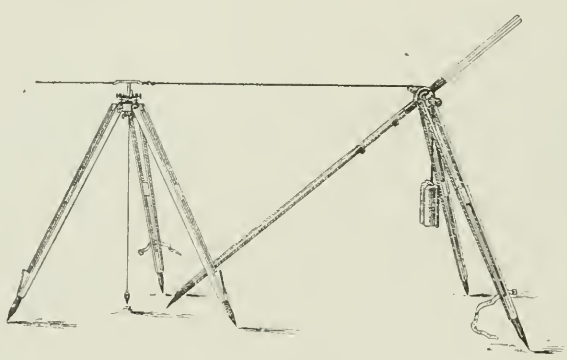

Fig. 6.

Tension Tripods.—The wires are stretched for measuring by submitting them to a constant tension of ten kg., which is applied by means of weights suspended and hanging freely from window-sash cord passing over ball-bearing pulleys. The pulleys are supported by tension tripods as shown in figure 6. During the measurements each tension tripod is placed in position by a man carefully drilled, and should be in the direct line of the base, and at such height that the graduated scale comes to within two or three millimetres of the datum mark. The ring at the end of the wire is attached to the tension cord by means of a hook and a snap and swivel.

Readings on the wire.—An observer at each end of the wire reads the position of the datum mark on the graduated scale, pressing the latter with a gentle lateral motion against the datum mark. The scales are graduated in millimetres and readings are estimated to tenths. At least five readings are made at each end for every portée. The two scales are graduated in the same direction so that the reading at one end is always positive, and at the other is negative. The difference between the two readings gives the excess or deficiency from the true value of the wire. The readings in a set should rarely differ by more than 0·2 mm., a discrepancy greater than 0·3 mm. denoting an error in reading. In such a case the recorder orders extra readings to be made. Every so often the wires are reversed in direction end for end, or the observers interchange their positions, in order to eliminate personal equation, the observer at the positive end then making negative readings, and *vice versa.* At each portée the readings are made on different portions of the scale, one observer alternately shoving and pulling the wire, gently, but firmly, thus eliminating tensional friction in the pulleys or other accidental sources of error.

A tabulated form is used for all records and computations at each portée, a specimen page of which is here shown.

Triangulation Base Measurement—Invar Apparatus—Records and Computations.

Portée No. 278.
Recorder, Carson. Date, Nov. 2, '09.
Observers. { Rear (+), Carson. Time, 10.30 A.M.
{ Front (—), de la Condamine. Direction, Southerly.
Weather, Calm, Cloudy.

Readings.							Slope (Tangent).		Temperature.
Wire No. 272.				Wire No. 273.			Forward.	Back.	°C 7·2 7·8
No.	Rear (+)	Front (−)	R—F	Rear (+)	Front (−)	R—F	+ 0406 0406	− 0407 − 0407	Mean......... 7·5
			m.m.			m.m.	Mean =	+04065	m.m.
1	42·0	21·3	+ 20·7	39·6	18·7	+ 20·9	Level Corr. =	0003	Correction (Table III) +0·042
2	59·0	38·4	20·6	46·4	25·6	20·8			
3	36·7	16·0	20·7	62·8	41·8	21·0		+04035	
4	50·9	30·2	20 7	46·0	25·1	20·9			
5	32·8	12·1	20·7	58·3	37·4	20·9		m.m.	
							Corr. Table IV	− 19·465	
								− ·048	
								19·513	
								− ·016	
								19·529	
							Corr. Table V	+ ·005	
	Mean.........		+ 20·68	Mean......		+ 20 90	Total Corr. (−)	19·524	

—	Wire No. 272.	Wire No. 273.
	mm.	mm.
Value of wire at 15°C..	24001·11	24000·88
Correction to 7°.5..	+ 0·042	+ 0·042
Sum..	24001·152	24000·922
Readings..	+ 20·68	+ 20·90
Sum..	24021·832	24021·822
Correction for Slope..	− 19·524	− 19·524
Value of Portee..	24002·308	24002·298

Balance sheets of the computations on groups of twenty portées greatly facilitate the final calculations and summations. A specimen page of one of these balance sheets is here given.

Triangulation Base Measurement—Invar Apparatus—Resume of Computations.

Value of wire No. 272 at 15° C on October 21, 1909=24001·11^{mm}. Section V (southerly).

No. of Portee.	Temp.	Corr. for Temp.		Readings.		Slope.		Value of Portée.
		+	—	+	—	Tangent.	Correction (—)	
	°	mm.	mm.	mm.	mm.		mm.	mm.
224	6·0	0·051			26·45	+·0276	9·125	23965·586
225	6·0	0·051			1·85	+·01955	4·584	23994·727
226	6·1	0·051			3·84	+·03745	16·806	23980·515
227	6·4	0·049		19·35		+·04693	26·400	23994·109
228	6·4	0·049			10·32	+·0385	17·755	23973·084
229	6·4	0·049			13·74	+·0366	16·046	23971·373
230	6·6	0·047			23·68	—·0184	4·058	23973·419
231	6·6	0·047		12·84		—·0175	3·674	24010·323
232	6·8	0·046		29·35		—·0407	19·872	24010·634
233	7·0	0·045		3·70		—·0379	17·216	23987·639
234	7·0	0·045		1·02		—·04698	26·434	23975·741
235	7·3	0·044			11·32	—·03635	15·830	23974·004
236	7·4	0·043			5·92	—·03055	11·186	23984·047
237	7·5	0·043		22·66		+·0082	0·807	24023·006
238	7·4	0·043			21·67	+·0103	1·273	23978·210
239	7·2	0·044			57·80	+·02145	5·507	23937·847
240	7·0	0·045		10·82		+·02455	7·231	24004·744
241	7·4	0·043			23·86	+·04275	21·877	23955·416
242	7·4	0·043			8·16	+·0009	0·010	23992·983
243	7·5	0·042			3·64	—·0036	0·156	23997·356
	Mean Temp...			99·74	212·25			
	6·9	+0.920			—112·51		—225·847	479684·769

The correction for the mean temperature at the bottom of column 2, multiplied by twenty (the number of portées) should be very nearly equal to the total temperature correction shown in column 3.

Twenty times the value of the wire at 15° C ± the total temperature correction ± total readings, minus the total correction for slope should be equal to the total sum of all the portées.

KOOTENAY BASE.

Kootenay base lies in townships 19, ranges 19 and 20, west of the fifth meridian, on the right or easterly side of Columbia river, British Columbia, about twenty-one miles southeasterly from the town of Golden.

By means of three secondary stations the base is projected to the main triangulation, connecting with primary stations 17, 20 and 21, the simplicity and rigidity of the projection being almost ideal.

The approximate mean longitude of the base is 116° 39′ W; the mean latitude is 51° 04′ N approximately; the mean elevation is 823 metres above sea-level; the mean bearing is 309° 08′.

The length of the base, reduced to sea-level, is 8565-56958 metres.

Station A, marking the southerly end of the base, is 14·62 chains west, and 0·50 chains north of the wooden post marking the quarter section corner on the east boundary of section 16, township 24, range 19.

Station B, marking the northerly end of the base is 20·53 chains west and 12·28 chains south of the iron post and mound marking the northeast corner of section 35, township 24, range 20.

The end of the base, or geodetic point, at station A is the intersection of a pair of fine lines at right angles to each other, stamped in the head of a brass bolt six inches long and three-quarters of an inch in diameter with a flat head one and one-half inches square. This bolt is set in concrete three feet beneath the surface of the ground and is covered with loose earth. The head of the bolt also bears the letter A stamped upon it. There is no surface mark, except four iron reference bolts fifteen inches long and one inch in diameter which bear north, east, south and west respectively from the geodetic point, and are each distant three feet from it. A plot of ground one chain square has been fenced in around the end of the base and reserved for triangulation purposes.

Station B is similarly marked except that the bolt bears the letter B stamped upon its head.

The base line skirts the westerly edge of the Beaverfoot range of mountains close to the bottom lands of Columbia valley. It crosses the Government wagon road no less than ten times, and also intersects the surveyed line of the projected Kootenay Central railway at several points. The base runs mostly through uncleared land covered with second-growth poplar and birch, crossing also several cultivated fields, and through occasional patches of spruce and fir averaging eighteen inches. The line was cleared of all timber, grass and brush for a width of six feet, large stumps being

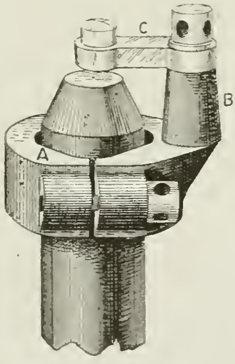

Fig. 7.

sawn off level with the ground. Beginning at the northerly end of the base, hubs twenty-four metres apart were set with a standard chain supplied by the makers of the base apparatus. This chain which is composed of twisted wire strands, was found to be unsatisfactory, as its lenghts varied considerably with the temperature. The chain also soon became twisted and kinked with repeated windings and unwindings on the reel; and when the measurements were afterwards made with the invar wires the distance between some of the hubs differed from twenty-four metres by as much as fifty mm. Tacks were placed in the hubs, the alignment being made with an ordinary four-inch transit. A forward line was run, sighting being made on the signal at station A, hence the errors of alignment were very small. The hubs were set along the whole length of the line and the southerly end of the base as previously established was changed and set at an integral number of twenty-four-metre stretches. This change was necessary as only twenty-four-metre wires were available for measuring, although with auxiliary wires of say four and eight metres any short distance can be conveniently determined.

The base was divided into six sections by means of controlling bench marks supplied with the apparatus. A cut of one of these datum marks is shown in figure 7. It consists of a round iron peg, pointed at one end, about eighteen inches long and one and one-half inches in diameter, which may be driven firmly into the ground. The collar A, which is fastened near the top of the peg by capstan screws, has a vertical gudgeon B, which again bears a revolving horizontal arm C. The end of this arm carries a small cross which serves as the datum mark. By the double motion of the two sets of screws this cross can be set very accurately on line, and within several millimetres of the desired longitudinal distance. It is not necessary to fix the datum mark accurately for distance, as, once it is in place, the distance to and from it is measured by setting a tripod accurately over it.

By dividing the base line into sections in this manner, six closing checks on the measurements were obtained, each section being considered separately In determining the probable error of the adopted length of the whole base the probable errors of each section line were combined. The base was divided according to the configuration of the ground, each section being about the length covered in a day's work.

The base was measured in a northerly direction with a single wire, Nos. 272 and 273 being used alternately. A complete double measurement was also made in a southerly direction using both wires. The method of using two wires is somewhat slower, but serves to check the relative lengths of the wires, mistakes in reading and other sources of error.

The weather during the measurements was exceptionally suitable for this work. The days were mostly cloudy, with rain at night. The range of temperatures on some days was only about five degrees, from 3°C to 8°C, with both rising and falling temperatures. On three days the weather was clear and the temperature rose from 3°C to 20°C, falling again to 7°C in the afternoon. Calm weather prevailed with occasional light winds, but not of sufficient freshness to disturb the wires. On two days rain fell during the measuring, but it is not thought that the sag of the wires was appreciably increased by the weight of the clinging rain-drops.

The small difference between the lengths of the base as measured by wire No. 272 and wire No. 273 simultaneously is perhaps due to a very small discrepancy between the relative lengths of the wires, combined with a probable error due to erroneous readings. The persistency of this small discrepancy always in the same sense seemed to indicate that the wires differed in length by only 0·21 mm. instead of 0·23 mm. as given by the certificate. Following this indication a cursory examination of the wires was made. A portée was set up under as favourable conditions as possible, and one hundred readings were made on each wire. While this was by no means an accurate comparison, it was very accordant with the other evidence, and the mean of the two wires has been used for the final length of the base. This discrepancy of 0·012 mm. in twenty-four metres, or four mm. in the whole base of 8·5 km. indicates a probable error of only one in two million.

The distribution of the staff of seven engaged in the measurements was as follows: one man setting tripods over the hubs, one porter carrying tripods from rear to front, one man at each of the two tension tripods, two observers, one of whom acted also as recorder and leveller, and one porter carrying an end of the wires in lieu of the observer who performed the levelling. The work would have been materially expedited had a competent man been available to take the levels, this duty falling on one of the observers whose manifold duties retarded progress. Before commencing the measuring the party was drilled with a practice wire until all became thoroughly familiar with the work, and acted together as a team with preconcerted signals. Before the completion of the base a speed of four hundred metres per hour was attained, when using one wire, which is indeed satisfactory, considering the nature of the ground on a base line in the Rocky mountains.

Results of Measurements.—The results of the measurements of the Kootenay base have been tabulated in the appended table. The mean of the double wire measurement for each section has been combined with the length obtained with a single wire, giving equal weights, although the double wire method might lay claim to a slightly greater value. The probable errors of each section due to measurements have been combined to obtain the probable error of the whole base due to measurements, each section being given a weight corresponding to the number of portées it contains. This probable error due to measurements together with the probable error of the wires give a probable error for the adopted length of the base of 4·5 mm. in 8·5 km., or one in 1,900,000.

The length of the base has been reduced to sea-level, the correction being a function of the measured length, the elevation above the sea, the latitude, and the bearing. The correction for this base is 1·1043 meters. (See tabulated statement on page 70.)

I have the honour to be, sir,

Your obedient servant,

P. A. CARSON, D.L.S.

TABULATION OF MEASUREMENTS OF KOOTENAY BASE.

Section.	Portées.	No. of Portées.	Direction of Measurement.	Date.	Temperature Range.	Mean Temperature.	Weather.	Wire Number.	Observed Measurement.	Correction to wire, mm. No. 272 = −0·012; No. 273 = +0·012	Corrected Measurement.	Difference.	Mean.	—
				1909.	°	°			mm.	mm.	mm.	mm.	mm.	mm.
I....	1–60	60	N. S. S.	Oct. 21.. Oct. 22..	3 to 20 to 7 7 to 14 to 5	12 10	Calm, cloudy to fair. Calm, cloudy. Occasional breezes.	272 272 273	1,441,008·006 1,441,006·115 1,441,005·666	−0·720 Mean.	1,441,007·286 1,441,005·890	1·396	1,441,006·588	±0·698
II....	61–109	49	N. S. S.	Oct. 23.. Oct. 25..	3·4 to 7·5 2 to 13 to 7	6 9	Calm, cloudy, rain. Calm, cloudy to fair.	272 272 273	1,176,325·233 1,176,323·980 1,176,322·080	−0·588 Mean.	1,176,324·645 1,176,323·030	1·615	1,176,323·837	±0·807
III...	110–181	72	N. S. S.	Oct. 26–7 Oct. 26–8	3 to 20 to 14 6 to 12 to 0	12 7·5	Calm cloudy, light wind, fair. Calm, cloudy. Calm, foggy.	273 272 273	1,728,533·381 1,728,538·689 1,728,536·729	+0·864 Mean.	1,728,534·245 1,728,537·709	3·464	1,728,535·977	±1·732
IV...	182–223	42	N. S. S.	Oct. 29.. Oct. 30..	9 to 20 to 9 6 to 11 to 3	13 7·4	Calm, cloudy to fair. Calm, cloudy. Occasional breezes.	273 272 273	1,007,435·637 1,007,438·340 1,007,437·430	+0·504 Mean.	1,007,436·141 1,007,437·885	1·744	1,007,437·013	±0·872
V....	224–282	59	N. S. S.	Nov. 1.. Nov. 2..	3 to 7 to 4 6 to 8 to 6	6 7	Calm, cloudy. Calm, cloudy. Occasional showers.	272 272 273	1,414,994·519 1,414,995·192 1,414,993·762	−0·708 Mean.	1,414,993·811 1,414,994·477	0·666	1,414,994·144	±0·333
VI...	283–357	75	N. S. S.	Nov. 3.. Nov. 4.. Nov. 6..	5 to 10 to 5 5 to 15 to 2	7 7	Calm, cloudy. Calm, cloudy to fair.	273 272 273	1,798,375·976 1,798,376·625 1,798,374·915	+0·900 Mean.	1,798,376·876 1,798,375·770	1·106	1,798,376·323	±0·553

Total number of Portées = 357.

Length of Base (measured N.)..... 8,566,673·004
Length of Base (measured S.)..... 8,566,674·761

Mean.............. 8,566,673·882

Total length..... 8,566,673·882 ±4·5 mm.
−1,104·3 (correction to ocean level).
8,565,569·58

$$\text{Probable error due to measurement} = \sqrt{\frac{357}{6}\left(\frac{0\cdot698^2}{60}+\frac{0\cdot807^2}{49}+\frac{1\cdot732^2}{72}+\frac{0\cdot872^2}{42}+\frac{0\cdot333^2}{59}+\frac{0\cdot553^2}{75}\right)} = \pm 1\cdot 6 \text{ mm.}$$

Probable error of wires = ±4·2 mm. (or 0·012 mm. per 24 metres).

Probable error of adopted value of Base line = ±4·5 mm., or $\frac{1}{1,900,000}$

APPENDIX NO. 14.

EXTRACTS FROM THE REPORT OF W. CHRISTIE, D.L.S.

SURVEY OF THE FIFTEENTH BASE LINE WEST OF THE THIRD MERIDIAN.

On April 5, we left Onion Lake and travelled north by a winter road used by the settlers for hauling wood. This road followed close to the fourth meridian for a distance of about five miles, where it ended. From here we followed a chain of small lakes lying west of the meridian to a point in section 25, township 56, range 1, west of the fourth meridian. From this point we cut a road through the woods to the northeast corner of township 56, which was the starting point of my survey. We arrived there on April 6.

On the 7th I retraced the east boundary of section 36, township 56, range 1, west of the fourth meridian, and commenced the survey of the base line.

From this date the work was prosecuted as vigorously as possible until October 9, when the line was completed to the third meridian.

Having been informed by your letter of March 29, that contracts had already been given for the subdivision of townships 54, 55 and 56, ranges 23, 24, 25, 26 and 27, west of the third meridian, I did not explore the country to the south of the line in the first three ranges, as the surveyor making the subdivision will doubtless furnish a complete description of this part of the country.

A wagon road leading from Onion Lake settlement to Ministikwan lake crosses the line in section 34, township 56, range 26. This lake is situated about the north boundary of township 58, range 25.

Horsehead creek, which comes from the southeast, crosses the line in section 35, range 21, and flows north. Rabbit creek crosses the northeast corner of township 56, range 20, and flows approximately straight north across townships 57 and 58. Along the banks of both these streams are some excellent hay meadows.

The road from Battleford to Meadow lake crosses the line in section 34, township 56, range 20, running in a northeasterly and southwesterly direction. Another trail branches off this road south of Horsehead creek and runs northwest crossing the line in section 35, range 21. This latter trail goes to Makwa lake, which is reported to be about twelve miles north of the line. Along this line are some small patches of prairie.

Rabbit creek flows west across townships 56, ranges 18 and 19, and a number of small creeks tributaries of Rabbit creek, flow northwest across townships 57, ranges 18 and 19. A new road from Battleford to Meadow lake crosses the line in section 36, range 17 and Chitek river crosses in section 36, range 13. This stream is about sixty-six feet in width and has an average depth of about three feet. It flows into Meadow lake, not into Green lake as is indicated by the maps. A tributary of Chitek river, which has its source in the large swamps in townships 55, ranges 16 and 17, flows northeast, crossing the line in section 33, range 15. Along the banks of this stream are some excellent hay meadows. The south end of Green lake is in township 58, range 12, around the south end of which the country is low and swampy.

East of the Green lake road, lying in a northwesterly and southeasterly direction, is a ridge of sand hills which rise about a hundred feet above the adjacent country. These hills are covered with brule and small birch, poplar and jackpine.

A number of small lakes occur in townships 55 and 56, range 12, and Cowan lake is crossed by the line in section 34, range 8. Several large timber berths have been located in this vicinity, and they are held by the Big River Lumber company.

Cowan lake is about thirty-five miles long by about a quarter of a mile in width. It lies in a northwesterly and southeasterly direction, the south end being in section 7, township 56, range 7. It is a shallow muddy lake and we crossed it by means of a raft, rafting horses and all across, as it was too shallow for horses to swim and too muddy to ford.

Big river empties into the south end of Cowan lake, at the mouth of which the Big River Lumber company are building a large sawmill to handle the timber held by them in the vicinity. The Canadian Northern Railway company are building a branch line to this point.

Between Cowan lake and DeLaronde lake, which the line crosses in sections 35 and 36, range 7, the surface along the line is gently rolling and is covered chiefly with old brule and small poplar, with scattered clumps of larger poplar and spruce. Around the north end of this lake are some quite extensive hay meadows.

DeLaronde lake is about thirty miles long and has an average width in the vicinity of the line of about one and one-quarter miles. It lies about due north and south and extends about two and one-half miles south of the line. Whitefish and jackfish are quite plentiful in this lake, and fishing is carried on to some extent during the winter months. This industry will no doubt be much more important in the near future, not only in DeLaronde lake but in the other large lakes to the north, with the transportation facilities afforded by the branch of the Canadian Northern railway being built to the south end of Cowan lake.

Waskesiu lake, which is about fifteen miles long and varies in width from half a mile to about four miles, lies to the north of the line in a northwesterly and southeasterly direction, in ranges 1, 2 and 3, the east end being in township 57, range 1 and the west end in township 58, range 3. A lake which is almost round and about five miles in diameter, lies north of the west end of Waskesiu lake, in townships 58 and 59, range 3.

Waskesiu river flows from Waskesiu lake to Montreal lake and Little Red river which flows into Saskatchewan river at Prince Albert has its source in the southeast corner of township 56, range 2.

The road from Prince Albert to Montreal lake passes through townships 55 and 56, range 1, running approximately straight north. It crosses the base line in section 32, township 56, range 1, and crosses township 57, range 1, in a northeasterly direction. A road branches off the main road in section 32, township 56, range 1, at what is locally known as 'the forks' and goes to Waskesiu lake. During the winter months a stopping place is kept at 'the forks.' It was abandoned at the time of the survey (October). Whitefish are plentiful in both Waskesiu lake and the lake in townships 58 and 59, and fishing is carried on to some extent during the winter.

On October 9 the line was completed to the third meridian. The surplus chainage was twelve chains and fifty-four links, and the line struck four chains and twenty-seven links north of the northeast corner of township 56, range 1, as established by the survey of the third meridian. On October 11 we started for Prince Albert, arriving there on the 15th.

As there was nothing in our records to account for the large error in longitude in closing on the third meridian, you instructed me on November 26 to re-chain the base line from the third meridian. I, therefore, organized a small party and left Prince Albert on December 21.

I began the chainage at the third meridian on December 27. As the snow was very deep the progress which we were able to make was much slower than I had anticipated. However, the work was carried on as vigorously as possible, and on February 15 the chainage was completed to the fourth meridian. No error in the original chainage was found, and the difference on the one hundred and sixty-three miles between the re-chainage and the check chainage on the original survey was one chain and sixty-eight links.

APPENDIX No. 15.

EXTRACTS FROM THE REPORT OF W. J. DEANS, D.L.S.

SURVEYS IN WESTERN MANITOBA.

On June 1, I left Brandon in company with one man to carry out your instructions in reference to a correction survey required in township 24, range 30, west of the principal meridian. While at work in this township I noticed that the Canadian Northern railway were extending their Rossburn branch westerly to connect with the main line. The building of this railway will be a great benefit to the settlers who have waited long and patiently, and now that their hopes have been realized they will be encouraged to go more extensively into grain growing, for which this district is well adapted. On June 2 I completed the work in this township.

On June 9, having completed the organization of my party, I left Brandon for Glenella. Glenella is a prosperous village situated in a good agricultural district; it contains three general stores and two elevators, all of which appear to be doing a large trade. The stores are generally busy with customers, representing many European nations, seemingly happy and contented and all enthusiastic with the prospects. Few pessimists are to be found in these cosmopolitan crowds. On June 11 I left Glenella for township 20, range 12, which was originally subdivided in 1874. At the time of the original subdivision, the township was covered with a thick growth of brush and scrub, and although the lines may have been well cut out in the first survey the settlers were unable to find the lines or monuments. It was, therefore, necessary before the settlers could undertake any extensive improvements that they should know the exact position of their boundaries.

Most of the monuments to the west of Mary lake were lost; in many cases not a trace could be found of the original survey. The monuments in the easterly part of the township were mostly in existence and in a good state of preservation, except those along the east outline, which had to be reestablished. The monuments along the north boundary of the township were nearly all lost or badly obliterated.

One settler who had a homestead entry for the northwest quarter of section 28 had a newly erected house and about six acres of crop on the northeast quarter of the section. I think, in a case of this kind where a settler unintentionally makes improvements on the wrong quarter, he should be compensated by the party acquiring the improvements. This man explained to me that he had done his best to locate his land; he had even employed another Galician who had achieved quite a reputation as a surveyor, paying him three dollars a day, to locate his quarter, and now to be told he was on the wrong quarter, without any prospect of obtaining compensation for his hard labour was very discouraging. Most of the settlers in this township are Galicians, but there are a few English speaking Canadians. The Galicians have made good progress, taking into consideration the short time they have been on the land and the disadvantage of having little or no capital to start with.

Township 20, range 12, is in a recently formed drainage district. It is the intention to run drains east and west on every second sectional road allowance using the excavated material for road building. These ditches will no doubt reclaim a great deal of waste land while the roads will enable the settlers to go about at all seasons of the year. The cost of the work will be quite a tax on the settlers, but it is necessary, if the township is to keep progress with other parts. Mary lake, a large marsh with open water in places, is situated in the westerly part of the township, but will likely disappear when the drains are completed.

Bellhampton post-office is situated in this township and has a weekly mail from Glenella. There is a new school erected lately which is well attended, the settlers apparently understanding the great importance of giving the children an education.

On July 10, I moved camp to township 20, range 13. This township was originally subdivided in 1873. The monuments were principally wooden posts; these had been destroyed in various ways. The settlers were uncertain where their boundaries were, and for that reason they were unable to fence the land and make improvements. I found very few of the marks of the original survey and as a great many new settlers were coming into the township to locate on the land, it was necessary, in order to prevent confusion and trouble, that a restoration and resurvey be made.

I found two settlers in this township on the wrong quarter sections and one on the road allowance. These men had made quite extensive improvements in the way of buildings and they felt badly when they found that it would be necessary to take the buildings down and erect them in other places.

The township is settled entirely, I think, by Galicians who appear to be making fair progress; some of them had considerable wheat and oats to sell last season for which they received a good price at Glenella. They are also raising a good many cattle and horses, so that the prospect is that in a few years they will be prosperous and well-to-do. The westerly part of the township is very low and wet and will be of little use until drained. It is expected the drainage of the township will be commenced in 1910 and completed as soon as possible. Blueberries grow in great profusion in the northerly part of the township, and are quite a source of revenue to the settlers who pick large quantities and market them at Glenella, where there is always a good demand.

On September 14, I crossed the end of the Big Grass marsh into township 18, range 10. I had instructions to examine the portions of this township which had not been retraced and report as to the necessity of making a retracement and restoration survey, and upon examination I came to the conclusion that it was not necessary to do this work. I accordingly proceeded to township 16, range 9, arriving there on September 15. I had instructions to examine this township and if considered necessary, to make a resurvey; after a brief examination I decided to go on with the resurvey.

This township having been originally subdivided in 1873, many of the marks were either lost or obliterated, and the settlers being in great doubt about the boundaries of their lands were unable to make the improvements they wished. Most of them were therefore well pleased that this work was to be done. The township is in a drainage district and some six or seven years ago large ditches were excavated along every alternate section line running east and west. The excavated material was used for a road so that travelling through this township is easy and pleasant. There are also two good trails running north, one along the Kinosota ridge and one near the east side of the township.

The construction of a branch of the Canadian Northern railway through this township has created quite a demand for the land and as the soil is generally good, and suitable for grain growing, a number of new settlers are preparing to go into that business extensively; judging by some of the crops I saw in the district, I think the venture will be a success. The Canadian Northern railway were ballasting this road and otherwise improving it last fall so now the settlers have a fairly good railway service. It is the intention of the company to extend this line, in the near future to join the main line. This extension will open up a large extent of country now without railway facilities and give a great impetus to farming operations in the district between the line and lake Manitoba.

During September and October I was also engaged in retracing the lines and restoring the monuments in township 17, range 10, an examination showing the necessity of this work. There are very few settlers in this township although there is considerable land suitable for mixed farming purposes. Probably the lack of railway facilities has retarded the settlement. There are a few Icelanders in the west part of the township, along Big Grass marsh, engaged in cattle raising and dairying. This section is well adapted for that industry as there is an abundance of hay and water. I completed the survey of this township on November 4.

On the 6th I moved camp to township 16, range 8, and the same day started to retrace the lines and restore the monuments. This township is a fractional one and is known by the settlers as 'Big Point.' Nearly all the monuments in the township were either lost or obliterated. The settlers were well pleased to have the lines run and properly marked. They went to the expense of nearly three hundred dollars in grading a road which they intended to run along the east boundary of the west half of section 30. Some of the swamp land examiners set up their compass at the quarter section post on the north boundary and gave them a bearing for the line, setting up two pickets for them. This line was produced through to the south boundary of the section and as there was no quarter section post at this point, they did not know the line was erroneous and graded their road and built a new schoolhouse. I don't know the exact position of the building, but I think it will either be necessary to move it or buy a small piece of land from the owners of the four quarter sections. They wanted me to adjust this difficulty for them, but as I had no instructions to interfere in difficulties of this kind I refused.

The weather turned very cold on November 12, and I was enabled to traverse lake Manitoba across townships 16, ranges 8 and 9, thus completing my work in this part.

On November 16 I left for township 20, range 12, where I had some lines to run in the vicinity of Mary lake having been unable, on account of the water, to complete this work in the early part of the season.

On November 25 I started for township 20, range 13, to traverse Pockett lake situated in the western part of the township. I completed this work on the 26th, and sent the outfit to Glenella while I went to township 20, range 11, to report on the necessity of making a restoration and resurvey of this township. A brief examination convinced me that a survey was required, and I at once reported this fact. Many of the monuments are either lost or obliterated, and as the lands are now being settled, it seems to be the time to carry out the survey.

APPENDIX No. 16.

EXTRACTS FROM THE REPORT OF W. A. DUCKER, D.L.S.

SURVEY OF PART OF THE ELEVENTH BASE LINE, WEST OF THE PRINCIPAL MERIDIAN.

On the morning of January 17, I left Winnipeg and reached Novra, the nearest station to my work, on the Prince Albert branch of the Canadian Northern railway, the same day, about 10.30 p.m. At Novra there is only a section house and there are no settlers nor roads in the district. I at once commenced cutting a road to get to my work, about seven and a half miles from Novra and some two miles less in a straight line from the railway track, and the latter portion of this road I found about the roughest country I have seen in Manitoba. The total ascent up the Porcupine hills in about four miles is nearly one thousand feet, and a number of deep ravines had to be crossed, the descent at one point being two hundred and ten feet, and at some points the sleighs had to be let down with heavy tail-rope. Most of this portion is heavily timbered with large poplar and birch and a great deal of very fine spruce up to thirty inches in diameter.

The eleventh base line across range 27 forms the south boundary of a portion of the Porcupine Forest reserve, and from the east boundary of range 28 to the second meridian runs practically through the centre of this reserve. The surface is rolling to hilly and many lakes, some of considerable size, were crossed by and seen from the base line. These lakes, and rolling hills covered with a dense growth of small jackpine give a pleasing appearance to the landscape.

As this line crosses about the highest part of the Porcupine hills very few streams were crossed, and nearly all were dry during the past winter owing to the slight rainfall of the previous summer. In the lakes having regular outlets the water is of good quality and some small fish were seen, but I had no way of ascertaining whether they contained larger specimens, though I have little doubt they do.

Nearly all the original timber in sight of this base line has been destroyed by fire and most of the surface soil or humus is burnt off, so that the present soil is chiefly a sandy clay with a great deal of stone on the hills and ridges, and swamps with marsh and peat surface lying between.

Some belts of good poplar up to eight and ten inches in diameter were crossed but the present timber consists chiefly of a dense growth of Banksian pine, commonly known as jackpine, with some spruce, tamarack and poplar, nearly all of which is under three inches in diameter.

It seems regrettable that the Banksian pine takes so readily on recently burnt ground, largely to the exclusion of spruce and more valuable varieties as the former rarely attains much value as merchantable timber. The spruce is, however, a more persistent variety and much longer lived, and will in a time doubtless largely take the place of the other timber.

This district would be of little value for agricultural purposes or grazing, and is best suited for its present purpose as a forest reserve. If fire can be kept out of this reserve till the fallen timber rots away, it will form valuable wood supply for the surrounding country and be of untold value in conserving the rainfalls and maintaining the flow of the streams which rise in it. In its present condition with a large amount of decaying fallen timber and dense growth of young conifers, a fire starting in a dry season would be almost uncontrollable.

The evidence of moose, elk and jumping deer were very plentiful, but these animals appear to take to the lower grounds in winter and very few animals or fresh tracks were seen during my survey. Timber and prairie wolves were heard and their tracks seen, also a few lynx, but this year rabbits seem to be an unknown quantity and all other fur-bearing animals seem to be scarce in consequence. A few partridges and prairie-chickens were seen.

APPENDIX No. 17.

EXTRACTS FROM THE REPORT OF C. C. FAIRCHILD. D.L.S.

SURVEY OF DOUKHOBOR VILLAGES IN THE PROVINCE OF SASKATCHEWAN.

Acting under instructions I proceeded with the survey and subdivision of fifty-four Doukhobor villages, finishing on October 15 at Kamsack and Canora.

The Doukhobors are a very peculiar people, apparently simple minded and rather unstable. My opinion of them on my first visit underwent a radical change during my second visit. On the first the Doukhobors were up for official examination before the Commissioner, while on the second visit I found them engaged at their daily pursuits and living, as I concluded, a more natural life. The communistic idea is fostered chiefly by the women and older men, and while there were distinct threats of secession in many places among the younger men individually, this disappeared if a number were present, even if each had previously individually expressed himself opposed to the idea of communism.

As to the survey itself, in some cases I found the Doukhobors indifferent, while in other cases they were very much interested, and on the whole apparently satisfied, but in a few cases quite antagonistic. We were generally kindly dealt with by them, although they attempted a few unsuccessful 'hold-ups,' in the way of charges for team hire.

I would strongly recommend that owing to the changeable and unsettled condition of the Doukhobors that none of the plans be registered until the Minister or Commission have decided which lots are to be sold, and then that only those plans of villages in which actual sales take place be registered. In many villages at the time of my visits indications led me to believe that none of the Doukhobors were likely to become qualified to own their lots for some years at least, and if they decided to leave for British Columbia or elsewhere in a body, the registration of the plans would make the final disposition of the lands unnecessarily complicated and many of the roads surveyed would be quite useless.

The services of Mr. Michael White, Inspector of Doukhobor lands, who accompanied me as interpreter, were almost invaluable. In addition to acting as interpreter, he took an elaborate census of each village and was always useful in advising me when in doubt as to the survey itself, and, in the actual field work he was ever ready with his assistance, which I was glad to, and did, avail myself of during the entire survey.

APPENDIX No. 18.

EXTRACTS FROM THE REPORT OF T. FAWCETT, D.T.S.

MISCELLANEOUS RESURVEYS IN SASKATCHEWAN

Leaving Toronto on April 19, I proceeded to Winnipeg and inspected some iron posts manufactured by the Manitoba Bridge and Iron Works for the Department.

I next investigated the conditions in township 1, range 7, east of the principal meridian to ascertain if a retracement should be made. At the time of my inspection, April 24, and the week following, I found a large portion of the township covered with water, an overflow from Roseau river which at that time was unusually high. After inspection I was of the opinion that a retracement and restoration survey should be made.

In township 16, range 18, west of the principal meridian, I traversed the part of Cape lake, extending into this township from the adjoining one. The lake in question is a favourite resort with the people for some miles around, because it contains a nice sandy beach, is a good place for boating, and contains fine fish, consisting of pike, pickerel and gold-eye. Traverses of two other lakes omitted in the original survey were made in section 1, township 18, range 21, and in section 23, township 20, range 25, west of the principal meridian.

In township 19, range 21, and in township 20, range 23, west of the principal meridian, several witness monuments had been planted in such positions as to encroach on the allowance reserved for roads. These were destroyed and the monuments established either at the true corners of the sections or on the section boundaries. Other cases where the witness monuments had been planted in the road allowance were found in township 20, range 8, township 23, range 18, and township 35, range 26, all west of the second meridian. In all these cases the old monuments were destroyed and new ones established either at the true corners or at points on the section boundaries.

Reports had been sent in by settlers from several localities that duplicate monuments were found on the ground marking corners of their lands. Of the points investigated there was only one case where the duplicate monument was found, viz., on the east boundary of section 22, township 23, range 9, west of the second meridian. One of the monuments was found in the correct position and the other was four hundred and sixty-eight feet too far north: the last mentioned was obliterated and the pits at the other point renewed. There were several points where correction surveys were required, some of the errors having occurred through the men who followed to dig the pits mistaking a line picket for the section or quarter section corner. An example of this kind was observed in township 41, range 18, west of the third meridian, where I found the iron post and pits five hundred and fifty-eight feet south of the true corner. In township 25, range 28, west of the second meridian, settlers had petitioned the Department to have the road allowance across sections 20 and 21 straightened. I found the monument at the northeast corner of section 21 over one hundred and three feet south of the line joining the other section corners. In locating the source of the discrepancy, and making the corrections for which land owners petitioned, I retraced sixteen miles of line and the whole indicated careless work in the original subdivision. Besides the places above mentioned, correction surveys were made in township 11, range 22, township 25, range 27, and township 46, range 23, all west of the second meridian, township 13, range 12, township 34, range 3, and township 34, range 6, all west of the third meridian.

In townships 20 and 21, ranges 3 and 4, west of the second meridian, about thirty miles were retraced and results show that no part of the work done in the original survey had been done with any pretence or effort towards accuracy. In the early eighties when this work was done, the railway terminus was not farther west than Brandon, the country was considered almost without value as a field for agriculture, and the man who did the work evidently thought anything good enough for a place which he imagined would not be settled for generations. Had these great discrepancies been discovered a few years ago, before the tide of immigration set in, the effect would not have been so serious, as then the survey could have been corrected. Now that all the sections open for homesteading are occupied and the other sections that are unoccupied held by companies or individuals for sale at a high price, the effect of these bad surveys will become more serious year by year. The lines retraced in townships 20 and 21, range 8, were nearly as defective as those in ranges 3 and 4, but the land being at a greater distance from the railways, is not so valuable, and not so much in demand. Retracement surveys for the purpose of ascertaining the true bearings and lengths of erroneous lines were made in townships 20, ranges 4, 7 and 29; townships 21, ranges 4 and 7; township 22, range 6, townships 23, ranges 9 and 18; township 24, range 12; townships 25, ranges 27 and 28; township 28, range 6; township 29, range 15; townships 30, ranges 28 and 29; townships 31, ranges 17, 28 and 29; township 33, range 9; townships 34 and 35, ranges 27 and 28; and township 46, range 23, all west of the second meridian; also township 13, range 12; township 32, range 7; township 33, range 6; township 34, range 3, and township 41, range 18, all west of the third meridian.

In addition to the lakes before mentioned as traversed in Manitoba, the following in the province of Saskatchewan were also traversed; one each in township 27, range 14; township 31, range 16; township 38, range 28; townships 39, ranges 24, and 25; townships 39, ranges 25 and 26; townships 39 and 40, range 26; township 40, range 17; township 40, range 26; and two in township 40, range 25, all west of the second meridian, also one in township 34, range 6, west of the third meridian.

In townships 6 and 11, ranges 1 and 2, surveys were made for the purpose of rectifying a discrepancy existing between former surveys, and in townships 16 and 17, ranges 8 and 9, the bed of what was formerly 'Reed lake,' but which has, within a few years past, dried up, the greater portion of it being now fit for cultivation was subdivided, and the section and quarter section corners marked in the usual way with iron posts and pits. The soil being of a recent lacustrine formation is full of a marly deposit and is of a clay character, very adhesive when wet. The vegetation covering this lake bed at present is composed mostly of weeds which would disappear under cultivation. If used for meadow land I would judge the ground to be well adapted for timothy. That it would produce an immense crop of oats we had ocular demonstration as a portion of the lake bed under cultivation last year returned upwards of one hundred bushels per acre. The people who had seen the ground when covered by water up to seven and eight feet in depth were questioning and reasoning with themselves as to whether this might not occur again, and would have some hesitation about going to much expense in making improvements on the flat. As to the drainage of the lake, there is no visible cause, and it may be due to some underground channel having opened up. The condition of the surface at present is such that cultivation would be very easy, there is no sod to be broken up and the surface soil is of a loamy character and which when dry could be ploughed with the greatest of ease. The village of Morse, a station on the main line of the Canadian Pacific railway is situated on the north bank and near the middle of this former lake. The village contains three elevators, several stores, livery stables. blacksmith shops, agricultural agencies, school, churches, a hotel and other business places, which makes the locality a choice one.

In township 48, range 19, west of the second meridian, I retraced a portion of the east boundary and the north boundary of the Hudson's Bay Company's reserve for the purpose of ascertaining the boundaries of adjoining sections. Mr. Philip Turner, of Coxby, who was the officer in charge of the company's post at Fort-a-la-Corne when the original survey was made, and his brother who assisted him in chopping out the lines, and who has lived in the locality ever since, were both present for the purpose of pointing out the boundaries, but they found the timber had been burned and a new crop grown during the thirty-eight years which had elapsed since the lines were run, and nothing could be found in the vicinity of the north boundary to determine the position of the lines or monuments. There was a mound at the southwest corner of the reserve and I had to retrace the lines as best I could from that. In some places where we found the timber growing to a size of from eight to ten inches in diameter and brush very thick, the Indians, who were working on the lines, said they could recollect the time when this country was nearly all prairie. The fact that the wooded area is increasing was one thing I noticed in many localities, especially in the neighbourhood of Round Plain, Touchwood Hills, Newdorf and Humboldt. All through those parts of the country the timbered area is encroaching on the cultivated land instead of cultivation driving back the timber. Protection from fires which formerly passed over the country every fall will to a great extent account for this change.

Never in the history of the Northwest did I see such a rapid growth. The spring was by no means an early one, and disappointment was depicted on many countenances that climatic conditions did not admit of early seeding. However, the crops met with no set-back after once they were in the ground. Warm weather set in soon after the middle of May, followed by warm rains, and the growth was so rapid that before the end of August new wheat had been marketed as far north as Prince Albert. With the exception of a few localities where hail-storms occurred good crops prevailed over the entire province of Saskatchewan, and I can speak for the entire province as my work carried me into nearly all the settled portions of the province. I found the people everywhere enthusiastic and full of hope as they had every reason to be. The yield more than met their anticipations. Scarcity of labour was the principal drawback and the greater portion of the crop had to be threshed from shocks in the field. The country was greatly favoured by the fine weather which prevailed during the entire harvesting and threshing season. The rainy weather which continued all through the growing season had suddenly changed and the most beautiful weather prevailed all through September and the greater part of October or until a large proportion of the crop had been threshed and delivered to the elevators or shipped on the train.

A large number of the farmers united their forces to ship direct by car, and did not use the elevator, and this saved the elevator expenses, but the crop was so abundant that notwithstanding this united action on the part of the farmers the elevators had nearly if not all they could handle during the more active part of the season. Land values may be expected to make a further advance as a result of last summer's crop.

APPENDIX No. 19.

EXTRACT FROM THE REPORT OF L. E. FONTAINE, D.L.S.

INSPECTION OF CONTRACTS IN EDMONTON DISTRICT.

The inspection of contract surveys involved a large mileage of travel both by wagon roads and pack trails, and those principally made use of were the wagon road leading from Edmonton to Tomahawk, the Buck Lake pack trail, the wagon road from Tomahawk to Entwistle, the Grand Trunk Pacific 'tote' road and the Jasper's and Jacques' pack trails.

The principal difficulty to be reckoned with in most cases when covering such an extent of territory is the lack of transportation facilities but in order to obviate this in a certain measure one can have his supplies freighted to depots designated in advance, during the winter months, thereby ensuring travel to and from with comparatively light loads during the course of the survey. These drawbacks I may say will gradually disappear as the country becomes more settled and new roads opened. I have noticed quite an improvement already in this respect in several sections, and more so along the route of the Grand Trunk Pacific railway where the conditions are totally different to what they were two years ago, and to-day at such places as Entwistle and Wolf Creek, two thriving little villages on the railway line, all the necessaries of life can be procured in the numerous stores and good accommodation is furnished to the travelling public patronizing the stopping places.

APPENDIX No. 20.

EXTRACTS FROM THE REPORT OF J. FRANCIS, D.L.S.

RESURVEYS IN MANITOBA AND EASTERN SASKATCHEWAN.

On Friday, May 28, I proceeded to Lowes lake in section 2, township 25, range 4, west of the second meridian, about five miles south of Yorkton, where I traversed a lake. As the monument for the northeast corner of section 3 was lost, this corner had to be established and the north boundary of section 2 retraced before the traverse of the lake could be properly connected with the monuments. The level of the water in the lake seems to be normal, but was lower in 1901 according to the survey of that year, it being a much drier year. Jackfish are plentiful in the lake.

Leaving here on June 3, I proceeded to section 1, township 27, range 5, west of the second meridian, where I found an error of 5·895 chains in the position of the quarter section monument on the east boundary of the section. With the consent of the owners the error was rectified and the north boundary of sections 1 and 6 were also retraced. Proceeding next to the northeast corner of section 19, township 26, range 6, west of the second meridian, I found duplicate monuments consisting of an old mound of the original survey, still unmistakable, and I. P. Pits erected later. The adjacent quarter section lines were retraced and I am convinced that the I. P. Pits have been made by mistake. Leaving this township on June 10, I proceeded to township 23, range 12, west of the second meridian, where I made a retracement survey of the township. The odd numbered sections are nearly all vacant; the even numbered ones have been homesteaded but many are now unoccupied because of climatic conditions and want of railroads.

My next work was in township 29, range 32, west of the principal meridian where I arrived on July 10. I made a retracement survey of this township. The land is nearly all taken up and fenced, fifteen to twenty per cent being cropped. The soil is first-class, and the present crop is as good as could be wished for.

The Doukhobors, who have two villages in this township, largely occupy the south half, while the remainder is taken up by English speaking people.

From this township I proceeded to townships 31 and 32, range 32, west of the principal meridian, where I found that the survey of sections 22, 27 and 34, township 31, range 32, had been extended westward into the 'Kee-see-koose' Indian reserve.

The reserve boundary was retraced through that part of townships 31 and 32 affected, also the north boundaries of fractional sections 10 and 22 in township 32, sections 22 and 34 in township 31, and the south boundary of fractional section 22 in township 31, eastward to connecting monuments. All mounds and pits within the reserve were destroyed. The road adjacent to the reserve was eliminated and added to the fractional sections. Proceeding next to township 25, range 32, west of the principal meridian, which I reached on August 10, I found the township very wet owing to a heavy downpour of rain on the day preceding our arrival. A restoration and retracement survey of this township was made. Many of the monuments had disappeared and it was only where mounds were erected that any signs could be found. Most of the even numbered sections are taken up by Galicians who have more or less land cultivated, growing wheat, oats, rye, barley and potatoes. These crops are medium, though not so good as farther north.

Leaving this township I proceeded to section 17, township 25, range 30, west of the principal meridian to determine whether the monument at the northeast corner of section 17 was represented by a witness trench or I. P. Pits. I was unable to find either as they had both been destroyed by making a grade in the adjacent low ground. The adjacent quarter section lines were retraced and a monument erected at the northeast corner of section 17 as the ground at that corner was dry this season. Leaving here and going to township 23, range 29, west of the principal meridian an inspection was made to determine if a restoration survey was necessary. Many of the monuments are lost and obliterated and a restoration survey of the township is recommended.

My next work was in township 24, range 4, west of the second meridian, where I arrived on September 2. A retracement survey was made of a portion of the township, and that portion of the lake which had dried up was subdivided. The waters of Leech lake have risen since the survey made in 1902, as some of the monuments then erected are covered with three to five feet of water.

Leaving Leech lake on September 20, I proceeded to township 18, range 15, west of the principal meridian where I arrived on September 29. The original survey of this township was very irregular. Settlements, roads and improvements prevented a complete change of the survey of the township, so a retracement survey was made in the greater part. The township is traversed from north to south by the Canadian Northern railway. It is settled with English speaking people. Under the Manitoba Drainage Act drains are being made which will reclaim nearly all the swamp land in the west half. The village and station of Riding Mountain are situated on section 10. It is reported that boring operations are to be begun in the spring on a scale large enough to ascertain if petroleum or gas exists in paying quantities in the underlying shale in this township.

A retracement survey was also made in township 19, range 15, west of the principal meridian and of a few miles in township 29, range 17, as well as a traverse of White wood lake in this last township.

APPENDIX No. 21.

EXTRACTS FROM THE REPORT OF A. H. HAWKINS, D.L.S.

BASE LINE SURVEYS IN NORTHERN ALBERTA.

We started westward on Wednesday the 14th of April and reached Athabaska river, at the mouth of Prairie creek, on the 27th, where in compliance with your instruction to have my supplies sent over the snow in winter, I had arranged to have my goods stored. I found the cache in good condition, except that a traveller hearing that it was a Government cache decided it was a good place to winter, and had established his headquarters in a shack a few miles down the Athabaska, and was drawing his supplies as required. The freighters, however, reported the matter to the Royal Northwest Mounted police, who apprehended the man, and he, being questioned, was found to be unsound in his mind, and he is at present in Brandon asylum.

From this point we turned north, but from reports I had received, I decided to remain a few days on the Athabaska, as the snow was still very deep on the divides and high lands to the north.

The trip to this point had been comparatively easy, as we were able to pass Pembina and McLeod rivers on the ice, and the muskegs were still quite solid, although usually from six inches to a foot of water lay on them. Our greatest difficulty was to procure hay for our horses, the railway contractors having attached everything in that line months ahead; after leaving Entwistle it could not be purchased until we reached 'Big Eddy,' and very often our pack train had very short rations.

We crossed the Athabaska and started north on May 4, and on May 11, we struck the fifteenth base line some three miles east of the northeast corner of section 36, township 56, range 25, west of the fifth meridian, our starting point.

From this point to the sixth meridian the country is rolling, forming the watershed between Hay and Baptiste rivers, a succession of muskegs and jackpine ridges, the surface being covered with heavy windfall and small second-growth jackpine, with an occasional clump of green timber, generally small.

The country both north and south of the line was very rolling and broken by numerous creeks and gulches, and is, in my opinion, of little value for agriculture, although generous draining would probably convert it into very fair grazing land; on the best lands, however, windfall is so heavy that the expense of clearing would be very considerable.

No signs of game were noticed after leaving Hay river except an occasional moose or deer track, and along the streams a few signs of beaver.

The soil on the jackpine ridges is a mixture of quicksand and clay and when the frost is coming out they are almost as bad to cross as the muskegs, as after two or three horses have passed over, the trail becomes a bottomless mud-hole; a new trail has to be cut out and horses are frequently snagged or otherwise injured in getting over it.

In range 26 we ran through a rather good valley for this country where we fortunately found several fair hay meadows along the creek while passing through sections 31 and 32; my ranger reported that they extended to Baptiste river, although in most places they were badly littered with windfall and some of them were very wet. Several clumps of fair spruce and jackpine were encountered in the valley but all were of small extent and at present are very difficult of access.

From this valley to the sixth meridian, the country is rather more broken, the windfall heavier and muskegs larger, making it a rather uncomfortable country to traverse. However, on Saturday, June 12, we completed the base line to the sixth meridian. The country in the immediate vicinity of the meridian is covered with an enormous amount of dry timber, both standing and fallen, indicating somewhat better soil, but making progress very difficult.

From the meridian the country is very broken as Baptiste river is approached; it is cut up by several deep and very rugged ravines, leading to the river, but it apparently has been more frequently and more effectively burnt over, as within two miles there is but a small amount of windfall, and second-growth willow and alder with a few jackpine are to be found. In the valley proper are numerous clumps of rather fine spruce timber, ten to thirty inches in diameter, of good length and appearance, which could be easily logged by way of Baptiste river. This river is a very rapid stream, the current being from four to seven miles per hour and eight to fifty inches deep. The Indian name means 'the rushing devils,' and the rapid current and the numerous gravel bars to be found along the channel would make driving a rather difficult undertaking. The flats in the valley are largely composed of gravel in the vicinity of the base line, supporting a luxuriant growth of goose grass in many places but no meadows are to be found for six or eight miles up stream, and I believe as far or farther below. Up the river, above this last mentioned point, however, are numerous fine meadows, which sustain a luxuriant growth of bunch grass on the higher portions, and marsh grass in those portions more subject to flooding.

Along the west bank of the Baptiste at this point and from three to five miles on either side of the base line extends a very fair tract of timber consisting of jackpine, spruce and a few large balsam, six to twenty-four inches in diameter, clean and good, and extending back from the river from two to four miles. The country, however is cut by many deep and difficult ravines and is very rough and broken.

Drift coal was found in several places along the Baptiste and numerous outcrops of sandstone were noticed on the banks but no coal in place was found in this locality.

In range 2 the watershed between Little Smoky and Baptiste rivers was crossed and for several miles the country is nearly all swamp and muskeg in which many tributaries of these two rivers rise.

In section 33, township 56, range 3, the main branch of the Little Smoky is crossed, flowing through a very broken country covered with dry timber, both standing and windfall, for several miles. An old trail was followed that comes from Baptiste river and continues on down Little Smoky valley, but it had apparently been little used of late years, and was badly fallen in. Patches of very fair feed were found along this stream.

From this point to Muskeg creek, the country was rolling, jackpine ridges, muskeg and swamp. From Muskeg creek the country appears to change. It has apparently been more frequently burnt over and is consequently more open and numerous fair meadows are to be found from this stream westward.

The line passes through a beautiful jackpine grove in sections 31, range 4, and 36, range 5 extending from one-half to three-quarters of a mile on either side, timbered with small jackpine two to eight inches in diameter and no underbrush. South of the line the country is very rough but to the north extending from two to two and a half miles is a very fine valley with many good hay meadows and but little windfall. This valley extends westward along Muskeg river and in many places hay could be cut and pasturage could be procured for several hundred head of cattle or horses.

Muskeg river was crossed in section 35, township 56, range 5 and from this point we were in the foothills proper, the line running parallel to the river for several miles, but unfortunately along the sidehill through a very rough and broken country.

To the south this rough country extends right to the mountains, while to the north of the valley were rolling broken hills, also covered with windfall; this description would include all the country through ranges 6 and 7. A small amount of timber is to be found along Muskeg river consisting of spruce and balsam from eight to twenty-four inches in diameter and of good length, and these clumps are to be found both up and down the valley as far as it was explored to the north, but for only three miles to the south. In range 8 the Grand Cache valley was crossed by the base line, the greater and best portion of it lying to the south. Here, as one of the party remarked was the beauty spot of our travels for the season. Lying in among these hills the valley extends to Sulphur and Smoky rivers to the west and thence up the Sulphur valley two or three miles. The valley itself is made up of poplar groves and patches of open prairie, supporting a luxuriant growth of grass and pea-vine and is said to be a favourite camp ground for the Grand Prairie Indians, as game is evidently abundant from the numerous signs on all sides that were noticed of bears, moose and caribou. Just on the east side of the valley two of the party encountered three grizzly bears one evening when returning to camp.

While camped on the shores of a small lake (which I have called Victor lake), in this valley, P. V. Montpetit, one of the party was drowned while bathing. The lake is small, but very deep in places and is apparently fed by springs, making it very cold. It was supposed that he took cramps and as no assistance was at hand, sank, and although a diligent search was made, which was continued for several days, no trace of the body was ever found, which melancholy circumstances were more fully reported in my progress reports.

The valley of Smoky river is very deep and rugged along this portion, but at the time of my visit the water was low and with a good raft we had but little difficulty in crossing, although the current in all these mountain streams is very rapid, being four to five miles per hour and the channel frequently broken by numerous bars. The water is cold and good to the taste, but has a milky appearance except in pools where it has the beautiful clear blue colour of the glacier from which it takes its source. There is some very fair timber along the river, chiefly spruce, eight to thirty inches in diameter, of good height and in places fairly thick. The bottom land in the valley being chiefly gravel, affords a good growth of goose grass, but meadows are exceedingly rare.

Smoky river trail to Grand Prairie now crosses just south of the base line, continues down the valley to Sheep creek and thence turns northwesterly to the Porcupine valley. The old trail started north in range 4, crossing the divide and thence down Simonette river crossing Smoky river again below the sixteenth base line, but this trail has been practically abandoned by the Indians as the Muskeg-Simonette summit and the Simonette-Smoky summit were through a country covered with dry standing timber, and very difficult to keep open. The valley of the Muskeg and Grand Cache extending from range 4 to range 8, and having a width of from one to three miles, is so exceptional as to deserve further notice in a country where such tracts are exceedingly rare. In many places hay could be cut without any preliminary clearing and with slight preparation a very large area could be brought under cultivation. Thus the open lands could be utilized to provide winter feed and most excellent pasturage is to be found in places along the hillsides which are generally partially timbered. The distance from market alone stands in the way of making these valleys a most admirable horse or cattle range, and to some extent the new Grand Trunk Pacific railway will overcome this objection. In such a locality there would be little or no danger of homesteaders encroaching on the range.

A large amount of coal was noticed in range 7. On every little stream drift could be found and, on several, seams of various widths were noticed, but along the main branch of Grande Cache creek, which crosses the base line in section 35 it was to be seen to the best advantage. This creek comes out of the mountains through a canyon with perpendicular cliffs rising at times to two hundred feet above the water, the formation seems to be very much broken and contorted but in many of these perpendicular cliffs could be seen seams of coal from a few inches up to eight or ten feet in width. One seam just north of the base line showed a width of about eleven feet extending up the cliff a distance of fifty or sixty feet and from this ledge the sample transmitted was taken. Then also on the creek passing through section 33, were noticed some very fine ledges. Indeed from the amount in sight in this locality, one would infer that a very large amount of coal was near at hand and should the quality warrant, mining would not be a very difficult matter as from the creek valleys the coal appears to be quite accessible. Drift coal was also noticed on the bars of Smoky river, all of which go to indicate very extensive deposits in this locality.

The scenery from Victor lake in range 8 was very fine indeed. To the south numerous snow-capped peaks are always visible on both sides of Sulphur river, and westerly the mountains come right up to Smoky river, while from the high points on the base line to the east, peak after peak, each higher than the last could be seen right ahead. The point where the line extends is partly up a very steep and rugged mountain side and although not impossible, it was deemed unwise to attempt its production farther.

The fifteenth base line was completed to the east boundary of range 9 on September 11, and on the 13th preparations were made to proceed to the sixteenth. A grave was dug and a coffin prepared in case the remains of our late comrade should be found later; the timber was cleared, a rough fence erected, and a cross planted on which was inscribed his name and date of his death. On the 14th we started for the sixteenth base, remaining one day at Muskeg cache to cut out the old Simonette trail, which leaves the Smoky trail near this point.

The Simonette trail over the ridge was badly blown in, and exceedingly difficult to find, as the numerous fires that have swept over the country have in many places destroyed every vestige of trails; however, as there is considerable green timber, jackpine and spruce six to twenty inches in diameter, in places quite thick and good, we succeeded in locating the trail in these places and camped on the head waters of Simonette river on the 17th. The river at this point is a very small stream, three to five links wide and five inches deep, but increases in size very rapidly. On October 2 we were able to begin the production of the sixteenth base line westward. From the sixth meridian to the west fork of the Simonette the country is covered with burnt timber, both standing and windfall on the ridges and a large amount of muskeg sustaining a very scanty growth of small spruce in places and rather difficult for trail making; this condition apparently extends a very considerable distance on either side of the line.

At the intersection of the base line and meridian, huckleberries were found in greater quantities than I ever remember seeing elsewhere, the ground in the vicinity of the corner being almost black with them.

Considerable difficulty in finding horse feed was experienced in this locality. Two or three small meadows on the head waters of the east fork being all we could find; however, as the chopping was comparatively light the line was pushed rapidly ahead to the Simonette valley where feed, especially goose-grass, was more abundant.

On October 9, the first heavy snowstorm overtook us and from that time on there was more or less snow. The evidences along the valley and sidehills would indicate a very considerable annual snowfall, and this evidence is confirmed by reports from Indians met in the locality.

The timber in the valley of the Simonette is rather the best seen during the trip, many trees that would measure twenty-four to thirty inches in diameter being noticed; it is fairly thick and long and extends for twelve miles along the valley on either side of the base line, broken in places by patches of meadow and parts that have been burnt over; in many places it extends high up towards the summit of the valley on either side, but the valley on both sides is very rough and broken, cut by numerous small creeks having high precipitous banks.

From the Simonette to the summit between it and the Smoky the standing dry timber and windfall is very heavy indeed, and the continued snowfall made travelling over fallen timber not only exceedingly difficult but dangerous. The ascent, however, is gradual and as the summit is reached the soil seems to be of a better quality, as dry trees up to thirty-six inches in diameter were noticed on several occassions on our line, and apparently extended a considerable distance on either side. Along the summit was found a very excellent growth of grass (of course killed by the frost at the time of our visit), but as it was plentifully mixed with pea-vine it afforded very good feed for the pack train while we were in that vicinity. From the summit to Smoky river the country is exceedingly rough as the soil appears to be of considerable depth and every little stream has cut its way so deep as to make work very slow and arduous and the location and opening of a trail far from easy. The line passes through a burnt country, the timber of which is chiefly standing on account of the depth and quality of the soil and dry trees two feet in diameter were frequently in line and had to be removed. To the north, one and a half to two miles, a very fine body of green spruce timber was observed and apparently extended some distance down stream reaching from the summit to the bank of the river.

From the summit a very excellent view of the country was obtained and it was the general opinion that the mountains were from forty to fifty miles distant, but as far as the eye could reach, what appeared to be an interminable mass of dry tops met the vision, broken only in a few cases by green branches indicating living timber.

The river itself flows through what is practically a canyon, for a number of miles on either side of the line there being a rise of between three hundred and fifty and four hundred feet in ten chains, where the line crossed from bank to bank. It was very thickly covered with heavy windfall so that we had to cut out a winding trail which required to be graded in order to get the pack train down in safety. An open prairie of from thirty to forty acres on the west side of the river was very fortunately found close to the line, covered with a heavy growth of grass; otherwise our horses would have fared very poorly, as beyond a small amount of goose grass in the bottom the valley is devoid of feed.

On the west side of the river the valley ascends by a series of terraces, covered with the worst windfall that had yet been encountered, in many places rising to eight and ten feet above the surface of the ground. The soil appears to be of good quality however, and at the end of the line a fairly good growth of grass was found.

The line was produced to the east boundary of range 5 on November 13, and we then decided to close operations for the season; we started back on November 17, and arrived in Edmonton the night of December 15.

In my report of 1907-08 the suggestion was advanced that the territory along the eastern slope of the mountain from the eleventh to the thirteenth base line should be reserved as a national park and game reserve. To that suggestion I would now add that it extend to the seventeenth base line as this whole country is such that it will be many years before any great amount of it will be in demand. The large area now covered by muskegs and a much larger area covered by windfall together with the summer frosts prevalent would cause intending settlers to look askance and seek for land more easily brought under cultivation. Then, too, the game throughout this entire region is being rapidly killed off, as the wandering bands of Indians and half-breeds that are to be met with have no respect for the season of grace for any animal, and to see them is to kill if possible. It seems not only a very great pity, but a disaster that such noble animals as the moose, caribou and mountain sheep should be ruthlessly slaughtered as in a few years, if it is not prevented, they will be but names to Canadians.

Such a reservation would also preserve in addition to those mentioned in my 1907-08 report, the following rivers:—Hay, Baptiste, Little Smoky, Muskeg and Smoky. While it is true the Smoky and Baptiste have branches originating in glaciers it is also true that these waters are largely augmented by large streams that rise in the muskegs and timbered land adjoining, which, if the timber were removed, would cause a very noticeable decrease in their volume.

This district affords an excellent place for those who delight in examining the flowers. Even at high altitudes many varieties were found of the hardier plants. During the season quite a number of the plants were examined, and of the thirty-four orders of the Dicotyledon class given in Gray's new manual thirteen representatives were found in this district.

Most of the flowers bloom late in the season and are generally seen in July and August. The fruits ripen in the latter part of August and the beginning of September. Many small fruits grow wild and in places very abundant, such as strawberries, raspberries, gooseberries, currants, huckleberries, cranberries, blueberries, June-berries, bunchberries and dewberries. These make choice food for the many bears which are to be found in the district.

The principal tree of the district is the jackpine. The country at one time was thickly covered with forests of this variety, but owing chiefly to carelessness these are now nearly burnt off and are either standing dry timber or windfall. Some of these dry pines on the rich slope measure two and a half to three feet in diameter, at four feet from the ground. A dense second growth of pine is again springing up where the fire passed over a few years ago, and if proper care was taken the country would soon be reforested. Other varieties of this district are spruce, poplar, balsam, cottonwood, tamarack and a few birch along Smoky river.

Below is given a catalogue of the various plants which were examined during the season. Nothing was done with the grasses, the mosses or the lichens, and only a few of the members of the Compositæ family were examined.

MONOCOTYLEDONS.

Order.	Family.	Genera.	Species.	Common Name and Remarks.
Orchidales.	Orchidaceae.	Calypso.	C. borealis.	
Liliales.	Liliaceae.	Veratrum.	V. viride.	American white hellebore (poisonous).

DICOTYLEDONS.

Polygonales.	Polygonaceae.	Oxyria.	digynia.	
Caryphyllales.	Caryophyllaceae.	Stellaria.		Chickweed.
Ranunculales.	Ranunculaceae.	Delphinium scopulorum.		Larkspur.
		Anemone.	A. multifida.	
		Aquilegia.	A. formosa.	Columbine.
Rosales.	Crassulaceae.	Sedum.	S. roseum.	stone crop or orpine.
	Saxifragaceae.	Mitella.	M. nuda.	mitrewort, bishop's cap.
		Ribes.	R. oxyacanthoides	wild gooseberry.
			R. floridum.	wild black currant.
			R. prostratum.	fetid currant.
		Parnassia.	P. palustris.	
		Saxifraga.	S. tricuspidata.	

DICOTYLEDONS—*Continued.*

Order.	Family.	Genera.	Species.	Common Name and Remarks.
	Rosacea.	Spiraea.	S. opulifolia.	meadow sweet.
		Amelanchier.	A. canadensis.	June-berry.
		Potentilla.	P. anserina.	silvery cinquefoil.
			P. fruticosa.	shrubby cinquefoil.
		Geum.	G. rivale.	
		Fragaria.	F. vesca.	wild strawberry.
		Dryas.	D. Drummondii.	
		Rubus.	R. Strigosus.	raspberry.
			R. Chamaemorus.	cloud berry.
	Leguminosae.	Lupinus.	L. arcticus.	wild lupine.
		Oxytropis.	O. splendens.	
		Hedysarum.	H. boreale.	
		Vicia.	V. americana.	vetch, tare.
		Lathyrus.	L. ochroleucus.	everlasting pea.
Geraniales.	Geraniaceae.	Geranium.	G. Richardsonii.	cranesbill.
Violates.	Violaceae.	Viola.	V. blanda.	white violet.
			V. palmata.	blue violet.
			V. canadensis.	Canada violet.
Mystales.	Onagraceae.	Epilobium.	E. angustifolium.	great willow herb.
Umbellales.	Umbelliferae.	Archangelica.	A. atropurpurea.	great angelica.
	Cornaceae.	Cornus.	C. canadensis.	bunchberry.
Ericales.	Ericaceae.	Andromeda.	A. polifolia.	
		Arctostaphylos.	A. uva-ursi.	bearberry.
		Kalmia.	K. glauca.	pale laurel.
		Purola.	P. minor.	wintergreen.
		Moneses.	M. uniflora.	one-flowered pyrola.
		Ledum.	L. latifolium.	Labrador tea.
		Rhododendron.	R. albiflorum.	
		Gaylussaoia.	G. dumosa.	
		Vaccinium.	V. canadensis.	Canadian blue berry.
Gentianales.	Gentianaceae.	Gentiana.	G. acuta.	
Polemonales.	Polemoniaceae.	Polemonium.	P. Franklinii.	
	Boraginaceae.	Mertensia.	M paniculata.	lungwort.
	Scrophulariaceae.	Pentstemon.	P. cristatus.	beard-tongue.
		Castilleia.	C. pallida.	pale-painted cup.
			C. miniata.	red-painted cup.
		Pedicularis.	P. eanadensis.	lousewort.
			P. lanceolata.	
Rubiales.	Rubiaceae.	Galium.	G. boreale.	northern bedstraw.
	Caprifoliaceae.	Lonicera.	L. involucrata.	honeysuckle.
		Linnaea.	L. borealis.	twinflower.
Campanulales.	Campanulaceae.	Campanula.	C. rotundifolia.	Scotch bluebell.
	Compositae.	Aster.	A. radula.	
		Erigeron.	E. acris.	fleabane.
		Achillea.	A. millefolium.	yarrow.
		Arnica.	A. cordifolia.	

There were six of the exposures of coal seams found in range 7 examined, five of these were in section 2 and one in section 4. It is very difficult to make out the geology in this district, owing to the crushing and folding due to the mountain formation, and the time spent was not long enough to make it possible to determine with any degree of accuracy the position and amount of coal. The displacement and folding had been such, that within fifty yards the same rock may be seen dipping in opposite directions. All that was done therefore was to make a rough examination of the exposures and their approximate positions.

Exposure No. 1.—Beginning at the bed of the creek, and going upward were seen the following strata: First about ten feet of brown sandstone then six bands of coal and shale mixed, and from one to two feet thick, between these bands were beds of sandstone; these covered about fifteen feet and afterwards there was about sixty feet of shale and sandstone, with small layers of iron clay. On top of this was about thirty feet of alternate bands of coal and highly carbonized shale; the bands of coal in these thirty feet are from two to eight feet thick and above this there was about sixty feet of brown sandstone with a couple of bands about one foot thick of coal. The dip of these seams was about 60° from the horizon towards the northeast, the strike was about S 45° E.

Exposure No. 2.—The formations of all the exposures are very similar and much like that described in No. 1, but the outcrops of coal are different. Here was found a seam of coal from eight to ten feet thick; this seam was better defined than any in the preceding exposure. Part of the coal here projected out from the rocks, and it had a very good appearance. The dip was about 45° towards the northeast and the strike was about S 20° E.

Exposure No. 3.—Here was seen a seam about six feet in thickness, but was not nearly so well defined, nor of as good a quality as No. 2. The dip was 75° toward the northeast and the strike about S 50° E.

Exposure No. 4.—This was very similar to No. 3, but the seam was much wider, and twisted and crushed. There has evidently been a folding of the rocks here, as the dip was completely changed, being about 50° towards the southwest while the strike was about due north.

Exposure No. 5.—The coal of this exposure was the best found on Creek No. 1, but the seam was only four feet in thickness, and the walls were very good, the dip being about 50° toward the northeast and the strike S 20° E.

Exposure No. 6.—This was the one found on Creek No. 2 and appeared to be the most promising of any. It was about eight to ten feet thick, and the coal appeared to be of good quality. The dip here was nearly opposite that in creek No. 1, being about 45° toward the northwest and its strike was about N 30° E.

This coal is thought to belong to the Kootanie measures, and if so, it is the farthest north along the Rockies, that this variety has been found.

APPENDIX No. 22.

EXTRACTS FROM THE REPORT OF H. S. HOLCROFT, D.L.S.

RESURVEYS IN CENTRAL ALBERTA.

I left Camrose by trail on June 6, and arrived at section 29, township 44, range 19, west of the fourth meridian, on the 7th, and at once proceeded to traverse the banks of Battle river, in townships 44, ranges 18 and 19, township 43, range 18, and townships 41 and 42, range 17. I also retraced several blocks of sections in various parts of the surrounding country, and traversed some small lakes.

Here the country is moderately well settled, and appears to be prosperous; there are many schools, stores and post-offices. In some places the roads are graded and the work appears to be advancing very rapidly, but there is still room for immense improvement. Lack of scientific drainage and suitable road metal is the cause of inefficient work. The summer was rather dry and the crops were excellent, only an occasional narrow strip being hailed out. There is very little ranching being done now, as hay in large quantities is difficult for one person to get, but it can be cut on the uplands in considerable quantities. The soil is generally a clay loam, overlying a clay subsoil, although in many places the top soil is black loam of a good depth. The soil in the valley of Battle river is pure hard clay, and not suitable for agriculture except in a few places; this valley is from one-half to one mile wide The river itself is, in summer time very little over a chain wide, with a very swift current in most places, and in depth it varies from two to eight feet. It is very tortuous, in some places winding around bends of nearly a mile in length, and coming back within a few feet of itself again. The banks are covered nearly all the way with a dense jungle-like growth of willow, poplar and balm of Gilead.

Driedmeat lake, an expansion of Battle river in township 44, range 19, is a lake about half a mile wide, and contains pike in large numbers. Later in the year the lake drops considerably, and becomes filled with a dense marine growth, but the water in the river is fresh. Although the river is swift and contains a few small rapids, no water-power could be developed in any of the townships that I surveyed. More bridges over Battle river are badly needed to facilitate communication.

A good domestic quality of lignite occurs abundantly in the valley, and outcroppings can be seen for many miles. Sometimes there are three or four outcrops at different levels from the river bed to the top of the hill, and in several places there are tunnels where the farmers in the surrounding district get out all the coal they need. The longest tunnel I saw was about one hundred and fifty feet, and was timbered up. From this mine a considerable quantity of coal was freighted to Daysland and other points on the railroad. No other minerals of economic value were seen.

A considerable number of ducks and some geese, pinnated grouse and ruffed grouse were seen. There were some signs of red deer, muskrat and mink, while coyotes and gophers were plentiful, but badgers and foxes scarce.

The Canadian Northern railway is partially completed from Vegreville to Calgary and a Grand Trunk Pacific branch line is surveyed through and the location partially chosen.

Late in August I drove from Ferry Point in section 35, township 43, range 18, to township 38, range 16, to traverse a small lake in section 12. On this trip I passed through an excellent and prosperous portion of the country, near Red Willow and Stettler. The farmers there were working all night, by moonlight, to get their crops cut.

I next investigated and corrected the markings on some posts in township 47, range 14, and then a portion of township 57, range 12. I finished the subdivision of this township on the 23rd, and on the 24th moved to section 2, township 58, range 10, and proceeded to lay out the parcels of land for the half-breed claimants in townships 57 and 58, ranges 9 and 10, according to instructions.

ST. PAUL DE METIS HALF-BREED RESERVE.

What is known as the St. Paul de Metis half-breed reserve consisted of townships 57 and 58, ranges 9 and 10, situated about fifteen miles north of the Saskatchewan. These townships were recently thrown open for homesteading, and it was decided to mark out the several corners of the parcels of land in these townships which were allotted to the half-breed claimants. My experience while doing this work proved to me that it was necessary to lay out all the corners of the various parcels, as most of the claimants had very remote and vague ideas where the limits of their parcels were, and where the road allowances were to be left. Houses and fences were scattered indiscriminately over the land. Hitherto these people had lived more or less as a community, squatting where they pleased, and cultivating any little patch of land that was convenient. Now more settlers are coming in and taking up homesteads there, and in the adjoining townships. The settlers who settle close by are mostly French Canadians, though others are coming in.

Quite a village has sprung up at St. Paul de Metis, in sections 4, 5, 8 and 9, township 58, range 9. About four hundred acres is laid out into town lots, and about fifteen or twenty buildings were erected during October, 1909. There are about forty or fifty buildings now, including shops, stores, houses, &c. There is a tri-weekly mail, twice a week from Vegreville and once a week from Vermilion; a land agent is resident here, and is always busy. As with most new towns the people are optimistic about a railroad coming in. The first query is generally 'Where do you think the railway will go?' or 'When do you think they will start building the road?'

Townships 57 and 58, range 10, and township 58, range 9, contain a large amount of excellent farming land and there is plenty of water of fair quality in the sloughs and lakes. The water got by digging wells is usually slightly alkaline. There is lots of slough and meadow hay, and plenty of fuel in the form of poplar, willow, balm of Gilead, and a few spruce. No coal or lignite has been discovered near here yet.

On November 20 I finished the work at St. Paul de Metis, and proceeded on the old Battleford-Fort Pitt trail to Hewitt Landing in township 53, range 26, where I had instructions to do some work.

APPENDIX No. 23.

EXTRACTS FROM THE REPORT OF E. W. HUBBELL, D.L.S.

RESURVEYS AND INSPECTION OF CONTRACTS IN THE PROVINCE OF SASKATCHEWAN.

We left Prince Albert on March 23 to begin inspection work in townships 51, ranges 14, 15, 16, 17 and 18, and townships 52, ranges 14 and 15, west of the second meridian and crossed the Saskatchewan river on the ice and proceeded northeasterly along the Candle lake trail for about forty miles. From there to Lost river, we passed through a country which is fairly heavily timbered with spruce, jackpine, tamarack and poplar, a fair portion being suitable for manufacturing purposes. There are numerous sloughs and muskegs with sand ridges intervening covered with jackpine. The soil is generally of a sandy nature and the surface is fairly level. The townships inspected are thickly covered with poplar, spruce, jackpine and willow. The surface is fairly level, except where there are sand ridges, and towards the Saskatchewan and Whitefox rivers.

There are no trails in this section of the country except one made by the surveyors, which enters these townships from the west, via. Prince Albert, nor are there any settlers, but doubtless there soon will be as many fine homesteads are available. Lost river, the nearest post-officé, situated on the south side of Saskatchewan river in section 32, township 49, range 15, has a weekly mail service from 'Star City,' on the Canadian Northern railway, and distant about forty-five miles. The country is well supplied with fresh water but hay swamps are scarce and game is plentiful

My next work consisted of resurveys in southern Saskatchewan, in township 24, range 11, west of the third meridian.

We commenced the survey of township 24, range 11, on June 17, and finished on the 22nd, surveying sixty-six miles of section line and traversing several small lakes. I found the original monuments so obliterated that a resurvey was preferable and more satisfactory. The soil in this township, in general, is a clay loam, varied occasionally by gumbo and gravel. In my opinion all kinds of grain and vegetables could be successfully raised here. The surface might be classed as rolling, although in places is quite hilly and the tops of the hills are frequently covered with boulders and stones. There is no timber whatever and but a few small hay sloughs. The larger bodies of water are strongly alkaline but in occasional pot-holes a limited supply of fairly palatable water is obtainable: however, from subsequent knowledge I found that these pot-holes during the months of July and August become dry.

There are no trails or settlers in this township, and the nearest post-office is Rossduff, situated in section 24, township 24, range 10, where they have a weekly mail service, the mail being brought from Elbow, a small town on a branch line from Moosejaw on the Canadian Pacific railway, which is also the nearest express and telegraph office. My next work was the resurvey of township 23, range 11, consisting of fifty-four miles which we commenced on June 23, and finished on July 6.

The same characteristics and topographical features occur in this township as stated in my report for township 24, range 11.

We now proceeded to resurvey townships 22 and 21, range 11, west of the third meridian, commencing July 7 and finishing August 4, having surveyed one hundred and eight miles. The soil of these townships is in general a clay loam, interspersed throughout with gumbo, gravel and alkali. The nearest post-office is Lucky lake, situated in section 30, township 23, range 8, to which the weekly mail is brought from Elbow, distant thirty miles. The eastern part of township 21, range 11, is considerably broken by ravines and coulées which extend into the South Saskatchewan river. There is one settler on section 1, township 22, range 11. From here we proceeded to township 23, range 12, and completed the resurvey on August 21, having surveyed sixty-six miles and traversed several lakes, mostly alkaline. We now travelled to Zealandia, distant sixty-five miles by trail, where we arrived August 25. The greater portion of the country in this district is admirably adapted for settlement, and most of the homesteads are appropriated. Everywhere signs of prosperity were visible, and at that time of the year, August 24, about sixty per cent of the magnificent crops were harvested. It was a grand sight indeed to see such tangible signs of prosperity, and the unusual excellent crops speak well for the future development of this section of the country. The average yield, as far as I could ascertain, was, wheat, twenty-five bushels to the acre, oats, about sixty, and flax, eighteen, truly a remarkable yield. The only drawback is lack of good water, and in this respect it may be in order to mention that upon more than one occasion I paid for drinking water for man and horse. However, this objection will soon be overcome as many settlers are digging wells and as a rule are fairly successful in obtaining a supply of good water.

In the five townships surveyed by me there is no wood, and a very small percentage of drinking water, in fact, during the months of July and August, we had to dig wells and were frequently disappointed in the results. There are no indications of coal or minerals; all the lakes are alkaline, and but a few small springs of fresh water are in township 23, range 12. This is an ideal ranching country, and large herds of cattle and bands of horses roam in the vicinity. Unfortunately newly dug pits appear a special attraction for these animals who paw and tear them up with their horns and hoofs, so much so, that in a few days they become almost obliterated and unrecognizable as survey monuments. The largest ranch in this district is the 'Matador' comprising townships 20 and 21, ranges 12, 13 and 14, and completely fenced. There are about 30,000 head of cattle in this ranch and their shipping place is Swift Current. During the time we were at work in this vicinity, about three months, June, July and August, the heat at times was excessive, July 24, being almost unbearable. Mosquitoes and bot flies were most troublesome, especially the latter, which at times almost drove the horses wild. A limited amount of firewood is obtainable from the coulées and ravines which extend into the South Saskatchewan. Good water is very scarce, a few springs and scattered pot-holes which contain rain and surface water being the principal source. It becomes extremely limited during the dry season as the supply depends upon the rainfall. Settlers of the surrounding district draw water many miles in specially constructed tanks. During June and July we had ten rainy days in each month and but two days in August. On several occasions these rains were accompanied by severe electrical storms and on July 6, a little hail fell.

In township 23, range 12, at sixty-five chains north of the northeast corner of section 10, we saw a portion of a large petrified tree with very distinct axe marks on it. When one considers that there have been no trees in this section of the country for centuries, the discovery is at least peculiar and interesting.

On August 26, we left Zealandia, bound for Prince Albert where we arrived the following evening. From here we travelled on a good trail to Tisdale, about one hundred miles, passing through a beautiful, and fertile country, interspersed with clumps of poplar. In every direction numerous reaping machines and an occasional threshing outfit were in operation. It was quite apparent that the various grains were not as far advanced as in the southern part of Saskatchewan, doubtless due to the higher latitude and heavier soil. About fifty per cent of the crops were cut at this date, September 1, and I afterwards learned that the yield was quite up to the expectations of the farmers. The soil for the greater part of this district adjoining the Canadian Northern railway is excellent, suitable for the production of all varieties of grain and vegetables; a continuous and excellent supply of fresh water abounds everywhere and the climate is delightful. We continued inspection of contract surveys in the vicinity of New Osgoode and Lost River until October 15.

While in township 50, range 14, we came across a large camp of Indians engaged in drying moose meat, their camp resembling a perfect shambles. We subsequently learned that they had killed fifteen moose in ten days. As this slaughter is done out of season, and in various locations, it does not require a very vivid imagination to predict the inevitable and final result. Surely some stringent and drastic method might be adopted by the different governments to prevent this indiscriminate slaughter of Canada's most noble game.

The only trail in these townships is one made by the surveyors. The nearest post-office is Lost River, twenty-five to thirty miles distant, where there is a weekly mail service from Tisdale, a small town on the Canadian Northern railway, distant forty miles. While at work on this contract there were several large bush fires, and on one occasion so close was the fire that we had to stop work for the day. These large fires are at times a serious menace to survey parties as the opportunities for retreat are rather limited and it sometimes happens that surveyors have had their whole outfits destroyed by fire.

Inspection work was carried on from October 16 to November 16 in the vicinity of Crooked river, when we were compelled by weather conditions to close operations for the season.

In passing through the Indian reserve at Nut lake, the spectator is astonished at the immense area of uncut magnificent hay at the north end of the lake. This reserve is very prettily situated and I was agreeably surprised to see such a number of fields of grain cultivated by the Indians, which speaks well for their progressiveness and the fertility of the soil. They were very proud of the result of their labours and expressed their intentions to increase the yield next year.

Speaking generally the weather was favourable for surveying operations, although the atmospheric conditions, at times, were averse to observing Polaris as often as desired. On April 10, there was a heavy snowstorm which covered the ground to a depth of two feet, making travel with wagons most tiresome. On May 9, some of my party crossed Saskatchewan river on the ice, and the following day the ice broke up. The snow was practically gone by May 8, and its first appearance again, of any account, was October 22. The greatest quantity of rain fell during June and July, ten days in each month. The hottest day was July 24, the thermometer registering 98° in the shade, and the coldest day, November 13, 36° below zero. Sloughs were frozen over October 15, while April and the latter part of November were exceptionally cold.

Mosquitoes and black flies were not as numerous as the previous year, but during July and August, while at work on the prairie, the horses suffered very much from the constant attack of bot flies.

Swamp fever was again quite prevalent on the prairie and three of my horses succumbed although every known precaution was taken.

We did not perceive any indications of minerals or coal during the survey. Great quantities of game, both of the feathered variety and deer abound throughout this country. Moose especially were most numerous north of Saskatchewan river, in Lost river district.

On May 15th, at 9.10 p.m., a distinct earthquake was felt, lasting about thirty seconds.

The Canadian Northern railway has completed its magnificent steel railway and traffic bridge across Saskatchewan river at Prince Albert and have graded their railway as far as Shellbrook, a new small thriving town about fifty miles from Prince Albert.

APPENDIX No. 24.

EXTRACTS FROM THE REPORT OF A. W. JOHNSON, D.L.S

SURVEYS IN THE RAILWAY BELT OF BRITISH COLUMBIA.

My first work in the New Westminster district during 1909 was to pick up and perpetuate as many of the old corners as possible around the Musqueam Indian reserve and lots 2 and 3, group 2.

I have indicated in the notes that it is probable the southwest corner of the plot of land made over to the Department of Militia and Defence is incorrect, and have shown its probable true position.

In most cases I put in a piece of iron pipe and a cedar post as well, where there was no reasonable doubt as to the true position of the corners. The weather while we were here was very wet.

On February 20, we camped on loch Erroch, near Harrison Mills, for the purpose of correcting the positions of the posts on the seventh meridian. I made very careful connections with various Canadian Pacific traverse points and the seventh meridian and then put all posts on that meridian. The posts in township 24 east of the coast meridian were generally forty links to the east. I destroyed these and substituted iron posts and stone mounds on the seventh meridian itself.

I traversed loch Erroch and a proposed road leading from the present road between Harrison bay and Nicomen, and Nicomen slough, besides running lines in section 20, township 3, range 30, west of the sixth meridian.

I next moved with my assistants and two men to Yale to finish work on the old Emory townsite, I found too much snow, and so went up to Kamloops on March 10 to finish my notes.

On April 22 I began again at Emory and connected the townsite with the Dominion system. Afterwards I moved up to Yale and ran some lines connecting the townsite with the Queen mineral claim on Yale creek.

On May 13 I moved down to Mr. Hogg's ranch near Agassiz.

I defined the northeast corner of section 22, township 3, range 29, west of the sixth meridian and the north boundary of section 22 from Canadian Pacific traverse points and other data and then went across the Fraser to Rosedale.

I retraced some old lines and ran some new ones in sections 26 and 35, township 2, range 29, and in section 6, township 3, range 28, west of the sixth meridian. This land is rapidly settling up and is suffering only from the fact that 160 acres is four times as much as one family can clear in this district of big timber.

Then I surveyed timber berth No. 296, block 1. About two-thirds of this berth is on the precipitous buttresses of Mount. Cheam. In fact we often had to climb between two and three thousand feet between breakfast and the beginning of work, and the angles were tremendous, in one case more than sixty degrees, so that though I had sighted up, on looking back the plate prevented my seeing the back picket, and I had to go back again and work around in a different way.

There is good cedar and fir on the flat, averaging thirty-six inches and good fir on the hillsides averaging twenty-four inches, but most of the timber on the hill is hemlock.

The agricultural land on the flat part of the berth consisting of about 200 acres altogether, is good. The hillsides are so steep that on the remaining 440 acres agriculture is out of the question.

I had instructions to survey timber berth No. 533 on Lillooet lake, which we began at the end of June. Where timber berths are not sections or other regular parts of the Dominion system, it strikes me that a compass survey would cover the case. To have a line that sidles up a couple of miles of precipices because it is inaccessible, is liable to bring a note from the Crown Timber agent, and while there are probably no timber berth lines that an enterprising surveyor who sets small enough store by his neck or his transit cannot define by at least two posts, somewhere on line, the same result, barring a little accuracy, could be obtained in a very much shorter time by compass.

While this work was going on I took an assistant and one man to Harrison lake to run the lines of timber berth No. 534.

We continued work in township 3, range 4, west of the seventh meridian from where I left off near Pitt meadows the year before, and ran the township line east, to the top of the ridge between the Lillooet and Stave rivers. This is heavily timbered country and very rough, particularly the first two miles east of the Lillooet. There are no trails near the line, until the top of the ridge is reached from where one runs into Whonock.

We had an unusually wet summer; the ordinary rainfall on Stave lake, I am told, is one hundred and twenty-six inches. It is probable that upon the ridge it is fifteen inches more than this in an average year. What it was this year I don't know, but we had a tremendous lot of rain. In fact, for weeks we were hardly ever dry, especially as the undergrowth is dense huckleberry, as high as a man's head.

The ground is swampy in many places and the cedars themselves seem to feel the excessive moisture, for you find over hundreds of acres of them with dead tops and the inside rotted.

I understand that there is a fire clay on this ridge. There is some fine cedar and fir on the slopes of the hill, but also a lot of cedar that will only make shingles. There is more yellow cedar than I have seen anywhere except around Chehalis lake.

The land will not be used for agriculture for many years, and at least half of sections 6, 5, 4, 3, 2 and 1 in township 4, range 4, are either too steep or too swampy for that purpose.

The rain, which was with us always, got heavier towards the end of September, and we had snow as well which made the huckleberry bushes worse than ever.

While the Lillooet survey was beginning I went up the Bedwell bay on the north arm of Burrard inlet with Mr. Harkin, Secretary to the Minister of the Interior, and a few men to make a preliminary contour sketch of parts of sections 24 and 25 in the fractional township west of township 39, west of the coast meridian. It was proposed to subdivide this into acre and half acre lots approximately, with the idea of making a summer resort. With the help of Mr. Harkin I made a sketch of a proposed subdivision, sent it to Ottawa, and then went back to the party on the Lillooet.

In the middle of October we came down here again from Whonock and began the subdivision. I posted a large part of this, making use only of the straight lines in the design. Later on it was decided that curves should be substituted and that a road should be left along the water front. Also a great deal more of the Government land was included in the part to be subdivided.

There are 'skid' roads running through this property, which it is advisable to utilize on the plan as roads, and the character of the land is decidedly hilly in places. In fact the best part of the subdivision lies on a hill that faces the head of the inlet and slopes to the salt water of Bedwell bay.

The view is unsurpassed in the neighbourhood of Vancouver. There is a lake nearly a mile long, half a mile east from the inlet, from which a good skid road on an excellent grade runs to the inlet close to Port Moody, so that this subdivision could be very easily made accessible from New Westminster by land, as it is now by water from Vancouver. The distance is about the same from both places, being ten or eleven miles in either case, an hour and a half by motor boat, or three-quarters of an hour by motor car when the road is improved. With my new instructions I began work again and kept it going all winter. When the rain was a regular waterspout we worked on the roads; at other times we worked the transit under a carriage umbrella.

I am opening out eight-foot roads, cutting out all logs and blasting the stumps. I am not doing any grading as that would necessitate horses and a large number of men, but the present roads will be very useful to people who live a short distance from the water front.

The work has been slow, because the lines have to be altered so often to avoid obstructions along roads that the contour sketch, from which the design was made, did not show. In spite of the hills most of the roads are on good easy grades and very few in the entire subdivision that a horse and rig could not climb. The blocks are being laid out over the whole property, but only a limited number of the more accessible ones close to the water and the skid roads are being actually subdivided and posted in detail at this time.

The others can be easily picked up on the ground and cut into lots at any time when more land is sold.

APPENDIX No. 25.

EXTRACTS FROM THE REPORT OF G. J. LONERGAN, D.L.S.

MISCELLANEOUS SURVEYS AND INSPECTION OF CONTRACTS.

The first work of the season was the reposting of St. Albert settlement. This work covered an area about fifteen miles long with a width varying from two to three miles. The settlement was originally subdivided into irregularly shaped lots in order to give the squatters the land they were settled on. In the original survey wooden posts were used without mounds and the repeated fires had destroyed about nine-tenths of them.

The town of St. Albert is situated on both banks of Sturgeon river and has a population of about 500. It is nine miles from Edmonton and will soon be connected with the capital of the province by an electric railway, although at present the Canadian Northern railway passes through the town. It is generally understood that this railway company intends to make St. Albert a junction town for the two branches of the road, one going northwest to Peace river and the other northeast to McMurray, and to locate their car shops there. The headquarters of the Roman Catholic mission of the West are situated at St. Albert. They have a large seminary and college, and a school for Indian children. The only manufacturing establishments at present are a flour mill with a capacity of one hundred barrels per day, and a brick yard. Big lake, the south boundary of the west half of the settlement, is very shallow. If the bottom of the river were lowered a few feet a thousand acres of the best hay land would be available. and I beg to recommend that the attention of the provincial government be drawn to this so that a survey may be made and the costs of draining the lake ascertained.

Having completed the survey of St. Albert, I left to inspect survey contracts that had been awarded to the different surveyors in the eastern part of the province of Alberta and the western part of Saskatchewan. We left Edmonton on August 23 and going in a northeasterly direction passed through the towns of Fort Saskatchewan, Bruderheim and Andrew. All along the road the country is well settled and we travelled on graded roads most of the way. The Galicians are proving themselves worthy of Canadian citizenship. I have been through the district a number of times. and every year I can notice the improvements, a larger number of acres under cultivation, permanent and straight fences and the sod-roofed shacks being replaced by sanitary and more comfortable dwellings. The oxen are kept for breaking purposes only, to which they are more suited than horses. The farmers have good and well kept horses for the lighter work as well as for driving. Schools are seen in every direction and they are well attended. These foreigners realize the benefit of an English education and they are trying to have their children take advantage of the schools.

After crossing Saskatchewan river at Desjarlais a few miles, mostly up hill, brought us to Sacred Heart, the Sister's mission near the west boundary of the Saddle Lake Indian reserve. Here is a school for Indian children, where they are boarded, clothed and educated. Although I did not visit the school when passing I enjoyed a rare musical treat furnished by the children. It may be news for many to learn that there is printed here a newspaper in the Cree language that has a large circulation and is much appreciated by the Indians. They are anxious for their paper and read the news as eagerly as any white man. When at Saddle lake, through my interpreter, I learned that the Indians were under the impression that the Government was about to enfranchise them and give them the same freedom as other citizens, not in a body but according as they proved themselves worthy. It might be a good move; at least an experiment could be tried on a small reserve. To-day the Indian who makes a success of farming or any other occupation is in the eyes of the law no better than his fellow Indian. If he wishes to sell an animal or leave the reserve he must first get permission from the agent. Of course there is no doubt that the agent uses discretion and gives the entirely self-supporting Indian greater privileges than his lazy brother, nevertheless they are keenly sensitive to the fact that they must see the agent for every business deal they wish to make. It will be a long time before they can be freed, for it is surprising the number who would willingly exchange anything they possess for another article one-hundredth of its value, that takes their fancy, but as possession dims the lustre of the diamond, so with the Indian, and he soon cries for an exchange back. Were they all free from the reserve we can easily realize that their cries would go unheard and consequently their families would perish and once more the ruling law of nature would be exemplified, 'The survival of the fittest.'

Leaving Saddle lake I travelled northward to townships 63 and 64, ranges 13, 14 and 15. These townships are traversed by both Beaver and Little Beaver rivers. The land consists generally of a few inches of black loam and a white clay subsoil. It is covered with poplar and spruce from three to eight inches in diameter with a thick undergrowth. A good cut of spruce, about two miles in width, crosses township 64 in an easterly and westerly direction. This spruce is from fifteen to thirty-five inches in diameter, straight and without limbs for the first twenty feet, in short it is as fine a lot of timber as I have ever seen. Leaving here I followed the north bank of Little Beaver river to its confluence with the Beaver in range 10. We then worked easterly through ranges 10, 9, 8 and 7, in townships 62 and 61, just following the northern edge of the St. Paul de Metis settlement. Although this newly surveyed district is not yet settled it certainly is not the kind that will remain idle long. The soil is a black loam, three or four inches deep with a clay subsoil; many places are open but there are bluffs of scrub with a few patches of good building timber, making an ideal home for the poor man. The first year he can build himself a shack and stable, cut sufficient hay as well as break a few acres and have a small crop the second year.

Continuing easterly I arrived in October at Cold lake. Here the country is rolling, that is for a mile or two around the lake and I was told by a settler that vegetation was a month later within a mile of the lake shore than farther back. This is unfortunate, for the prettiest building sites in the world are around this body of water. The lake is large and teeming with fish; large fresh salmon-trout were worth only ten cents each.

From information received from the Indians and from what I saw I would judge that the land between Cold lake and lac La Biche is of the best quality. At one place ten miles west of Cold lake there is a piece of prairie twenty miles square. The land generally is three to four inches of black loam with a clay subsoil and is covered with small poplar, birch and spruce.

A ferry is badly wanted on Beaver river, and some roadwork should be done on the hills on either side. Taking the ford on the south side the horses and wagons drop down a ten-foot cut bank and plunge into a whirling stream. Land seekers are afraid to risk their teams and in some cases most of their possessions in such a place, consequently settlement of this district north of Beaver river is at a standstill, and will remain so until some improvements are made. Going south from here on the old trail and crossing Frog creek at its mouth we came to the burying ground where the victims of the Frog lake massacre during the half-breed rebellion of 1885, were buried. A word of praise is due to the Royal Northwest Mounted police who have contributed part of their salary to build a fence around this graveyard. The detachment at Onion lake trim up the graves and give to the visitors passing this lonely spot twenty miles from a settlement, proof that these dead and their deeds are not forgotten, for this plot is as neat and as well kept as any city cemetery.

The best part of the land between Cold Lake and Onion Lake Indian reserves is taken up by the Frog Lake Indians, although northwest of Frog lake some good sections of rolling country are to be found. In most of the unsettled country here, however, the soil is poor and there are many lakes and tamarack swamps. The clay soil is covered with small spruce, tamarack, poplar and white birch. About the same conditions of soil and vegetation extend easterly along the ridge north of Onion Lake mission until the land starts to drop towards Red Deer river. For ten miles on either side of this river is to be found ideal land to locate on, and an abundant supply of water can be had from wells not exceeding twenty feet deep. The surface of the country is slightly rolling with four to eight inches of black loam, and seventy-five per cent is open prairie, the poplar bluffs gradually running into thicker timber northward. I was in this valley only a week and met over twenty people looking for homesteads.

Leaving here I started for Edmonton whence I went northwest to townships 62 and 63, ranges 25 and 26. This country is principally swamps and gravel ridges with a little fair land in places. However, when drained it will be fair farm land.

APPENDIX No. 26.

EXTRACTS FROM THE REPORT OF C. F. MILES, D.L.S.

MISCELLANEOUS RESURVEYS AND INSPECTION OF CONTRACTS IN SOUTHERN SASKATCHEWAN.

I found township 23, range 5, west of the third meridian well settled, but the monuments were nearly obliterated. It consists of open undulating prairie, mostly second-class. Owing to its proximity to the sand hills in the east, most of the soil is light.

While encamped in this township a very disasterous prairie fire occurred, doing in many instances great damage to the property of the settlers, injuring some of their stock so that they had to be killed, also destroying houses, mostly built of sod, and hay-stacks.

We next resurveyed townships 21 and 22, range 10. There were but few iron posts remaining and they were not marked, the old tins having disappeared and pits and mounds being nearly obliterated.

Probably three-quarters of township 21 is well adapted for farming purposes, the remainder being more or less broken by spurs of the 'Snake Bite' ridge from the west. and ravines running into the creek of the same name on the east.

From here I moved my camp westerly, passing to the north of the Matadore ranch, which is all fenced in. This part of the country is rolling and hilly and better adapted for cattle raising than farming. There are a number of small ponds scattered among the hills and signs of cattle also were seen. We discovered that the cattle of the Crookshank ranch were summering here; early in the season we had seen them grazing in townships 21, ranges 10 and 11. The country to the south, as far as could be seen, appeared hilly and broken.

We then resurveyed townships 25 and 26, range 17. The soil is a very stiff clay with but very little black loam, which I am informed, after being broken up, will produce good crops. There were no settlers in these two townships. The surface is mostly rolling and undulating open prairie, the nearest wood for fuel having to be procured from the South Saskatchewan river, where it is not too plentiful either. From this camp we moved west to section 14, township 25, range 18. to a spring, the water of which was quite alkaline. From here we made a restoration survey of the township, the southeast part of which was in a low flat and the remainder on a plateau, the eastern part being chiefly rolling and the western part more level. The soil is heavy clay.

We then moved northerly and camped in township 26, range 18, and retraced that township which is rolling in the eastern part, and undulating in the western part, the soil being the same as in the others. For water we had to depend on rapidly drying sloughs. Along the western edge of the township were several settlers who had made considerable improvements.

A new railway from Saskatoon to Calgary is under construction and supplies from there can be brought with comparative ease. Zealandia and Rosetown are the two stations on the Goose Lake branch of the Canadian Northern railway nearest to these townships. Up to the present settlers have brought in their supplies from Swift Current on the Canadian Pacific railway more than double the distance, besides having to cross the South Saskatchewan at the 'Landing,' which at times is a somewhat risky undertaking. When my outfit crossed, after completing the restoration of these townships, going south to Swift Current, there had been heavy rains and the approaches to the ferry and out of the valley had been washed out; these however. have since been repaired and put in good shape.

West of my work in ranges 17 and 18, through Tyner and south to the river there are many settlers, whereas south of the 'Landing,' for about twenty miles there were no improvements noticed; entry may have been made for the land but it was not then occupied. On our way to Swift Current, we took occasion to branch off to sections 14 and 23 in township 18, range 14 to establish the monuments on the east boundaries of these sections. We left Swift Current on July 19, taking the old tote road along the Canadian Pacific railway track; however, owing to fences in many places, we had to make a detour, arriving at Maple Creek station on the 22nd. From here by outfit started for Battle Creek post-office, while I drove on to Walsh, where I had received instructions to settle with Mr. Nesbitt for wintering Mr. T. Fawcett's outfit and to dispose of the remainder of it. From Walsh I drove south through a well-settled country to the foot of the Cypress hills, about fifteen miles, mostly along the road allowance adjacent to the fourth meridian. From here the road ascends with some pretty steep ascents to the plateau on top of the Cypress hills. These hills (as they are called, although they are more of a raised plateau) are covered with a luxuriant growth of grass. A large quantity of hay is cut here, but ranchers in this district maintain that both horses and cattle prefer the shorter grasses. which are said to be more nutritious; few cattle are found on the plateau.

I descended by trail from the plateau into the Battle Creek valley. Here I struck a ranch which at one time had been 'Old Fort Walsh.' We were now over the 'divide' and the waters ran south, ultimately into the Gulf of Mexico instead of into Hudson Bay. Our work of inspection consisted of seven contracts (comprising about 175 townships) and extending along the international boundary from range 20, west of the second meridian to range 20, west of the fourth, the most northerly township being township 8.

Leaving Battle Creek post-office we struck south to Willow Creek post-office, and then worked westerly and back again easterly.

The whole length of our journey, on trails and off trails, we observed a great similarity in the nature of the soil, mostly gravelly and stony with but small areas of good soil. It appears that a tier of say four or five townships north from the international boundary should be reserved for grazing purposes. I think it might be advisable also to include the remaining timber, thus making it a combined grazing and forest reservation. Apart from the timber in the Cypress hills, there is none left but some on Milk river, in the coulees of Pinto Horse butte and in the ravines running out from Wood mountain. There is not enough timber in any particular locality to be set apart as a forest reserve. There are dozens of loads of timber drawn daily from the above sources of supply and it will be but a very short time, before the country will be completely denuded.

On July 29 we arrived at the Royal Northwest Mounted Police post, Lodge creek, an outpost from Maple creek, passing through poor country, covered in many places with cactus.

We passed several ranches, mostly stocked with horses, as owing to heavy losses during several winters past, the cattle have been gradually disposed of. South and west of Frenchman river the only remaining company of any magnitude, still in the cattle business, is the Blum cattle company. They have about 4,000 head north of the boundary, besides being the owners of other ranches in Montana, and one or two other western states. North and east of Frenchman river the largest cattle company originally starting with about 23,000 head of cattle, have gone out of business, their losses three seasons ago, aggregating about 12,000 head. Their cattle also ranged south to the international boundary. This company was generally known by the name of their brand 'Turkey Track.' One or two members of the old company have now gone into horse ranching altogether. Besides these there are still a few thousand head of cattle belonging to smaller ranches, running east of Pakowki lake. West of this lake for thirty or forty miles, quite a number of sheep men have located, principally along the Etzikom coulée, locally called Kipp coulée. Probably twenty miles south of this coulée, Milk river runs in a deep valley, increasing in depth and going easterly until it crosses the international boundary.

A number of settlers have located the past season northwest of Pakowki lake, the settlements extending all the way north to the Canadian Pacific railway and west to the Alberta Railway and Irrigation company's lands

My inspection work extended about twenty-five miles west of Coutts or Sweetgrass, a small collection of houses at the intersection of the Alberta railway with the international boundary. Ranchers along here are being gradually crowded out by squatters and homesteaders. This will have the effect of still further reducing the supply of beef cattle to be exported. The settlers will cultivate their lands and by degrees have the herd law introduced, which will be the beginning of the end of horse and cattle ranching.

Most of the land north of the boundary is more or less stony, and east of Frenchman river it is more or less broken by brooks and coulées running south across the boundary. There is no cultivation between Battle creek and Frenchman river, but in the valley of the latter there are a few settlers engaged in horse and cattle raising on a limited scale. East of Frenchman river are four tiers of townships north of the international boundary where there are no settlers up to near Wood mountain. Farther east there are some small areas of good land rather hilly and broken by Poplar river and its tributaries.

I travelled east as far as range 27 west of the second meridian. From here I moved north to Willowbunch, passing a prosperous sheep ranch on township 2, range 29. South of the Willowbunch in township 3, range 28, we passed through an apparently prosperous French settlement; a number of cattle were observed grazing around and a good number of hay stacks were also in sight from the trail. From Willowbunch we returned to Wood mountain and thence to townships 4, ranges 6 and 7.

On November 6 we started on our journey for Milestone on the 'Soo' branch of the Canadian Pacific railway passing again through Wood mountain and Elm Springs. Travelling northeasterly we passed a number of settlers, more particularly northerly from Willowbunch lake, and to judge by the number of grain stacks around their homesteads, they have had good crops in this vicinity. After traversing a range of hills and stopping to make a correction in township 11, range 25, on November 10, we reached a branch of Moosejaw creek, about six miles west of Milestone. From here the country is well settled to Milestone. Large fields are seen all along, flax apparently predominating. Much flax is sown about here on breaking, the seed fetching a good price on the market, bringing at that time $1.40 per bushel. Milestone is a flourishing little town, there being four or five grain elevators, which appear to be busy night and day. My camp was on Moosejaw creek on section 11, township 12, range 20, and from here we moved to township 15, range 20, about fourteen miles south of Regina, through a well settled country. We next moved westerly, by way of Moosejaw to Caron, on the main line of the Canadian Pacific railway, arriving in township 19, range 29, on November 19. It was getting very wintry, the mercury going down to 13° below zero on the following morning. We were travelling on wheels, although there was good sleighing, and it was surprising to see the quantities of grain still out in the field partly in stacks and a great deal still in the stook.

From the last camp we drove to Brownlee on the Outlook branch of the Canadian Pacific railway, retracing a few miles in township 21, range 29, thence to Girvin on the Canadian Northern railway. Adjoining Girvin, we did some work in township 25, range 28, on November 27, which concluded our work in this district.

Our last work was a survey of a timber berth in township 17, range 12, east of the principal meridian. We finished running the lines and making the traverses of the timber berth on December 28.

APPENDIX No. 27.

EXTRACTS FROM THE REPORT OF J. B. McFARLANE, D.L.S.

SURVEYS IN THE VICINITY OF YELLOWHEAD PASS.

On reaching Lake St. Ann we were compelled to change from sleighs to wagons. Our progress with wagons was impeded by the roads which had been opened for wagons only in places. On April 3 we reached Medicine Lodge flats, and my freighters returned from here as no wagon road was opened farther and no horse feed was procurable. The following Monday I cached part of my outfit and loading a pack train heavily with the necessaries for a week's camp crossed the divide and camped on the Athabaska near the north boundary of section 32, township 51, range 24, west of the fifth meridian, late Tuesday evening. The next day I located the Grand Trunk Pacific line and the sections it would cross. On April 8 I began the season's work by running the east boundary of section 33. This line intersects the location line of the Grand Trunk Pacific railway about eighteen chains south of the township boundary.

My work for the season was to survey the sections intersected by the location line of the Grand Trunk Pacific railway between the north boundary of township 51, range 24, west of the fifth meridian and Yellowhead pass in township 45, range 4, west of the sixth meridian. The railway line crosses the northwest corner of township 51, range 24, in a southwesterly direction, following the plateau east of the Athabaska. In township 51, range 25, it approaches the river, which it follows more or less closely, to the valley of Miette river. Thence it turns to the right and follows Miette river closely to Yellowhead pass. The Yellowhead pass pack trail, or the old Jasper pack trail, follows the railway closely; generally a branch of the trail is on either side of the Athabaska. A branch trail cut by railway surveyors along Brulé lake was also convenient for us, so that we had no trails to cut all season.

The Athabaska valley through townships 51, ranges 24, 25 and 26, is partly wooded with small jackpine and partly open brule with scattered poplar and willow. Spruce large enough for timber occurred only in a few small patches. The soil is chiefly sand and gravel, the loam on top averaging about two inches except in the muskegs or small flats where it has accumulated from the surrounding hills. In township 50, the western part of range 26 and the eastern part of range 27 are thickly covered with spruce averaging about ten inches in diameter, as is also the northeast corner of township 49, range 27, which lies east of Brulé lake. This timber is all included in timber berth No. 1099, and is almost wholly in Jasper Forest Park reserve, the northeast boundary of which passes close to the northeast corner of section 32, township 50, range 26, in a southeasterly direction. The southwest corner of township 49, range 27, is flooded to a large extent by the Athabaska, there being many ponds and channels at low water but at high water in many places the water is six feet deep among ten-inch spruce and thick willow. Several lines we contemplated running here had to be abandoned as there was no possible way of cutting them out. However the railway followed closely along lines run the previous year so that the object of the survey was not interfered with. Bullrush mountains on the west of Brulé lake and Folding mountain in the southeast encroach largely on this township and comprise the outside range of the Rockies. Above this the Athabaska valley is hemmed in closely with mountains, and our work was confined to a valley two or three miles wide, in which there is no good farming land, however, a half dozen settlers have each a few acres under cultivation. In places the river has many channels and low flats flooded at high water. but where the river banks are higher the land is sandy and dry. At high water the Athabaska, as well as all the smaller rivers, carry a great deal of suspended matter, a sort of fine clay silt. There is very little good timber between Brulé lake and Miette river, but some small spruce grows around the mouth of Rocky river and a few acres of spruce of good size is found around the northeast corner of section 34, township 48, range 28, which is contained in a timber berth. Hay is very scarce and is almost confined to a few muddy sloughs in township 47, range 1, west of the sixth meridian. Besides the rivers, small mountain streams are plentiful and supply the best of water. There are no valuable water-powers, but power in small quantities could be developed from small creeks which have a rapid fall down the mountain sides. The climate is moderate and is characteristic of the mountains, as innumerable small showers occur but no heavy rains. As far as we could learn the whole Athabaska valley in this vicinity is subject to summer frosts except a small area near Henry House, where perhaps some combination of winds down the Miette, Athabaska and Maligne valleys keeps the temperature above freezing point till late in autumn. Wood fuel is everywhere plentiful. Some veins of lignite were seen along the Athabaska. the thickest being about three feet, in township 51, range 25. Large deposits of better grades of coal are said to be found up Fiddle creek in township 49, range 27. No stone-quarries were opened nor were any minerals noticed.

The Miette valley lies nearly due east from Yellowhead pass to Athabaska river. The valley itself is very narrow, usually about twenty chains and the railway follows the river closely, mostly along the north bank. On the south side, Miette mountains have an even, steep slope almost to the river; this slope facing the Athabaska is covered with brule, then comes about six miles of small jackpine, then larger jackpine and lastly some spruce six to fourteen inches in diameter as far as the pass. On the north side a range of rocky foothills stretches between the river and the mountains. These hills are usually very rough and covered with brule or willow and poplar scrub in ranges 1 and 2, and with brule and jackpine four to eight inches in diameter in ranges 3 and 4. Scattered spruce up to sixteen inches in diameter is found in the river flats across range 2, but this is included in timber berths Nos. 1335 and 1336. A few large fir are scattered along the hills facing south on Miette river, and these are practically the only timber of value on timber berth No. 1333 at Dominion creek in range 3. A number of large hay sloughs occupy most of the valley in range 3, but all are very wet. Fresh water is plentiful and water-power might be developed from many of the creeks, to a small extent, but all the creeks at high water are very muddy and carry many times their ordinary volume. The climate is characteristic of the mountains, as many small showers and drizzly rains occur but no heavy downpours, and the district is subject to summer frosts. Wood fuel is everywhere plentiful. No stone-quarries are opened, but a number of mineral claims for graphite are staked along Dominion creek. The 'Ore' looks like an ordinary slate, but some of it is quite black and has many small specks of mica as from a decomposed mica schist and when weathered it has a greasy appearance. The slate contains a very small percentage of graphite, if any; it could be handled by steam shovels, and water-power is convenient for washing, &c.

Game on the Athabaska and Miette rivers is scarce on account of the proximity of the pack trail, and the presence of a number of half-breeds, who, as one of them expressed it 'live by their guns.' However, now that Jasper Forest Park reserve is protected by game regulations, we may sometime again see what settlers fifteen years ago saw, flocks of mountain sheep and goats on the hills facing the Athabaska, with many varieties of other game such as deer, black bears, beaver, marten, porcupine and the feathered varieties, and back among the mountains caribou and grizzly.

APPENDIX No. 28.

EXTRACTS FROM THE REPORT OF A. McFEE, D.L.S.

SURVEYS IN WESTERN ALBERTA.

I commenced work by running a meridian north from the eleventh base along the east boundary of townships 41 and 42, range 19, west of the fifth meridian. Along the streams in those townships the valleys are open with more or less scrub willow and good grazing for stock, but no hay, and they will average about half a mile in width. The hills and ridges between those valleys are covered with heavy timber, spruce, jackpine, balsam and fallen timber. Those hills and ridges which lie between the Bighorn range and the Rocky mountains are high and rough, and the soil is light and stony, but in the valleys the soil is fairly good. I do not consider the district anywhere along the Brazeau streams and between the two ranges of mountains will be suitable for agricultural purposes, for there was frost and hail nearly every week all summer. There is coal all along the streams in abundance; it can be seen cropping out all along the hillsides and there are mountains of limestone along the Bighorn range, with some good timber scattered over the hills nearly everywhere.

The water is the very best, and along the larger branches of Brazeau river are to be found trout in abundance up to six pounds in weight. Mountain sheep, goats and smaller deer are found, but spruce partridge was the only small game noticed.

No water-powers were noticed. The descriptions of those two townships are very much alike, with the exception of a portion of the northeast corner of township 42, which is crossed by the Bighorn range of mountains.

Township 40, range 18, is similar to 41 and 42, range 19, except that the timber is smaller and very much of it fallen. The east boundary of township 39, range 18, runs through more open country, especially near Bighorn river, which flows eastward through the northern portion of the township, as well as the northern portion of township 39, range 17, for about half way across the range; from there it bears southeasterly. The southeast portion of this township has good soil; it is partly covered with small poplar and willow and has the best of water. It is suitable for mixed farming and is much lower in altitude than the Brazeau country.

There are indications of coal along the streams and sidehills. Some scattering trees of good spruce grow, but as a rule it is much lighter than in the Brazeau district where we were.

The falls on Bighorn river are grand and would furnish great water-power; they are situated on section 28, township 39, range 17, west of the fifth meridian. The river above the falls is about twenty-five feet wide and eighteen inches deep and flows at the rate of five to ten miles per hour, according to the height of the water. It takes a drop of fifty feet into a large basin, and one hundred and fifty feet from the first drop it takes another of thirty feet, both nearly perpendicular. There are several smaller falls and rapids immediately below.

Township 40, range 17, is very rough and broken with ravines and mountains. The Bighorn range lies nearly diagonally across the township from southeast to northwest, the east boundary of section 23 running over the summit. The east boundary of sections 25 and 24 runs through a belt of good timber, some trees being as large as thirty inches in diameter, and I would say there is about one million feet of spruce and jackpine.

No minerals were noticed, and good water is found all through this district. Some large game, mountain sheep, goats and small deer were seen, but spruce partridges were the only small game noticed.

This district can be reached by way of Rocky Mountain House, Prairie Creek, Morley and Laggan.

APPENDIX No. 29.

EXTRACTS FROM THE REPORT OF GEO. McMILLAN, D.L.S.

BASE LINE SURVEYS IN NORTHWESTERN ALBERTA.

I arrived at Athabaska Landing on March 31 and proceeded up Athabaska river. The ice was good and no difficulty presented itself until Little Slave river was reached. This is an unsafe river to travel except in the middle of winter and was at this season abandoned by freighters. The land road was heavy and at times we chanced the ice on the advice of an experienced freighter who was travelling with us. Thus we reached Sawridge on April 7, where we remained for two days to rest the horses, and then proceeded across Lesser Slave lake. The ice on the lake was in prime condition, black and glossy without a particle of snow on it, and in three days Grouard was reached.

The roads to Peace River Crossing were heavy and miry, and this journey occupied five days. There was no more good wheeling till I reached Grand Prairie. The ice on Peace river was solid till May 4, and I crossed it at Dunvegan on May 2. Not in the recollection of the oldest resident had the ice remained strong so late in the season. Two days later I reached Spirit river and remained there till May 24. This delay was caused by the streams ahead being in flood and a dearth of horse feed farther on.

On May 31 I reached Saskatoon lake on Grand Prairie, procured supplies from the Hudson's Bay Company and proceeded towards the eighteenth base line. Horse feed was no longer a problem, as the grass was by this time well grown and the only obstacle was the crossing of Wapiti river. There is a crossing on this river about six miles south of Flyingshot lake, and a rude pack trail leads therefrom, crossing the eighteenth base about the middle of range 8. The Red Deer is a large river, very deep and swift, and the supplies and dunnage were crossed on rafts. The horses swam across, and being unable to land, returned three times. On the next day, June 4, the horses succeeded in landing and three days later the starting point on the eighteenth base line was reached. Three miles of range 8 were retraced and the new work was begun on June 9. There were no obstacles on this line, thirty-one miles having been completed in twenty-nine days. The district traversed by the eighteenth base has not long since been overrun by forest fires. These fires have made a pretty thorough cleaning up. To the north of the base line the land is adapted to stock raising and farming, to the south it is very rolling, gradually becoming more so and finally developing into the foothills.

At present this district is a most backward place to settle in because Grand Prairie offers a better inducement. I think settlers will not go south of Wapiti river till that district is tapped by a railroad. It is suitable for subdivision, but this is not urgent at present.

I began work at the northeast corner of range 9. This range comprises a series of low ridges and small muskegs. The soil is clay and sand with the loam burnt off. Grass and fresh water are abundant. There remains no timber of any value except in the valley of Wapiti river where there is some good spruce and poplar. One branch of the Jasper trail crosses the base line on the north boundary of section 34.

Range 10 is very similar to range 9 and in section 33 the base line crosses Dead Pinto creek. This creek rises in the muskeg south of the seventeenth base, and like many streams in northern Alberta it had a strong current and deep banks of at least three hundred feet. Coal crops out in several places, but the seams are thin. There is considerable spruce in the flats of this creek.

Range 11 is quite rolling to the south and to the north as far as Wapiti river. This river crosses the base line in section 32. The water level is four hundred feet below the upper level, the west bank is abrupt and the valley is about one hundred and twenty chains wide. After crossing the river a thick poplar scrub is entered and the soil is deep and rich. This condition prevails and improves as Grand Prairie is approached. Some small patches of green timber remain in this range. They are surrounded by marshes and so escaped the fire. A branch of the Jasper trail crosses the north boundary of section 33.

Range 12 is similar to range 11, but its elevation is greater and vegetation is ranker. There are more open patches and some small areas of green timber. The loam has not been burned away as is the case farther east.

Callahoo creek crosses the base line six times in this range. There is coal along this creek almost everywhere and in several places the bottom of the creek is a bed of coal.

Range 13 and fractional range 14 are still higher in elevation, more rolling and more densely timbered. There is a good pack trail crossing section 36 in range 13, which leads to Saskatoon lake.

The land, I think, that is adapted for subdivision is all north of the eighteenth base line west of Red Deer river. It is well wooded, but there is plenty of hay and water to make stock raising a success. The remainder of the district will fit in well as a forest reserve.

The eighteenth base was completed on July 6 and I proceeded to the starting point on the seventeenth base travelling by Saskatoon lake which I reached on August 2.

I had an experienced guide and his route was east from Saskatoon lake across Smoky river below the mouth of the Simonette. This was done and he lead us up the Simonette pack trail to the mouth of Moose river, thence up Moose river till within four or five miles of the northeast corner of township 64, range 1, west of the sixth meridian. My first work there was to move this township corner 16·70 chains north of where I found it and to run the north boundary of township 64, range 27, west of the fifth meridian. I ran this line twice as the first time I did not strike the post. I was unable to observe on this work as it snowed, rained or hailed almost continually and the electrical disturbances were alarming. This line traverses a dense wood with some splendid spruce, jackpine and balsam. It is really the original forest and it took four days to run about two and one-half miles with twelve men chopping. This great forest extends through range 1, west of the sixth meridian and turns into a deadfall about five miles north. The soil is of poor quality, being a dead gray clay overlaid with moss. This forest is too wet to burn, but the surrounding forests which are sufficiently dry have been burned over. Similar conditions prevailed over all my work. This forest extends through range 1 and the farther west the smaller the timber. However it is green as far as Moose river in section 31.

This river has its origin in the muskegs to the south and the water is of a dark brown colour. It has a swift current, is shallow and about fifty links wide at low water. Its valley is about half a mile wide and one hundred feet deep, but its banks are not abrupt. To the west there is a tremendous deadfall extending in an unbroken stretch through range 5.

There is some green timber yet in the valley of Smoky river, but the great fire that swept that district must have jumped the Smoky as the ruins on either side are identical.

This is the largest river in that part of the country. It crosses the base line near the northwest corner of section 33, range 3. It is swift and dangerous in low water and its bed is strewn with boulders. Our crossing was made on rafts while the horses swam. The line does not cross the valley at right angles, but follows it for about three miles; this valley is over six hundred feet deep.

Porcupine river joins the Smoky about four miles farther down than the crossing. The Porcupine is a cold, crooked. rapid river and the water a beautiful green. The line crosses it three times in a distance of two miles. Its water level is very unsteady and will rise and recede three feet in twenty-four hours. The valley is about five hundred feet deep and one mile wide. There is considerable good timber north of the line and between the two rivers, also about five miles to the south is a berth about six miles long and two miles wide.

The next stream is Cutbank river and its name is very suggestive. While the bank on one side is cut out of the clay the other spreads out into a flat and this condition alternates with respect to the sides. The water is a dark brown colour and the river runs almost parallel to the base line, crossing on the north boundary of section 31, in range 5. North of Cutbank river in ranges 4 and 5 is the largest timber berth observed. It is a valuable one and is known as the 'big mountain' berth. Cutbank river is the last large stream up to the middle of range 9.

Of the eight and one-half ranges of this base there is no land that could be called good farming or ranching land. The life has been burnt out of the soil and the grass is weak and puny. I would not have stopped work where I did except for a dearth of horse feed as there is positively nothing for a horse to live on in those burnt jackpine ridges. I left for Flyingshot lake on the last day of October and at the time the ground was frozen and there were flurries of snow several times a day. I reached Flyingshot on November 6 and proceeded to inspect contract subdivision surveys on Grand Prairie. On December 24 I finished the inspection, having examined one hundred and fourteen miles. The next day I left for Edmonton which I reached on January 21.

Grand Prairie is not one vast treeless plain as may be presumed, it is about sixty miles long, twenty-four miles wide and is scrubby. The vegetables and grains that mature in southern Alberta mature there also and stock raising is a specialty.

Coal is the only mineral that I noticed and there seems to be no scarcity of it. The game comprises ducks, geese, moose, bears, foxes and beaver. The climate is said to be milder than that of the country north of it.

APPENDIX No. 30.

EXTRACTS FROM THE REPORT OF A. L. McNAUGHTON, D.L.S.

RESURVEY. AND RESTORATION SURVEY IN CENTRAL SASKATCHEWAN.

May 22 we began retracement surveys in townships 46, 47 and 48, ranges 3 and 4 and township 44, range 3, west of the third meridian, which kept us engaged until January 19. The weather during the latter part of June and the early part of July was very unfavourable, rain-storms occurring nearly every day and sometimes there was a steady downpour for two or three days in succession. However, with the exception of this short period of three or four weeks, the weather during the season was all that could be desired, bright sunny days succeeding one another with almost monotonous regularity. Besides being of assistance in our work, this weather was a great boon to the farmers, turning what had threatened to be a poor season for crops into one of the best on record. In spite of the late spring, zero weather having prevailed until near the end of April, the crops ripened from a week to ten days earlier than usual.

Warm weather prevailed during October and the early part of November, but on the night of the 11th came the 'freeze up,' the thermometer recording 20° below on that and several subsequent nights. In a couple of days Saskatchewan river could be crossed on foot and in about a week it was safe for heavily loaded sleighs.

The district is badly cut up by lakes, these two townships alone containing nearly forty of them varying in perimeter from one to ten miles. As the shores were covered with dense brush, the traverse would have proved a very laborious task in summer but was finished very quickly on the ice, the greatest obstacle being the unusual depth of snow, which made the walking to and from camp very heavy and shortened our hours of work which were at this time of the year, none too long at best.

The townships resurveyed during the season are most conveniently reached by way of Duck lake. The trail to Carlton ferry passes through the centre of township 44, range 3, and the trail to Wingard ferry branches off the Carlton trail in this township.

Although the labour of clearing and breaking land is much greater than on the prairie, the settler may feel more assurance of uniform returns for his labour. I have been told by settlers who formerly lived in Manitoba that the crops ripen about ten days earlier in this locality. If that be the case the danger of summer frosts is much lessened and indeed throughout all the district surveyed I have not heard any complaint of loss on account of frost or hail. This township is largely settled by French Canadians, some of the older members of the families being unable to speak more than a few words of English. All seem prosperous and contented and a fine Roman Catholic church is located about the centre of the township.

Turning to the right off the Carlton trail and following the Wingard trail for about seven miles we entered township 46, range 3. Here the trail follows the road allowance between sections 5 and 6 for half a mile and then turns to the northwest towards the ferry. This township is one of the first settled in this district, some of the settlers having located there upwards of twenty years ago.

The ferry across Saskatchewan river in section 6 has proved a great boon to farmers on the north side of the river. Although the banks are two hundred feet in height the approaches to the ferry are so well graded that heavy loads can be hauled up the banks with little difficulty. Within a hundred yards of the ferry on the north bank of the river, the road crosses the boundary line and enters township 46, range 4. The easterly part of this township is fairly level and well settled, but the westerly part is more hilly and broken by lakes, sloughs and muskegs. There are no settlers in this part as yet. A trail was surveyed across the township this summer extending from Skipton post-office in township 46, range 5, to Wingard ferry.

In section 20 of township 46, range 4, a trail branches off the Skipton trail to the right and enters township 47, range 4, in section 5, thence proceeding to Parkside post-office at the northeast corner of section 31.

Township 47, range 3, is reached by a road turning to the right off the Skipton trail at Silver Grove post-office. It may also be reached by taking the Shellbrook trail from Prince Albert and turning to the south at Shellbrook. The settlers in this township are of English and Scotch origin and are rapidly building up comfortable homes for themselves. All seem contented with their surroundings and satisfied with the measure of prosperity they have attained since coming to this country.

During the period covered by the season's operations the temperature varied from 90° above to 47° below zero, these extremes, however, continuing only for a short time. In general the climate was very enjoyable on account of the large proportion of bright sunny days. Very seldom does one encounter the hot sultry weather so common in moist climates and even the extreme temperature encountered in the winter months is mitigated by the clarity and dryness of the atmosphere.

Immigrant settlers from almost every part of the civilized world, delighted by the fertility of the soil and the opportunities of acquiring a competence, are fast becoming loyal and progressive Canadian citizens.

APPENDIX No. 31.

EXTRACTS FROM THE REPORT OF L. R. ORD, D.L.S.

TRAVERSE OF LAC LARONGE.

Montreal lake and river are not at all difficult to navigate; the Hudson's Bay Company's sketch map showing the rapids and dangers thereof is misleading for the spring and summer stages of the water at the present time. The river would no doubt be more dangerous at low water, but it will probably keep its present level for a year or more, as the lakes are all high. Any skilled canoeman can go down or up the river, going down with fair loads and up with half loads; Montreal rapid is usually passed by portaging in order to save time.

There is said to be another lake, about twenty or more miles long, to the east of lac LaRonge, and separated from it by a 'narrows.' To the west is a lake, twenty miles long from end to end of its cruciform bays. The majority of the mining claims are said to be on the latter lake. The instructions permitting me to make a survey of this lake, instead of continuing the survey of lac LaRonge, if I thought it advisable, were received too late to be acted upon. However, I did not think it advisable, as I believe the existence of valuable mineral lodes there is all hearsay, and as usual many of the yarns are 'wildcat.' I would suggest a skeleton survey, either in summer or on the ice, based on the reports of Mr. McInnes, of the Geological Survey, and others; the details can be filled in later as desired.

The timber over most of this district is small and of no value, and I believe the geological horizon of the rocks to be so low that very few deposits of real value will be found. It is my opinion that the large finds of precious metals are mythical, if indeed they have not been 'salted.' The rumors appear to have been started with a view to 'booming' the place.

Many of the claims are worthless, and many are staked by men who have no intention of complying with the regulations. They hold the claim as long as possible without doing any work on it and then have it relocated by a friend or partner.

The widespread extravagant stories, which when sifted, have not even the proverbial grain of truth, have attracted a number of prospectors, many of whom do not know a coal seam from a bed of hornblende rock, with the result that many worthless claims have been staked out at considerable expense. Attempts were made at Mineral island, at Long point, and wherever claim posts were found, to tie them to the survey; it was easy to tie to posts, but much more difficult to tie to each separate group of claims as instructed. Most of the prospectors seem to have been too lazy or too ignorant to cut a line from one post to another; they have simply planted a post, scribbled a few remarks on it in lead pencil as to what post it is and added some nonsensical note, such as 'reflectory ore,' &c. Consequently the claims lap and overlap when plotted according to the marks on the posts, and therefore it was deemed more advisable to push on with the survey than to waste time trying to unravel the tangle of claims. The groups of claims were found on the ground to be very different from those shown on the plan of claims accompanying my instructions. Claims that are in reality on another lake are grouped in on the plan with claims on lac LaRonge, while claims in one place on lac LaRonge are shown with others at a considerable distance away. The tracing out and survey of these claims will be costly work, and it is suggested that a close inspection be made and those claims cancelled where the law has not been complied with. To put in a charge of dynamite and blow out a few yards of rock satisfies the requirements in the opinions of some claimants with exceedingly elastic consciences.

Lac LaRonge lies in a series of metamorphic rocks, schists, gneisses, &c., whose beds are considerably uptilted so much so at the northern part of the lake that they are overturned past the vertical. The geological strike of the strata is approximately northeast and the axis of the bays, points and islands, in a measure follow the strike, most of them being longer northeast and southwest. The verticality of the rocks and their durability in some cases and friability in others have produced a most irregular shore line, to delineate which with accuracy requires numberless sights. At one point on a convenient reef or islet a good sweep of shore could be covered from one 'hub'; at other times we had to crawl around a point with a series of short sights, sometimes cutting the overhanging trees and setting the transit in two or three feet of water.

Going northward from the Mission, the elevation of the points and islands is comparatively slight; proceeding northward farther from the edge of the overlying horizontal stratified rocks, the land rises gradually, but nowhere very high, probably rarely reaching one hundred feet above the water. The surface is all rock, only a few points occurring, with soil of clay and particles of sand; these points are of small area and of little value for agriculture. In the bays there are patches of muskegs here and there which break the monotony of the rock. The timber is inferior and of little value; it appears that the original timber was burned off fifteen or eighteen years ago, and is now replaced by a growth of poplar and white birch. The spruce and jackpine in the patches of the original timber that yet remain rarely reach a merchantable size, and all the timber may be classed as fit only for local use.

The lake abounds with whitefish, lake trout, pike and doré, some being of large size. Game is scarce, with the exception of the ruffed and Canada grouse.

APPENDIX NO. 32.

EXTRACTS FROM THE REPORT OF T. H. PLUNKETT, D.L.S.

SURVEYS IN THE RAILWAY BELT, REVELSTOKE DISTRICT, BRITISH COLUMBIA.

My first work consisted of the survey of the easterly limits of sections 20 and 29, township 20, range 9, west of the sixth meridian. A considerable portion of these sections, particularly section 29, lies well up on the Larch hills and for this reason is almost useless for farming; it is useful, however, for grazing land. Along the base of the Larch hills in these sections there is some first-class farming land. In this district a quarter section is often applied for when ten to twenty acres would include all the land adapted to farming. The soil is so fertile that twenty acres is considered ample to afford the owner a good living. I found that the applications for land in this vicinity, which included land in sections 6, 16, 20 and 29, township 20, range 9, and sections 1, 2 and 3, township 20, range 10, west of the sixth meridian, were applied for in the hope of working from ten to fifteen acres for fruit lands and using the remainder, where the topographical features rendered farming impossible, for grazing land. The fact that homesteaders are willing to exercise their homestead privileges when they know that such comparatively small areas are all that they can expect to find adapted to farming operations is easily explained when it is known that land in the valley of Canoe creek between the Larch hills and Mount Ida is selling at present from one hundred dollars per acre for uncleared land to one thousand dollars per acre for lands planted in orchards.

The climate is well adapted for the raising of fruit of all kinds. No summer frosts are to be feared, and the rainfall is sufficient for fruit raising and general farming.

Along the base of Mount Ida there is a considerable quantity of merchantable timber, and a small sawmill on Canoe creek gives the settler a ready supply of lumber for building purposes.

These remarks, regarding climate, summer frosts and timber supply, apply also to the land along Salmon river where our next work led us.

The valley of Salmon river extends southwest from the shore of the Salmon arm of Shuswap lake up along Salmon river between Mount Ida and the Spa hills. This valley at the town of Salmon Arm attains a width of from six to eight miles, but gradually narrows to a mile or two in width as it ascends the river.

The beautiful dairy and fruit farms, especially those in the vicinity of the town of Salmon Arm, present in summer a picture well worth the effort necessary to scale Mount Ida from whose first benches a remarkable view of the whole country can be had.

However, all the bottom land in this valley having been taken up, the new settlers are turning their attention to the extensive bench lands. Mount Ida on its eastern slope, facing Canoe creek, rises somewhat precipitously, but on its western slope above Salmon river are to be found large benches. This is even more characteristic of the Spa hills on the opposite side of Salmon river and particularly so in sections 6 and 7 of township 19 range 10, sections 30 and 31 of township 18 range 10 and sections 13, 14, 23 and 24 of township 18, range 11. It was in these last mentioned sections that most of our work this season was located. A number of settlers are already squatted on this land making a success of mixed farming, but fruit farming has as yet not been given a trial. The soil is not so rich as that in the bottom lands, being inclined to be sandy, but when irrigated, however, it is found to yield abundantly and no doubt in the near future will afford ample evidence of its value as a farming and fruit raising district.

Water for irrigation which is absolutely necessary on the benches is easily available from the numerous streams flowing from Mount Ida and the Spa hills, into Salmon river. A considerable portion of the land is still open for intending settlers, while in the valley some first-class land is offered at prices which, considering its producing value, seem reasonable.

The bench lands are wooded with scattered bull pine while in the bottom lands merchantable cedar, fir and spruce are to be found. Logs can be driven on Salmon river to sawmills which are in operation along the river nearer Salmon Arm.

The land in sections 29 and 32 of township 20, range 10, is also bench land. Some beautiful farms and orchards are to be found in this locality west of Adams Lake and Neskainlith Indian reserves. Here one has ample proof that irrigated bench lands scarcely take second place to the bottom lands in point of worth as producers of farm and orchard products.

Nestled in the midst of the districts just described and ideally situated on the slopes overlooking Salmon arm of Shuswap lake lies the thriving town of Salmon Arm. Situated on the main line of the Canadian Pacific railway this town affords a ready and convenient market for all kinds of farm, garden and orchard produce for the raising of which the land in its immediate vicinity has proved itself well adapted. Good roads lead from the town up Canoe creek and Salmon river valleys as well as to the lands west of the Indian reserves.

At present, ample employment is afforded at Salmon Arm at the building trades, and also in the sawmills and lumber woods in the vicinity.

Salmon abound in Salmon river during the annual run and plenty of trout are always to be had in the Shuswap lakes. Bear, deer and mountain goat are also plentiful in this district.

The Salmon Arm district with its most favourable climate, good roads, splendid market and shipping facilities resembles very much the famous Okanagan district to the south and east of it, and bids fair in the near future to successfully rival the Okanagan as a fruit raising district.

After completing the surveys around Salmon Arm we took the Canadian Pacific railway for Revelstoke where the survey of fruit lands along Columbia river south of Revelstoke occupied us for the next few months.

Commencing about twenty-four miles below Revelstoke these fruit land surveys were carried on in the valley of Columbia river up to within a mile or two of the town of Revelstoke.

The bottom lands in the valley range from a mile and a half to two miles in width. Generally speaking the land is covered with a dense undergrowth and heavily timbered with very large cedar from four to twelve feet in diameter and hemlock from three to four feet. The soil in some places consists of a rich black loam, but generally speaking it is inclined to be sandy. There is no doubt but that the land is well adapted to fruit farming. During the present season small fruits such as currants and strawberries, though as yet only raised in small quantities, were of exceptionally high order as regards size, colour and flavour. In only one locality in this valley has apple and plum growing been attempted as yet, namely in section 29 of township 20, range 29. The orchard is from ten to fifteen years old, and the returns have been exceptionally good. Conditions are the same as those in the upper portions of the valley and no doubt bespeak success for this district as a fruit country.

On the other side of the bottom lands extensive benches have been subdivided. The clearing is easily done, the timber consisting of small poplar, spruce and birch with some brush. The soil, generally speaking, is a sandy loam with a gravel subsoil, and irrigation either on the benches or in the bottom lands is not necessary. Summer frosts do not exist. The winters are sometimes cold but the exceptionally heavy snowfall in this district coming before the frost has entered the ground to any considerable depth insures the successful protection of the orchards from frost, keeps the ground warm and gives an important stimulus to spring growth.

The river is navigable throughout this district and the Arrowhead branch of the Canadian Pacific railway following the left bank of the river affords excellent transportation facilities. Wagon roads have as yet not been constructed farther than six miles below Revelstoke.

Excellent markets for farm and garden produce of all kinds are already established at Revelstoke where the demand far exceeds the present local supply while there is, with the present facilities for shipment to the prairies, no chance of an over production.

Plenty of employment at good wages is to be obtained in the mills and lumber woods during the entire year. Three large mills are in operation at Arrowhead, while the town of Revelstoke, where two large lumber mills are located, presents plenty of employment in all trades.

Concurrently with this work, we were engaged on timber berth surveys on Cranberry creek. There are a few fairly good locations for homesteads on this creek, but the quantity of farming land is limited.

Our next work was in township 25, range 20, west of the fifth meridian where we were engaged for a short time surveying sections 19, 20, 21, 28 and 29, and in section 36, township 24, range 20, and sections 30, 31, 14, 15 and 16 of township 24, range 19.

The work in this district was all on the benches where farming operations are as yet in the experimental stage. Summer frosts are here met and irrigation is necessary during some seasons.

During our surveys here we noticed small patches of vegetables planted by someone desiring to test the producing power of the soil and the effect of the summer frosts. It was evident, however, that the experiment had not received as much attention during the growth of the vegetables as would have been advisable. However, it shows that the attention of settlers is being drawn to these benches which offer good opportunities to settlers, if the summer frosts are not too severe. In most places plenty of water is easily available for irrigation.

A first-class wagon road from Golden up the valley to the Windermere district, affords the settler exceptionally good transportation facilities by land while Columbia river is navigable and steamers run tri-weekly between Golden and Windermere. A railway up the right bank of the Columbia river is now under construction.

Employment in the lumber woods along the river is obtainable during the entire year while a large modern lumber mill at Golden also affords work.

We next moved to the mouth of Blaeberry creek in section 30, township 28, range 22. Our work in this locality consisted chiefly of traverse work on Columbia river.

The climatic conditions are about the same as those just described in townships 24 and 25, ranges 19 and 20.

Some farming is being done, the principal crop being hay for which there is always a large demand in British Columbia. A new departure is being made here in hay raising along the Columbia. Along this river there are at intervals, large areas of land inundated during high water but which yield slough hay in large quantities in the fall. The trouble had been that during most seasons they do not dry up early enough to enable the hay to be harvested. At the mouth of Blaeberry creek there is an exceptionally large area of this slough hay land. The owner has constructed a system of ditches leading to the Columbia river through which the water is enabled to flow off quickly, as soon as the river drops. The slough in this way is sufficiently dry in the fall to permit of harvesting operations. It is found that if the hay is stacked in small stacks immediately after its being cut it cures in first-class condition and makes excellent fodder. A ready market already exists at the coast for this class of hay and it would seem likely that quite an industry could be built up by working the areas on this river. The land east of the railway has been retained as a timber reserve.

From here we proceeded to township 17, range 27, west of the sixth meridian. Our first work was in sections 24, 25 and 36 of township 17, range 28. Land adapted to farming here is very scarce, but owing to the favourable climatic conditions and markets every available acre of land is being eagerly sought. Irrigation is necessary and in the older settled parts considerable expense has been incurred to provide water for the land. This is an ideal fruit district as no summer frosts occur.

The timber consists principally of bull pine with some fir along the creeks. There is an abundance of fish in Fraser river during the annual salmon run and game on the mountain sides is plentiful.

After completing the survey of these sections and some traverse work on the Fraser, we packed a small camp over the mountain into section 24, township 17, range 27, and surveyed parts of sections 15, 16, 22, 23 and 24. This land lies along the southerly branch of the Laluwissin creek, and its elevation is about two thousand five hundred feet above Fraser river, at the north boundary of section 18, township 17, range 27. It is well adapted for raising hay and root crops, and the surrounding country would make good grazing land. Roads are as yet not constructed into these sections but they could be easily built from the south.

From this work we proceeded through the valleys into the Hat Creek valley where we were engaged in locating lot 10, group 1. Considerable merchantable timber was found here consisting of bull pine and fir. This valley is favoured with a fairly heavy snowfall and is well adapted for fruit raising.

Fruit farming to a limited extent has been carried on with gratifying success. Several new settlers are located here and there seems nothing to prevent this locality from becoming a good farming and fruit raising district.

Our next work was at Canford on the Nicola branch of the Canadian Pacific railway. The amount of land adapted for farming except that already taken up in the valley, is somewhat limited, and as in almost every other part of British Columbia the settlers are turning their attention to the benches.

This district also is well adapted to fruit raising. In the valley of Nicola river efforts to raise fruit have been very successful. There is every facility for shipping by rail while a fairly good wagon road extends along Nicola river.

There is also considerable activity in coal mining a little farther up the valley and large quantities of first-class timber is within easy access. A mill recently burned is about to be rebuilt at Canford.

APPENDIX No. 33.

EXTRACTS FROM THE REPORT OF W. R. REILLY, D.L.S.

RESURVEYS IN CENTRAL SASKATCHEWAN.

On Thursday, May 20, I started for township 49, range 21, west of the second meridian to complete the survey of this township. Following instructions received in 1908, a retracement was made of the south boundary of the township and a new survey of the east boundary, interior meridians and cross lines. My route was by the Fort à la Corne trail crossing the South Saskatchewan river by ferry at Mitchell's crossing, in township 48, range 23, following the trail to the centre of township 48, range 21, where I turned north into township 49 and began work.

The trail was in good condition with the exception of a few soft holes. I completed the survey of this township on June 14. Spring opened rather late, but warm dry weather immediately followed, making seeding conditions favourable, and growth rapid, so that by the middle of June crops were as far advanced as in many seasons where spring opened earlier.

Saskatchewan river enters the township on the west in the northwest quarter of section 19, flows southeasterly and crosses the south boundary at the southeast corner of section 2. Its width varies from about fifteen to twenty chains. Flood water rises from fifteen to twenty feet above ordinary summer height. Its banks vary from twenty-five to two hundred feet high. Generally where they are high on one side they are low on the opposite side. In places the high banks are bare and steep, with clay slopes right at the water's edge. Except on these cut banks a heavy growth of timber, scrub and brush grows right up to the water line. The varying heights, cut banks and timbered slopes form a rugged and picturesque outline to this mighty river. South of the river are two large flats, one in sections 21 and 22, and one stretching across sections 14 and 11.

The water in the river in this township is greatly increased in volume by the junction of the south branch, just west of the west boundary of the township. This naturally would add to its value as a water-power producer, although the natural features of its banks and current are not as favourable for developing power as on the north branch in range 22. A large amount of power could be developed but the cost would be excessive. As only a few sections are in any way fit for settlement, and these do not join other land fit for cultivation, it might be advisable to reserve the whole township, the south part to serve settlement to the south with building logs, fuel and fencing and the part north of the river for a future tie and wood limit.

Having completed the survey of the township on June 14, I started the following day for township 42 A, range 1, west of the third meridian, to make a retracement of that township. I took the trail south to Kinistino on the Canadian Northern railway then followed the trail skirting Carrot river, passing by Bonne Madone, Wakaw, and St. Julien post-offices. We passed through a rolling poplar bluff country, a large portion of which is thickly settled.

In making the retracement of the township, the majority of the old markings were found, but in many cases the markings were faint and fast disappearing. This is more noticeable in light soils and where stock range.

The south branch of the Saskatchewan skirts the west boundary of the township running northerly past the centre of section 18, where it makes a sharp turn easterly for over half a mile, thence nearly north crossing the north boundary of the township in the northeast quarter of section 18.

The north part of section 7 or the south part of section 18 presents a very feasible sight for a railway crossing, as an easy grade can be obtained on either side, without excessive work.

The river trail crosses sections 6, 7 and 18. but the old trails from Gabriel's crossing to old Humboldt which crossed sections 1, 11, 14 and 15 is nearly obliterated.

Fish Creek post-office is on the river bank on the road allowance, at the north boundary of section 7. A free ferry crosses the river at this point. It surmounts a breach in the road on a much travelled trail to Rosthern on the Prince Albert branch of the Canadian Northern railway.

The township is well settled with prosperous Galicians, with the exception of the river lots which are mostly occupied by French people. A Roman Catholic church is situated near the west end of river lot 12. Near the church is a new school which is well attended by the children of the district. Another school near the northwest corner of section 2, is largely attended by Galician children, who are readily learning to read and write English.

After completing this township I moved into township 41, range 1, to make a retracement of the whole township. Sections 31 and 32 are divided into river lots 1 to 8, numbering from the north. The northwest quarter of section 30 comprises a portion of river lots 9 to 12 which extend west to the river on the north half of section 25 in township 41, range 2. The south half of section 25 in the township is divided into river lots 13 to 16 inclusive.

Settlers on river lots in townships 41, ranges 1 and 2, were unable to locate their boundaries. The east end of lots 9 to 12, the west end of lots 1 to 8, range 1, and the west end of lots 9 to 16, range 2, were not posted in the original survey. General instructions for retracement would not cover this work.

The homesteads in the townships are nearly all occupied. Galicians are the principal settlers, but the majority of the odd sections are vacant. The soil is a rich sandy loam in most places, running into clay loam in streaks, while the subsoil is chiefly clay. On the whole it is a good township for settlement and settlers appear to be doing well and making good homes. Roads are being cleared and graded in many places and good farm trails run in all directions. A large Greek church is on the northwest quarter of section 22 and a Roman Catholic church on the southeast quarter of section 4. A public school is located on the southeast quarter of section 22, and Alvena post office is on the southeast quarter of section 18. Settlers in this township divide their trade between Rosthern on the Prince Albert branch, and Vonda on the main line of the Canadian Northern railway.

From June 20 to July 24, I was engaged in this district surveying townships 42 A and 41, range 1, and river lots in township 41, range 2. During this time excellent weather conditions prevailed, but heavy rains were frequent, followed by bright warm weather in the day time and no frost at night.

This is a good district for all kinds of grain raised in the country and for dairying and raising cattle and hogs.

On July 26, I started for township 36, range 1, west of the third meridian to investigate the condition of the survey in that township and to make a retracement of the whole township if necessary. I passed through Vonda on the main line of the Canadian Northern railway and between Vonda and this township the trail is crooked and hilly.

During the work the weather was ideal for growing crops, and in the south part of the township, which was cropped, grain was looking fine and gave promise of a good yield.

My next work was in township 45, range 28, west of the second meridian, and I travelled back through Vonda to Fish Creek, P.O. From there I took the road on the right bank of the river to Batoche, where I crossed the river and went back to Duck Lake settlement. From there the Prince Albert trail was followed until I was opposite the place and I went east across country into the township.

On August 27, I moved into township 45, range 27, and completed the survey of river lots 21 to 48 inclusive, into sections on September 8. Subsequently I returned to this township and included lots 13 to 20 inclusive within the survey, and completed the traverse of lakes, in this township and township 45, range 28.

The weather for the season was good, no frosts occurring to any extent and good harvest weather prevailed. No settlers were on any of the river lots included within the survey in this township, but the adjacent country to the north and east is well settled.

On September 9 I started for township 48, range 3, west of the third meridian in the Shellbrook district, to make a retracement of that township. After proceeding a few miles north of my camp, good trails were found in many directions, and going in a northeasterly direction for a few miles, I struck the trail from St. Louis to Prince Albert, passing on the east side of the Red Deer hill. Saskatchewan river was crossed at Prince Albert, on the recently constructed bridge, built for railway and passenger traffic, and from Prince Albert towards Shellbrook the road was good for six or seven miles; thence the trail became heavy sand passing through a jackpine country for about fifteen miles, but after leaving the sand the roads were good.

On reaching range 3 on the Shellbrook road, I turned south into township 48, and arrived there on September 11, three days after breaking camp on the South Saskatchewan.

The survey, with the exception of the traverse work, was finished on October 13, and the following day I started for township 45, range 27, west of the second meridian, having received your instructions to include in the changing of the river lots in that township into quarter sections, lots 13 to 20 inclusive, and also to complete the traverse work in townships 45, ranges 27 and 28.

It was reported that there were duplicate monuments on the north boundary of township 41, range 27, west of the second meridian, and I was instructed to make an examination on the ground. Before reaching Prine Albert I went ahead and took the train from Prince Albert to Rosthern, drove from there to Wakaw, found Mr. Kuzneruk, who had reported the matter, but found that no duplicate monuments existed, as only two lines had been run, a random and a true one. I returned to township 45, range 27, and completed the surveys in that township and traverse work in the adjoining one on October 27.

My next work was a correction survey of the south two-thirds of township 49, range 12, west of the third meridian. My best route appeared to be by Duck Lake settlement, Carleton crossing on Saskatchewan river, Aldina post-office on Muskeg Indian reserve, westerly to Bear lake, and northwesterly to the township.

On Friday, October 29, we got ferried across the river, and camped for the night on a hill, during a heavy snowstorm, the first of the season. Saturday, we reached the Indian reserve and camped there during Sunday. The snow was four inches deep and the ruts on the trail were drifted full. From the reserve to Bear lake, the country is very hilly, and travelling with wheels in the snow was difficult, but from Bear lake a faint trail northwesterly to the settlement south of Meeting lake.

The third day after leaving the reserve, I camped as near as I could to the southeast corner of township 49, range 12. Three miles of the south boundary of the township lay in the lake, but as there was no prospect of the lake freezing, so that I could chain across it, for some time, I was obliged to run an offset line on the north side to adjust the boundary and tie the interior meridian lines to.

On December 1, I took one man and a team with me to do the traverse work in township 48, range 3. I completed the work and returned to Prince Albert on December 13, and arrived home in Regina on the 15th.

With the exception of one township in the open plain, the season's work was in much the same class of country and the whole district covered presents much the same general features. It is a rolling wooded country with patches of swamp, small lakes, and large and small prairie openings. Over this district the same climatic conditions prevail and throughout the season the weather was ideal for farming purposes. Frequent rains kept the ground moist, and warm, bright weather in June and July produced rapid growth. I did not see any frost after rains in the early part of the season.

The season in the wooded country is perhaps a little shorter and more temperate than on the open plains, as there is less wind and not the extreme heat throughout the day. Snow generally lies a little longer in the spring in the north, being deeper and falling a little earlier in the season. The wooded growth has a tendency to preserve moisture, and to cause frequent rains.

Experience is teaching the farmer different methods of treating the soil, so that unfavourable climatic conditions are to a great extent overcome. Thorough cultivation, early sowing, and the selection of early maturing kinds of grain will largely overcome the frost trouble.

The north country is, perhaps, the best place for the man of small means to start farming, as there is no outlay for fuel, buildings can be put up cheaply, and there is the chance of a man finding winter work in the woods if he wants it.

APPENDIX No. 34.

EXTRACTS FROM THE REPORT OF E. W. ROBINSON, D.L.S.

SURVEYS IN THE RAILWAY BELT, BRITISH COLUMBIA.

As one travels westerly through British Columbia it is somewhat remarkable how the climatic conditions change within a short notice. For example, at Revelstoke, where I remained one day to purchase supplies, a foot of snow was still on the ground, the atmosphere was chilly and the country generally had a wintry aspect. Proceeding westerly the snow grew less until at Sicamous, on Shuswap lake, the ground was bare. The vegetation also shows a marked difference. The rank growth of alder, willow and other brush which characterizes the valleys in the Revelstoke district gives place to an open growth of the different varieties of the coniferæ, indicating less precipitation. As one proceeds farther west the change is still more marked. The timber becomes more scattered, deciduous trees disappearing almost entirely until Kamloops is reached. Here one is in the heart of the dry belt, where the hillsides support only a growth of bunch grass and sage brush with scattered bull pine. The precipitation here is so small that irrigation has to be employed for all crops. On the date I reached Kamloops I found that spring was well advanced, in fact, farming operations had been in full swing for several weeks. The short duration of winter in the dry belt is one of the many attractions which prove so alluring to newcomers

After consulting Mr. J. E. Ross, D.L.S., and discussing the division of work outlined for the season, I organized my party and left.

Timber berth No. 532, for the survey of which I received instructions, lies on the east side of Adams lake. It extends in an easterly direction, crossing the divide between Adams lake and the north fork of Scotch creek, thence down Scotch creek slope and crossing the north fork of Scotch creek, rises from half a mile to two miles up the opposite slope of this creek. The major portion of the timber lies in the valley of Scotch creek; fires have destroyed what was once a magnificent belt of timber on the Adams lake slope, but there are still a few patches left, principally Douglas fir, hemlock and a little white pine. These patches, unfortunately, are very scattered, making the logging expensive. Stretching along the summit between Adams lake and Scotch creek excellent spruce is found up to thirty inches in diameter, with second rate balsam up to twenty-four inches. As one descends the Scotch creek slope the balsam soon disappears and cedar and hemlock are found. A few cedar up to twenty inches were discovered to be sound, but the majority are 'hollow butts.' The hemlock will average about fifty per cent unsound with a greater proportion than this at lower altitudes. The Douglas fir and white pine are the best of the varieties of timber in this limit, the fir reaching a size of sixty inches and the white pine forty inches. The white pine, although scattered as is generally the case in this section of the country, will run more to the acre than the average for this part of British Columbia.

The logging of the Adams river slope will not present much difficulty apart from the scattered nature of the timber, as the land is not very steep and the logs can be readily rafted on Adams lake. The Adams River Lumber company tow their log rafts to the south end of the lake where they have a dam across the mouth of Adams river. They drive Adams river to Shuswap channel, and through this to the western end of Little Shuswap lake, where their mill is located. The logging of Scotch creek slopes will be more difficult. It would be possible to take the timber from the higher land on the west side of Scotch creek to Adams lake through a low pass which is approximately in the southwest quarter of section 20. This would, however, entail a long haul, especially from the northern part of the limit. The most obvious route is, of course, *via* Scotch creek to Shuswap lake. This creek, although averaging from seventy-five feet to two hundred feet in width, is not well adapted for log driving. It is crooked, has low land adjoining, which is flooded at high water, numerous obstructions, such as rocks, rapids and sand bars, and although it has a large volume of water in the spring, it would be difficult, if not impossible, to hold it back until required. This, coupled with the cost of clearing Scotch creek, renders this route a poor one. Possibly a logging railroad along Scotch creek would be the best method as this would tap other valuable timber claims.

The soil is light sandy loam with considerable surface rock on the steeper slopes. The only land of any agricultural value lies on the Adams lake slope close to the lake; the remainder is of too high an elevation. Mixed farming should be successful here, and the hardier varieties of fruit could be raised. On May 23 snow was found in the bush to within half a mile of the lake shore, although the heat on the shore was intense.

The only market at present for produce would be the lumber camps on Adams lake, as the distance from the railway is too great for profitable shipping. Caribou, deer, black bear, lynx, marten and the smaller fur-bearing animals are fairly numerous, and Adams lake is well stocked with rainbow, grey and Dolly Varden trout, char and a few other varieties of fish.

On May 27 I proceeded to China flats, about twenty-five miles north of Revelstoke, to undertake without delay the survey of fruit lands in the Columbia valley. The land suitable for agriculture and fruit growing north of Revelstoke may be roughly divided into three sections: First, the Jordan flats, being alluvial land lying between Jordan and Columbia rivers with a strip of bench land along the west side of Jordan river; second, some bench land on the east side of Columbia river lying in sections 9, 10 and 15, township 24; third, a strip of alluvial and bench land averaging half a mile in width lying north along the east bank of Columbia river and stretching from the north boundary of section 3, township 26, to the northern limit of the railway belt. There are also a few isolated patches of good land, the two largest lying along the north boundaries of sections 23 and 26, township 24, the first one being known as Steamboat or Mosquito landing.

A stage road starts from Revelstoke and follows the east bank of Columbia river to Steamboat landing, a distance of about six miles, connecting with the provincial government pack trail, known as the 'big bend trail' which continues north. A steamboat during the summer months is operated on Columbia river, starting in the earlier part of the season from Steamboat landing, and in the latter part from the city wharf at Revelstoke.

Columbia river through this section of the country is a swift stream with numerous sand bars, rocks and rapids making navigation difficult and often risky. Lining up is employed to get up the worst rapids. The steamboat, which has a powerful steam winch in the bow, is first moved to the river bank below the rapids and a cable taken out along the bank and fastened securely to a tree or rock ahead. The boat is then swung out into the current, and with the combined power of its engines and the winch hauling on the cable manages to get through the rapids. The provincial government is at present building a wagon bridge across Columbia river at Revelstoke, and this will connect with a pack trail around the 'big eddy' on the west side of the Columbia, giving access to the Jordan flats.

The valley of Columbia river north of Revelstoke is well timbered with hemlock, cedar, Douglas fir, white pine and spruce. Fires have destroyed patches of timber all along the valley, approximately five per cent, which is considerably under the average amount destroyed by fire in the railway belt.

The soil consists of from six to twelve inches of humus overlying sandy loam subsoil. In a few low lying spots and pockets there is six to twelve inches of rich, black muck with a heavy clay subsoil. Surface rock is showing, being specially noticeable on the steeper slopes. Mixed farming would undoubtedly prove successful, except on the Jordan flats, where the absence of creeks for irrigation would be a serious drawback during dry seasons. The hardier varieties of the standard fruits would flourish, and strawberries have been proved to be a very lucrative crop.

On July 24, I moved to the four-mile board west of Revelstoke to undertake the survey of timber berth No. 528, block 4. This timber berth is situated on the north slope of Mount MacPherson, about two miles from Columbia river, and from three to four miles in a direct line from Revelstoke. There is at present no direct communication by wagon road from Revelstoke, but the provincial government is now constructing a wagon bridge across the Columbia to connect with the existing wagon road on the west side of the river which runs to within half a mile of the north boundary of the limit. At present the easiest approach is by crossing the Canadian Pacific railway bridge over the Columbia, thence along the railway track to where the wagon road crosses at Griffith's ranch, situated three and a half miles from Revelstoke. From this point I cut a man-pack trail, going through Griffith's ranch and crossing Tonkawatla river which runs through the timber berth, touching the boundaries at several points. There is very little timber on the south slope of Tonkawatla river valley, a few scattered fir and hemlock having escaped the fire which at one time ran along the valley. The sidehill also is very steep with many precipitous rock bluffs, making the logging of any timber expensive if not impossible. Commencing at the summit between Tonkawatla river and its tributary south there is an excellent belt of timber consisting of hemlock up to thirty-six inches, cedar up to seven feet, scattered white pine and spruce up to twenty-four inches, and occasional Douglas fir up to thirty inches. This belt of timber extends southerly to about the centre of section 18, where the cedar and white pine become scarcer, balsam up to twenty-four inches taking its place. Farther south the only varieties are spruce and balsam up to twenty-four inches. The extreme southern end of the limit being the part lying in the south half of section 7, is entirely useless, being portion of a rocky ridge cut up by ravines and rocky bluffs.

The logging of this limit will not present any difficulties, the only drawback being its distance from transportation. The slope to Columbia river is not very steep and sleigh roads can be made quite easily. There is at present an old wagon road leading from the Big Eddy sawmill to a ranch in the southeast quarter of section 20 which might possibly be utilized.

The soil is a sandy loam with considerable rock in places, but the altitude would prevent the growing of any but the hardiest crops. Along Tonkawatla river is some marshy bottom land which would be difficult to drain as its elevation is only slightly greater than that of the river. On August 20 and 21, I moved the camp down to the railway track, and on the 24th pitched camp on the Jordan flats to complete the survey of fruit lands there, a description of which has already been given.

On September 6 I moved to Greely on the main line of the Canadian Pacific railway east of Revelstoke, to survey timber berth No. 528, block 3 and to do adjoining subdivision work.

This timber berth is situated on the north side of Illecillewaet river from four to six miles east of Revelstoke. The easiest approach to the berth is by train from Revelstoke to Greely and thence across Illecillewaet river by the wagon bridge which is about three minutes walk from Greely. There is also direct communication with Revelstoke by a wagon road which follows the valley of Illecillewaet river and passes through the southern portion of the timber berth. This road is in bad condition in some places, but the provincial government is now engaged in repairing and straightening it. The timber on this berth lies in two distinct sections. Commencing at the eastern boundary there is a belt about thirty chains wide and eighty-five chains long lying along the Illecillewaet river. This comprises hemlock up to thirty inches, scattered white pine up to twenty inches and cedar up to thirty-six inches. The hemlock will average sixty per cent unsound and the cedar, especially near Illecillewaet river, is hollow and punky. Some excellent Douglas fir at one time existed on the limit, but it has been logged off. The other belt of timber about two hundred acres in extent, occupies the northwest corner of the berth. This comprises Douglas fir, hemlock, white pine, cedar, spruce and balsam up to fourteen inches in diameter. Practically all of this timber is sound and although small will make good lumber. The remainder of the berth has been fire swept, the only other green timber being some small patches of hemlock up to twenty-four inches, and small white pine and cedar along the north boundary of section 4.

The bottom land along Illecillewaet river is a rich clay loam with black muck in places. It is marshy and would require draining for any other crop than hay. It was reported to me that in spring most of the land is flooded. The timber has been burned, second growth fir, cedar, hemlock with willow brush now covering the land. The sidehill on the north side of the valley is not very steep and several good benches exist. The soil is a light sandy loam with six inches of humus where the land has not been burnt. The bottom land after being drained and cultivated for a few years should prove ideal for vegetable growing. The sidehill land would undoubtedly raise fruit of the hardier varieties, although the soil is somewhat light and manuring would be necessary. The precipitation in the summer is ample and the average snowfall is from three to four feet. Summer frosts occasionally occur on the bottom lands of the valley, but these will probably cease as the country is cleared and drained.

On October 7 I corrected the monuments on the east boundary of timber berth 528, block 4, according to instructions received. On the 8th I moved to Three Valley to survey the swamp lands lying in the south pass. I saw the applicant for these lands and he informed me that he had abandoned his application. I, however, inspected the lands and found that they comprised the head of a mountain valley about three and a half miles south of Three Valley and were about fifteen hundred acres in extent. A creek about one chain wide and six to ten feet deep meanders through the valley and flows into Frog lake. The banks of this creek are low and beaver dams obstruct its course with the result that all the adjacent land is flooded.

It would be possible to divert this creek before it enters the meadows and by a short canal to carry the water across the low divide and connect with Three Valley creek flowing into Three Valley lake. If the beaver dams were then destroyed the land would speedily be drained and would make an excellent hay meadow. The soil is a rich black muck with a sandy clay subsoil, but it is doubtful if it could be utilized for tillable crops as these narrow mountain valleys are almost invariably subject to summer frosts.

On October 11 I moved to Armstrong in the Okanagan valley and camped in section 23, township 19, range 9. The Okanagan valley is in the dry belt and irrigation has to be resorted to. Celery, onions and cabbage are largely grown and prove to be lucrative crops. The land surveyed in sections 13 and 14, 23 and 24, township 17, range 9, is all hillside and suitable only for cattle ranging. Dense second-growth hemlock, pine and tamarack is commencing to cover the higher land. Good roads from Armstrong and Enderby run close to the above sections. On October 18 I moved by rail to Enderby and the next day by wagon along the Mabel lake trail to Kingfisher creek and camped there. This trail follows the valley of Shuswap river and in a dry season is in excellent condition; a prolonged spell of wet weather, however, will make it almost impassable, the soil in places being a stiff clay. Most of the available land in Shuswap river valley is taken up, the settlers being engaged in mixed farming and fruit growing. Apples seem to do particularly well. In sections 14, 23, and 22, township 19, range 6, there is a fine level bench the clearing of which would be easy. The soil is light sandy loam but, as the summer rainfall seems to be ample, would, with care, produce good crops. In sections 10 and 15 in the same township a gently sloping bench was found about two hundred acres in extent with an excellent clay loam soil. The best timber has been logged off and clearing of the land would be expensive. On October 25 I moved the party to Falls creek and traversed Shuswap river through section 2, township 19, range 7. On Falls creek a water-power exists capable of easy development. A head of six or seven hundred feet can be readily obtained. I did not, owing to a lack of time, investigate whether it would be possible higher up the stream to dam back the water until required. At this date the stream was about fifty feet wide and from one to two feet in depth.

On November 15 I arrived in Revelstoke to undertake the correction surveys on the west side of Columbia river, in township 23, range 2, west of the sixth meridian.

APPENDIX No. 35.

EXTRACTS FROM THE REPORT OF O. ROLFSON, D.L.S

SURVEYS IN MANITOBA AND SOUTHERN SASKATCHEWAN.

I arrived in township 13, range 26, west of the principal meridian on the morning of May 14.

The township is well settled with prosperous farmers who have good houses, large barns and plenty of stock. Many of them have telephones in their homes. Miniota, the terminus of a Canadian Pacific branch line from Brandon is on the west boundary of section 31 and the Grand Trunk Pacific main line is less than half a mile north of the township.

On July 7 I left for township 12, range 5, west of the second meridian, to make a retracement and restoration survey there.

This township is on the northern edge of what the settlers call the 'Little Moose mountains.'

The settlers here are mostly Hungarians, living in log houses plastered with mud and whitewashed. These people are steady and industrious and will some day have good homes.

I left here on August 21, moving southerly to townships 1 and 2, range 12 and township 2, range 11, west of the second meridian. The trail through the Moose mountains, which are really only hills, passes through a small valley south of the 'Little Moose mountains,' then up the 'Big Moose mountains,' and crosses a plateau on the top. The crops here were excellent, being fully ten days in advance of what we had seen farther north. Small lakes and considerable bluff add to the beauty of the scenery. Descending the south side of the hills the trail passes Kisby, on the Arcola branch of the Canadian Pacific railway, then through level prairie to Estevan. From Estevan west the country is still level prairie, broken only by the valley of Souris river immediately south of the town.

The settlers in townships 1 and 2, range 12, and township 2, range 11, are mostly Germans, Bohemians, Norwegians, Swedes and Russians who have lived in the United States and immigrated to Canada.

After completing the work here I moved to township 7, range 8, west of the second meridian. This township is reached by a good road due north from Estevan and is about five miles south of Stoughton on the Canadian Pacific railway. The country is slightly undulating prairie with a small amount of scrub.

On October 1 I moved to townships 13 and 14, range 7, west of the second meridian. The Reston branch of the Canadian Pacific railway passes through both these townships and the Canadian Northern through township 14. I retraced both townships, then moved, on November 3, to township 15, range 9, west of the second meridian. Glenavon, a new town on the Canadian Northern railway, is about two miles south.

I left here on November 13 and returned to township 1, range 12, west of the second meridian to correct some errors.

APPENDIX No. 36.

EXTRACTS FROM THE REPORT OF J. E. ROSS, D.L.S.

SURVEYS IN THE RAILWAY BELT, KAMLOOPS DISTRICT, BRITISH COLUMBIA.

Most of the land surveyed lies in the back valleys on the hills at an altitude ranging from two thousand to four thousand feet above sea-level, and is, I am somewhat reluctant to say, not suitable for general farming. The soil is not good, and the surface is much broken or hilly, but apart from this the many difficulties to be contended with, such as long hauling to the markets over heavy grades, lack of water for irrigation purposes and summer frosts, preclude the possibility of carrying on mixed farming successfully. Stock raising and dairying are the only branches of the industry that might be engaged in with profit, and these only on a small scale.

On March 15, I left Kamloops with my party to complete the survey I had left unfinished the previous season at Harper lake, where eight settlers had squatted. The land settled on consists of good bottom land, thickly wooded, and rolling hills lightly timbered. The settlement lies about four miles to the south of Shuswap station, at an elevation of about one thousand feet above the latter place. There is only a rough trail at present between the two places, but the settlers claim to have located a good road with easy grades that can be built at moderate cost. All the suitable land is now taken up.

From here I moved to Little Shuswap lake, where I retraced the boundaries of Little Shuswap Indian reserve and surveyed the adjoining quarter sections. The boundaries of the Indian reserve follow closely the foot of the high mountain to the south, leaving the strip of good land between so small that it is scarcely worth taking up.

My next move was to a small creek flowing into Adams river on the westerly side. I surveyed five or six sections here lying along the creek. About three miles up the creek there is a marshy meadow and considerable bottom land. With some drainage several sections could be brought under cultivation. There is some very large timber, cedar and fir, in this locality, which is included in a timber berth. Two settlers had camped here for a short time, and made some improvements, but apparently had abandoned them. The elevation above Adams river is about four hundred feet. At present there is only a pack trail, but a good road could be built at moderate cost. The lumber company will probably lead the way by making roads and clearing off the heavy timber.

The enterprise of the Adams River Lumber company is very much in evidence in this district. At the foot of Little Shuswap lake a large sawmill, fitted with the most modern machinery, has been built, while nearby, across the railway track, a townsite has been laid out upon which the new town of Chase is fast springing up. Waterworks were being put in at the time of the survey. A steamboat and a launch or two have been placed on Shuswap and Adams lakes for the company's private use. A good road, six miles in length has been built between the two lakes, and a telephone line follows along this road. Adams river has been much improved for log driving, and a most substantial dam constructed near the head of the river. On Upper Adams river, where the bulk of the company's timber lies, equally extensive improvements have been made. The large expenditures made would indicate the company's intention to operate here on a large scale for many years.

After traversing the right bank of Adams river and a part of the east side of Adams lake, I moved to the foot of main Shuswap lake. Between the lake and the high mountain to the south there is a considerable stretch of good land which has been taken up since the 'days of construction,' and is now thickly settled. The old survey was not altogether complete; I ran out the few necessary lines, completing the survey as far as Notch hill.

My next work was on the opposite side of the lake where I extended the old surveys up Meadow creek as far as Scotch creek valley. Three settlers have squatted here and are making fair progress. The bottom land along the creek is good, but the high land appears to be rather dry for farming.

My next camp was pitched on Mara lake. The land surveyed here lies along the east side. There is no road on this side of the lake, but Sicamous, the nearest station on the railway, can be conveniently reached by water. It seems strange to see, close to Sicamous, a considerable area of good farm land still in its primeval state. This farming land is held in provincial lots. The only reasons I can think of for no use being made of it are that it is held for speculative purposes, and that the mosquitoes make life scarcely worth living for about two months in summer.

I next made a survey in township 21, range 9, where a small creek flows into the Salmon arm of Shuswap lake. I carried the survey along the creek for several miles. There are two quarter sections along this lake suitable for farming. There is no road on the north side of the lake here, the only route being by water. Salmon Arm station and Sicamous Junction are the nearest railway stations.

On finishing the survey here, I went up Salmon river, making small surveys en route and establishing the boundary of the belt where practicable. At Ingram creek I carried the survey to the boundary of the belt where I found that a large meadow had been partly taken in provincial lots. The meadow is about two miles long and about a quarter of a mile wide, and the greater part of it lies within the belt. Farther up the creek, on a tributary, there is a smaller meadow. This has been squatted on by a settler holding a provincial pre-emption record. Outside the two meadows and the margin of bottom land surrounding them there is no land for settlement. The altitude is about four thousand feet above sea-level. A pack trail follows along the creek to the meadows.

From Ingram creek I moved to the end of the original surveys on Salmon river. From here I ran south to the boundary of the belt and connected with the survey made at Ingram creek. I then carried the survey up Salmon river to the east boundary of the Monte Hills forest reserve. From the latter place I ran a traverse along the river road to the boundary. Up to the reserve there is a narrow strip of good bottom land, but from here the mountains come down steeply to the river. Grande Prairie, the oldest and best settlement in Upper Salmon river valley, is ten miles long and from a mile to three miles wide. It is perfectly level and the soil is very productive. The farmers, however, do not seem to be so progressive as in other parts of the district probably on account of the lack of railway facilities. A syndicate were negotiating a deal by which they would acquire most of the land in the settlement. Their intentions were to subdivide the land into small holdings, and sell on easy terms of payment. In this way a much larger population could be accommodated. The syndicate proposed to put in an electric railway from Vernon and to build a large sawmill in the valley. It is to be hoped that the deal will be consummated, and the proposed projects carried out, as it would be a boon to the whole valley.

From Salmon river I went to Paxton valley where I made subdivisions on both sides of the valley. In sections 9 and 10, township 18, range 13, there is a small meadow and some good bottom land, but generally the land is not well adapted to farming. The scarcity of water and the distance from market will probably prevent the land from being settled on, for the present, at least.

After finishing the work in Paxton valley I made small surveys at Campbell creek, Back valley, Louis creek and Edith lake, all lying within a radius of thirty miles from Kamloops. The conditions and character of the country are very similar to those of Paxton valley and therefore will not require any particular description.

The weather conditions throughout the season were favourable for surveying, but the spring and early summer were too dry and cool for a good growth of vegetation. The hay crop was much below the average, but the grain crop was fair. On the hills the crops were the best for many years.

Except at Mara and Carlin we saw no damage done by forest fires this season. On the whole the losses from fires must be much smaller than for many years. This is, no doubt, mostly due to the watchfulness of the fire wardens, but the new provincial regulations, by which a farmer must get a permit before setting out fire for clearing land, should also be a help.

APPENDIX NO. 37.

EXTRACTS FROM THE REPORT OF A. SAINT CYR, D.L.S.

SURVEY OF THE SIXTEENTH BASE LINE BETWEEN THE THIRD AND FOURTH MERIDIANS AND PART OF THE THIRD MERIDIAN.

On December 17 I left Prince Albert and travelling by the Montreal lake road reached Indian reserve No. 106 A. We camped near the northeast corner of township 52, range 1, where I was to commence the survey of the third meridian.

The survey of the line proved to be a trying piece of work owing to the long periods of intense cold which prevailed during the winter and the deep snow which necessitated the daily use of snow-shoes by every member of the party who had to be on the line. During the winter months the snow seldom packs sufficiently hard to carry any great weight and even with large snow-shoes one had to flounder knee-deep through it, a most arduous and heating work for those who had to explore a country often very hilly or covered with high deadfall and where dense and tall undergrowth continually impedes progress.

Another drawback was that oftentimes work on the line had to be stopped and all hands set at cutting roads through miles of fallen timber, as all the streams intersected by the third meridian flow generally at right angles to it and the ice on such streams could not be taken advantage of in moving the camp or supplies forward.

DESCRIPTION OF THE COUNTRY ALONG THE THIRD MERIDIAN.

From the northeast corner of township 52 the third meridian crosses the valley of Little Red river and ascends to the high lands bounding its valley to the east. These lands extend northerly to the valley of Angling creek, an easterly tributary of Little Red river. In its widest part, in township 52, the valley of this river does not exceed two miles in width and the bottom lands, found only along its right bank, are included in parts of sections 2, 3, 10 and 12, the strip adjacent to the river having the best soil. Along the foot of the high pine ridges, which also limit the valley to the west, the prairie land has a drier and more shallow soil, overlying a subsoil of gravel. A few shanties, now abandoned, would indicate that this land was once occupied by squatters, who, however, appear to have done no cultivation beyond raising vegetables.

North of the valley of Angling creek are some high hills wooded with jackpine and a few spruce, and included in the same timber berth which covers nearly all of township 54. Then the line enters a low country with many lakes, the largest ones being called Whitesand, Trapper, and Beartrap. They drain into Angling lake by a small stream which meanders through large hay meadows extending southwards to the north shore of the lake. As the banks of this stream are very low it is probable that portions of the lands near the creek are flooded at certain seasons.

North of Whitesand lake, ridges covered with jackpine, or swampy lands with spruce and tamarack, continually recur through township 56, which mark the northern limit of timber berth No. 245, located east of Little Red river. This section of country has been lumbered over extensively for so many years that the merchantable timber must be either getting scarce or more difficult of access as no logs were cut on these lands during the last winter. Great activity, however, prevailed in the camps west of Little Red river, which at that time were located near Sandy lake, and on its outlet, McKenzie creek.

Townships 54 and 55 are covered with a better growth of poplar trees which are, however, found only in groves separated by extensive tracts of burnt-over country where the new growth is stunted. In approaching Montreal lake merchantable spruce timber from ten to twenty-four inches in diameter is found near its south end.

Continuing northwards from the fifteenth base line, the third meridian passes through low and swampy lands intersected by gravel and sandy ridges. The outlets from Waskesiu and Crean lakes are the two principal streams which drain these wet lands into Montreal lake.

A strip of good spruce from ten to twenty-four inches in diameter begins in section 24, township 60, and extends one mile north of the sixteenth base line and three miles east of the third meridian whence smaller timber covers the land as far as the west shore of Montreal lake. Patches of good timber are found at intervals in ranges 1 and 2. A narrow belt of heavy spruce is also found along a chain of lakes occupying a valley which crosses the middle of township 56 from west to east. This is all that is left of a good block of timber which at one time grew where the land is now covered with high deadfall.

The trees most commonly seen along the west side of Montreal lake are poplar, birch and cottonwood. Pine also grows on the high lands which rises from its shores and west of which is the low and boggy country above referred to.

Much of the upland in the vicinity of Crean, Waskesiu and Montreal lakes might be made productive. The vegetation such as I have noticed at many places consists of pea-vine and grasses indicative of a good soil, and I do not doubt that the ordinary cereals and all kinds of vegetables could be raised after the land has been cleared of the fallen trees and thick scrub which cover it.

This part of the country is easily reached from Prince Albert by the Montreal lake road, which though hilly is in fair condition for travel at all seasons.

Except Montreal lake, all the other large lakes are well stocked with large trout, whitefish, pike and pickerel and during the winter months large quantities are caught. I bought several boxes of fish for the use of my camp and was surprised at the great size of the trout packed therein.

Valuable timber, not included in the timber berths under lease at the present time, is still found growing in limited quantities and in sparsely distributed areas separated by large tracts of country which were overrun by fires years ago and where the trees of the second growth are still too small to be of any commercial value.

The merchantable timber consists chiefly of spruce growing on lands more or less swampy, such as adjoins lakes or streams with low banks.

Pine of a size sufficiently large to make it valuable is found in groves on the highest hills. It grows straight and limbs are found only near the top of the tree. As this kind of pine keeps its size well it could be used for railroad ties. It was first noticed in township 59, on the hills along the valley of Crean creek.

The other kind of pine is very common on all minor elevations. It has a stunted appearance and carries large and long limbs which drop almost to the ground. In size it runs up to twelve or fifteen inches.

Birch appears to decay after it has reached a diameter of six inches, very few of a larger size having been seen that were not already partly rotten. Tamarack up to eight inches were seen also, but they are generally hollow or unsound in the centre.

Poplar which have reached a diameter of twelve inches are often affected in the same manner. Pine and spruce appear to be the only trees which grow sound to the largest size noted, thirty inches.

The proportion of these different kinds of trees, distributed over the country traversed by the third meridian, and of size suitable for pulpwood, is as follows: Poplar, 50 per cent; spruce and jackpine, 40 per cent; and tamarack, birch and balsam, 10 per cent. Admitting that no trees smaller than four inch is to be cut, the estimated quantities of the above timber that could be utilized as pulpwood in the district adjacent to the third meridian is about two million cords.

Limited water-power could be developed on the following streams which intersect this meridian; Waskesiu creek in township 58 and Crean creek in township 59. These creeks flow into Montreal lake.

DESCRIPTION OF THE COUNTRY ADJOINING THE SIXTEENTH BASE LINE.

The survey of the sixteenth base line was commenced in the latter part of March, 1909. From the northeast corner of township 60, this line passes through eighteen miles of country several times overrun by fires, which have in many spots cleared the land of fallen timber. This land is, however, generally stony. Numerous lakes are seen in every direction and they all drain into Montreal lake.

After crossing the height of land in range 4, good soil was noticed in the vicinity of Lavallee lake, where Louis Lavallee, a half-breed, has resided for many years.

This lake is over six miles long and two miles wide, occupies the central portion of township 61, and its north end is surrounded by hay meadows. A small section of the other end of Lavallee lake lies in township 60, where a large creek which comes from the southeast flows in. The outlet of this lake starts a few chains south of the point where the base line intersects the west shore. At first it flows swiftly over a stony bottom, but after crossing the line, two miles farther, the current slackens considerably and the stream then winds across the hay marshes between Lavallee lake and Paquin lake.

A short distance north and south of the line the land is high, rolling and timbered with mixed woods of small poplar and jackpine.

North of Lavallee lake the country is more level and lightly wooded with second-growth poplar. The soil is good. In ranges 6 and 7, extensive swamps and bogs and the accompanying pine ridges reappear around Lawrence lake which discharges into DeLaronde lake but good and fairly level land is met again four miles east of DeLaronde lake, in range 8. A good growth of poplar covers the land on each side of this lake which the line crosses near the north end. During the summer I had an opportunity to visit the district at the south end of the lake when in search of some of my supplies which had been left by the freighters at a squatter's house as the only place where they could be safely cached. On that trip I travelled by canoe to the southern end of DeLaronde lake and thence overland to Cowan lake. By this portage the distance between the two lakes is about five miles. There are two small lakes and the north end of Ladder lake to cross before reaching Cowan lake. The land between DeLaronde lake and Cowan lake is good and level with some prairie and hay meadows. The outlet of Stony lake issues from the west side; it is increased in volume a few miles farther by the outlet of lac Voisin, and flows westward to the south end of Taggart lake, located in townships 59 and 60, range 18, where Taggart creek crosses the line before it joins Cowan river flowing out of Cowan lake. This lake is a long narrow body of water which extends southeasterly beyond the fifteenth base line.

Last fall a steam sawmill was erected near the point where a large stream enters this lake. In this vicinity are large timber berths where lumbering operations were carried on during the winter. The lumber company has secured several valuable timber limits in the district and in proximity to their mill sites, thus avoiding the difficulties met by the pioneer lumber companies who had to haul the marketable products of their limits over long distances to their nearest market, Prince Albert.

The Canadian Northern Railway company is also building their line in that direction and last fall rails had been laid as far as Shellbrook settlement. Work on the section of this road which is graded for a considerable distance beyond the settlement will be resumed in the spring.

Large hay meadows exist at the north end of Cowan lake which is connected with Green lake by a road principally used by freighters during the winter. Although the land adjoining these large lakes is at present generally wooded, there is some which it would be neither difficult nor expensive to clear. Good hay is plentiful everywhere and would provide fodder for numbers of cattle. The fact that a railway company is pushing their line through it ahead of the settlements should be sufficient inducement to homesteaders to take up this land. It lies about sixty miles north of Shellbrook district where last year the farmers raised phenomenal crops, principally oats, although according to the oldest settlers the spring season was the most backward experienced for thirty years. During the winter months employment at remunerative prices could be secured by the newcomers, either from the lumber companies, who always hire a large number of men, or by freighting merchandise for the two fur trading companies at Green lake, which still remains the gateway to the northern fur trade and where immense quantities of supplies of all descriptions have to be brought for distribution to their distant outposts.

Green lake settlement grouped around one of the oldest and most important trading posts established by the Hudson's Bay company in this country, was reached on August 23. It is well known that the cultivation of the soil was begun here very many years ago and that barley, oats, potatoes and all ordinary vegetables have since been successfully grown. Father Teston, O.M.I., who is in charge of the Roman Catholic mission, and is also the postmaster at Green Lake, showed me through his gardens, where besides vegetables, he cultivates several kinds of small fruits, such as currants, &c.

The settlement is peopled with half-breeds, who all own horses and cattle, it being easy to provide fodder by cutting wild hay, of which there is an abundance along Beaver river, and especially at a place called 'The Hill,' at the confluence of Meadow river and Beaver river.

West of Green Lake, the sixteenth base line enters a densely wooded country where some good spruce from ten to twenty-four inches grows and is included in two large timber berths under lease. This forest extends fully through two and a half ranges. Then comes the more lightly wooded country drained by Meadow river and its tributaries. Meadow river flows out of Meadow lake, north of which I saw good agricultural land fit for immediate settlement, it being largely in prairie land with occasional poplar groves. The more open land is, however, within an Indian reserve, and is not cultivated. Fresh water and quantities of hay growing on the upland and in the hay meadows is found throughout. The agricultural land around Meadow lake would cover townships 59, ranges 17 and 18 and the southern half of township 60, range 17.

At Meadow Lake there is a Roman Catholic mission and a trading post kept by the agent of the Hudson's Bay Company.

This settlement is connected with Battleford by a wagon road, but it is a circuitous route passing by Brightsand lake and Turtle lake. A new road nearly completed is being opened from Battleford. It follows the line separating ranges 16 and 17, and will be much shorter than the old one. There exist many large hay marshes and lakes through the northern half of township 60, range 17, and between these are belts of merchantable spruce timber. There are also some large tracts well wooded with poplar from six to thirteen inches in diameter. More merchantable timber is found at about two miles north of the base line and extends as far as Beaver river.

In range 19 the line crosses Makwa river near its confluence with Beaver river. The general course of Makwa river is southeast; its principal affluents are Horsehead creek and Rabbit creek, which rise south of the fifteenth base. A good road which I open to facilitate the transport of my supplies now connects Meadow Lake settlement with the Beaver river valley at the point where Makwa river and Beaver river meet.

Makwa river averages one chain and a half in width. Its lower reach is a succession of cascades and rapids with intervals of slack water. As the fall of this stream is considerable, water-power could be developed along its course. Dams could be easily and cheaply built at suitable points as the materials required for such construction is close at hand.

I explored the country on both sides of Beaver river from its junction with Makwa river westward to the fourth meridian in order to ascertain the quality of the soil and the timber growing thereon. I have also made a track survey of the river which is accurately mapped on the sketch map accompanying this report. The width of this river varies very much. In some places it is nearly four chains wide, whilst at others it is hardly half that distance. The current averages about three miles an hour. There are very few islands and no rapids, the 'riffles' noted at the time of survey (December, January and February) would not be noticeable in the ordinary stage of water during the summer. The elevation of the river banks varies from ten to twenty feet and the adjacent strip of bottom lands extending back to the foot of the high hills which rise from either side of the valley proper, varies greatly in width. In places it is three-quarters of a mile wide, at others, where the hills from opposite sides approach the river, it is considerably less. On some of these bottom lands wild hay grows, but such lands are liable to be flooded at high water. Where the banks rise to eighteen or twenty feet the land is wooded, sometimes with spruce, but more frequently with poplar, birch and cottonwood. In a distance of seventy-five miles along the sixteenth base line, between the fourth meridian and the mouth of Makwa river, Beaver river receives only two creeks from the north. They are Wild-carrot creek, which flows across township 61, range 21, and another unnamed stream in township 61, range 25, East of this last creek there is a winter trail used by the Indians travelling from Onion Lake settlement to Big Island lake. Open country along the left bank of Beaver river begins at range 25 and extends westerly through the next range.

Between Beaver river and the sixteenth base line from range 24 to range 26, the land is covered with scrub and a second growth of poplar, birch and a few spruce and jackpine. However, in the southwest quarter of township 60, range 25, and the east half of range 26, there is a considerable area of partly open and prairie land with good soil where quantities of upland hay could be procured, and where good water is found in numerous small streams. The land would be suitable for agriculture and stock raising. It lies about thirty-six miles north of Onion Lake settlement, with which it is connected by a good wagon road which passes by the trading post on Ministikwan lake.

There are at present several families of Cree Indians living along the north and west shores of this lake where the country is rolling and fairly open, and hay is plentiful. This accounts for the residence in this locality of the Indians who own horses and cattle, while those do not at other parts of the lake shore which is surrounded by thickly wooded hills, the highest ones rising a short distance east of the lake. These hills gradually slope down towards the south end of the lake, where a small creek flows in.

The stream which connects Ministikwan lake to Makwa lake is about twenty-five feet wide and at one mile and a half east of the first mentioned lake runs between hills with very steep slopes. Beyond this the country is, however, tolerably level, and the land is covered with scrub and sparsely timbered with a few jackpine and poplar not exceeding six inches. There is a wagon road between Onion lake and Ministikwan lake.

Eleven miles east of Ministikwan lake is Makwa lake, where Big Bear and his band of braves had entrenched themselves in 1885 and where he met General Middleton's troops. As a result several Indian graves to-day mark the spot where the encounter took place.

Makwa lake is of a very irregular shape and divided into two unequal expanses of water by a large island well wooded over its north half with spruce trees up to fifteen inches. The other half is covered with smaller trees such as poplar and birch. The narrow passage between the two lakes is east of this island where some fisherman has built a house. At very low water this island appears to join the mainland north by marshes where wild hay grows and which are fringed with thick willow. These willow lands extend northward for a considerable distance.

High hills which in places slope steeply down to the water's edge rise around Makwa lake except a short distance along its north shore where the country is flat and heavily timbered with spruce up to thirteen inches. Through these flats runs the outlet of Ministikwan lake, before it discharges into Makwa lake.

Merchantable timber consisting of spruce eight to twelve inches is found in small quantities at two or three other spots near the lake shores, the most common trees found in this part of the country being poplar and birch rarely exceeding six inches and of stunted growth.

The tract of country between the two lakes above mentioned would cover ranges 23 and 24, along the fifteenth correction line and may be thus described. Travelling eastward from the northeast end of Ministikwan lake, the country is rolling or undulating, and the land, which is covered with poplar groves and scrub-willow, could be easily cleared. Here are also many patches of prairie land. Good water would be found in the lakes which dot this section, and in the creeks. Beyond Half Way creek, so called because it is midway between the two lakes, the country gets very hilly and could be utilized only for stock raising. At present it is sparsely wooded with poplar. A narrow belt of jackpine up to fifteen inches crosses these hills from north to south. A strip of spruce trees was also noticed along the east side of the valley of Half Way creek. The rest of the timber is small and of no commercial value.

There are a few hay meadows along Makwa lake, notably at the southern extremity of the smaller lake and also along the north shore, opposite the 'narrows' and the large wooded island above referred to. Many shanties have been built along its shores by fishermen.

Like all the larger lakes in these parts Makwa and Ministikwan lakes abound with whitefish and another kind which resembles it, but is smaller and which the natives call 'Tuladi.' In Beaver river pike is caught all the year round; in the winter it should be looked for only in places where there are eddies and deep water. Sure indications of the proper spots are given by the otters air-holes along the banks of this stream.

Large game is plentiful, and deer or moose meat fresh or dried according to the season forms the principal food of the Indians and those who travel through the country. Of the furs collected by the fur trading companies, the muskrat skin is still the most commonly exchanged for such commodities as sugar, tea, tobacco and flour. Partridges and prairie-chickens are still quite common.

Between the third and fourth meridians the territory adjacent to the sixteenth base line comprises twelve miles on each side, or 3,816 square miles. Deduct two-thirds of this area for streams, lakes, swamps and boggy lands and the large tracts of burned over country at present covered with sapling and willow and the reservation of the merchantable timber included in leased berths, and there remains 1,300 square miles or 832,000 acres of forested land where poplar and balm of Gilead represent sixty per cent; jackpine and spruce thirty per cent and birch and tamarack ten per cent.

Allowing an average cut of fifteen cords per acre, this district will supply about 12,500,000 cords of different kinds of wood suitable for the pulp industry.

Along the sixteenth base line water-power could be developed on Meadow river in township 59, range 17, and on Makwa river in township 60, range 19.

APPENDIX No. 38.

EXTRACTS FROM THE REPORT OF J. B. SAINT CYR, D.L.S.

SURVEYS IN THE PEACE RIVER DISTRICT.

I established my camp on the south side of Peace river, six miles above Dunvegan, at a place commonly called 'the island,' and on April 28, early in the morning, I went with my men to the northwest corner of township 80, range 5, west of the sixth meridian. I first moved the corner post 16·70 chains north of its original position and started the east boundary of township 80, range 6. I destroyed the monument on the primitive base and established a new one 16·70 chains north. Two days after I crossed and chained the line on the ice. I certainly arrived in good time at Dunvegan, as to perform the same work after the breaking up of the ice would have been a very hard task. I produced the said line as far south as possible and surveyed three miles of the north boundary of township 79, range 5, from the same camp. In the meantime the ice broke away on the river, so I built a raft and a few days after when the river was safe enough we floated down to Dunvegan with our baggage. We landed on the south side of the river as there was no means of crossing at the time, the ferry being only under construction. The following day I camped on the hill to complete the north boundary of township 79, range 5, west of the sixth meridian. My next camp was established near the southwest branch of Ksituan river, north of Spirit River settlement. From that point I completed the east boundary of township 79, range 6. The country crossed by that line is cut by deep and wide ravines, thickly timbered, and in the bottom of which regular torrents were flowing. On May 27 I went farther south to run the east boundaries of townships 77 and 78, range 6, which was completed on June 17. The subdivision of township 77 and 78, range 5, which was commenced in June, ended on September 8.

Egg lake trail with Dunvegan and Grand prairie wagon road cross those townships. I have surveyed river lots along the above mentioned streams in both townships.

On September 9 I began the subdivision of township 79, range 5, which was completed on October 16. Ksituan river and Rat creek, tributaries of Peace river, and Spirit river, flowing into Brule river, drain that township. Dunvegan and Spirit river wagon road crosses that country in a southwesterly direction. Sawmills and dams can be erected on different points along Ksituan river, as the general fall of the water in that stream and its tributaries varies from forty to fifty feet to the mile. The width of the river is about one hundred and forty feet with a depth of from six to eight feet in the spring. The water is somewhat muddy when the river is high but it is clear and fresh after that. Hills ranging from four to six hundred feet in height border these streams. I did not lay out any river lots there owing to the difficulty for the settlers living on the table-land to get to the river. It would be advisable to reserve the northern portion of township 79 as a timber berth.

While completing the subdivision and the mounding of that township, I explored the country from the twenty-first base to the twentieth correction line and between ranges six and seven, west of the sixth meridian. Heavy windfall is met with everywhere and the country is cut by deep ravines. There is no pack trail or road of any kind through the country and it would require a very long time to open a road or even a pack trail there. On October 16 I established camp in township 77, range 6, and surveyed the east boundary of townships 77 and 78. The country adjoining the line is covered with thick bush and large tracts of windfall. On October 29, I started the subdivision in township 77, range 6, and completed it on November 12. The climate is better than along Spirit river. The frost comes generally two or three weeks later in the fall than in the adjoining townships.

The subdivision of sections 1 to 24 in township 78, range 6, was completed on November 29. Spirit river flowing from west to east crosses sections 6, 5, 4 and 3. Spirit river people with the residents of Pouce Coupe prairie intend to open a wagon road between the two places very soon. The location of the road is said to follow a long ridge south of the existing pack trail.

I next located permanent access of the road to the water on both sides of the river at Dunvegan. Changes have been made also to the front road on the north side of the river. I connected the settlement south of Peace river with the nearest subdivision posts north and south of the river.

I then went to township 82, range 24, west of the fifth meridian to destroy some monuments made there last year, north of a road allowance along the north boundary of Indian reserve No. 151. I also established a regular monument in place of the witness trench on the northerly limit of the road allowance along the northerly boundary of Indian reserve No. 151 E.

On December 8 I arrived at Peace River Crossing settlement and connected the surveys of Shaftsbury settlement made by Mr. H. S. Holcroft, D.L.S., in 1908, with those of the addition to Peace River Crossing made by me in the Spring of the same year. The positions of the cable, towers and anchorage on both sides of the river were determined by me. I have also extended the survey of the road allowances to have the towers and anchorage on public lands. At Peace River Crossing as well as at Dunvegan, some changes will be made to both cable ferries for the following reason. In Dunvegan the ferry gives a poor service and the tower on the south side of the river has to be shifted farther east. While at Peace River Crossing it is impossible to make a good grade on the east side of the river and furthermore it is a bad landing place. It is intended to make the above mentioned changes next summer and I have located enough land in both settlements for that purpose.

APPENDIX No. 39.

EXTRACTS FROM THE REPORT OF B. J. SAUNDERS, D.L.S.

SURVEY OF PART OF THE NINTH AND TENTH BASE LINES WEST OF THE FIFTH MERIDIAN.

Upon completing the organization of my party at Innisfail, I moved westerly from that town along the road leading to Raven, Stauffer and Rocky Mountain House, leaving this road about ten miles west of Stauffer in order to cross Clearwater river by means of the new steel bridge recently erected by the Alberta government over that stream in township 37, range 6, west of the fifth meridian. From this point to the northeast corner of township 36, range 8, we had to cut and make our road the greater part of the way, owing to the soft and wet condition of such roads as the settlers had been using, rendering them impassable for loaded teams.

The survey of the tenth base was commenced on June 29 by reopening and taking up the line to the east of range 8 as preparatory work, and after duly observing for time and azimuth, the survey was steadily carried on up to September 9, by which time the line was completed through ranges 8, 9, 10 and 11, and as far as I considered it practicable to establish it owing to the mountainous nature of the country.

Throughout ranges 8 and 9, and nearly all of range 10, the country traversed by this line is, generally speaking, rolling and hilly, while the west side of range 10 and all of 11 is mountainous, the outer range of the Rocky mountains being crossed in section 31, township 36, range 10.

The whole country has been more or less burned over within the last twenty-five or thirty-five years, with the result that the timber is rather small with the exception of here and there, in small patches, fairly large spruce and pitch-pine.

The soil is of a sandy nature and inclined to be stony. There is practically no grazing land, except along the creeks where the natural grasses grow with most remarkable luxuriance, some six feet high being noted along one of the tributaries of Prairie creek. The drainage of the country is to Prairie creek, a number of tributaries of which are crossed by the line.

In township 37, range 8, to the north of the line, a number of settlers have located on Prairie Creek, where a considerable area of good hay land is found.

No economic minerals were met with during the progress of the survey. Gold 'colours' were obtained from panning the gravel in Prairie creek, in range 8, and outcrops of lignite were noted in township 36, range 11, about two miles south of the line on a small stream leading to Prairie creek. There are sulphur springs to the north of the line in the same range, the water of which is cold.

I do not consider the land to the south of this line desirable for settlement at the present time, but as already mentioned a number of settlers have located to the north on Prairie creek.

Having completed the tenth base as far as range 12, on September 9, on the following day we started for the ninth base line at the northeast corner of township 32, range 8, west of the fifth meridian. This line was established through ranges 8, 9 and 10, west of the fifth meridian, well into the mountains and within a mile or two of the snow-capped peaks.

The whole of this line lies within the Rocky Mountains park, and in consequence no settlers have located west of range 7, the line between ranges 7 and 8 being the east boundary of the park.

The country along this line throughout the three ranges surveyed by me is practically all mountainous, range 11 being particularly rugged. At the ninth base and in its vicinity the eastern face of the mountains is not so well defined as at the tenth base and farther to the north. The country gradually changes from hilly to mountainous.

The country traversed by this line is very well timbered with spruce and pitch-pine of good quality and size. There are some open patches of land in the valleys, but they are all more or less inclined to be wet and of a muskeg nature. The soil is chiefly of a sandy or gravelly quality.

The line crosses James river, a tributary of Red Deer river, on the north boundary of section 34, range 9. It is a mountain stream with an average width of about forty feet, flowing between well-defined banks with a general northeasterly course. This is the only stream of importance, although the whole country is very well watered with numerous small streams from the mountain sides.

Lines of levels were carried along both base lines, the datum for the tenth base being determined by barometric readings taken at the point of commencement and compared with readings taken on the Canadian Pacific railway track at Innisfail, while the levels on the ninth base depend on angles of depression taken at two points on the line, upon the grain elevator at Olds station on the Calgary and Edmonton branch of the Canadian Pacific railway.

During the season the usual foothill weather prevailed with considerable cloudy weather, and heavy thunder showers in June and July. September and October were very fine months, but before the middle of November it was extremely cold with the thermometer down to 20° below zero.

The country on both sides of each base was pretty well examined by the explorer attached to the party and the results of his work are shown on the sketch plan already forwarded to your office.

Very little game was observed during the summer and autumn, and unless measures are soon taken to stop the annual depredations of the Indians from the reservations to the south, there will be no game left in the country.

APPENDIX No. 40.

EXTRACTS FROM THE REPORT OF W. A. SCOTT, D.L.S.

SURVEYS IN SOUTHERN ALBERTA.

The season was unusually late and wet, and the roads were in bad condition. For this reason we were forced to wait until May 25, before starting out for township 13, range 1, west of the fifth meridian. The shortest route to reach this township is by going almost straight north to the west side of Porcupine hills, but at this time of the year it was considered advisable to go by the east side, and the wisdom of this move was apparent when the party returned south in July by the shorter route. The move from Pincher creek to the work occupied five days and the country passed through was that which, at one time, was the undisputed range of the cattle-men, but which, during the past few years, has been rapidly taken up as farm lands. Many steam plow outfits were seen and the country looked good and the people prosperous. The cattle ranches are fast disappearing, but there are still a few large ranches in existence.

While in the township a trip was taken to Calgary via Nanton to purchase a pack outfit for use in the mountains. The road to Nanton follows the valley of Willow creek as far as Willows post-office, crossing the creek many times, which makes it impassable for a month or six weeks in the spring. A road could be easily built on either side of Willow creek cutting out all crossings and making a good road the year round. There is at present a trail leaving Willow creek at the junction of the north and south forks, which goes in a northwesterly direction to Nanton and is much shorter than the one generally used, but it is very hilly and it would not be advisable to build a road following this general direction.

After completing the subdivision necessary in this part, the party moved to township 13, range 3, and here experienced the first mountain work.

We next moved south to commence work in township 9, range 3, passing through the eastern parts of townships 12 and 11, range 2. Only part of township 11 is subdivided, but both townships appear to be good farming land if they are not touched by summer frosts. The small mountain streams in their rapid descent afford an excellent opportunity to irrigate the land, and several small irrigation ditches were seen.

During the summer a preliminary railroad survey was made up this valley to investigate the possibility of connecting Cowley with Calgary by a line through the hills. The location, I was told, was not very satisfactory because of the heavy grades which would be necessary. A survey was made several years ago which followed up the valley of Oldman river and over the divide to Highwood river. This, I believe, would be a better location, as there is only one summit and the road would give access to the great area of coal lands in the vicinity of Oldman river. A part of this road will no doubt be constructed in the near future.

An alternative and much shorter route to reach the coal areas north of the Canadian Pacific railway is by going north up the valley of Gold creek and down the valley of Daisy creek to Oldman river. There is at present a railroad from Frank to Lille. At the divide a tunnel would have to be driven through the hill.

On September 11, all the work in this part was completed and the next work was the production of the third base line across range 4. To reach this work I found it necessary to cut a pack trail through a most difficult country lying between the 'Gap' and the town of Coleman.

North of Coleman the country is of a most mountainous character. The third base line was produced across range 4 and the end is a quarter of a mile up the lower slope of Crowsnest mountain. The general direction of the valleys is north and south coinciding with the strike of the rocks. The rocks may be divided into three main divisions, viz: The Devono-Carboniferous, the Middle and Lower Cretaceous, and the Upper Cretaceous. The Devono-Carboniferous rocks consist principally of limestone. The important division from an economic standpoint is the second division or Middle and Lower Cretaceous. This division consists of, in ascending order, (1) Grey and black shales; (2) Productive coal measures; (3) Hard cherty conglomerate. The dip is towards the west and varies from 30° to 60°. The outcrop generally seen along the tops of the hills is conglomerate.

The most noticeable feature of the weather in the mountains is its variety and the suddenness with which changes occur. Work may be commenced in the morning in the finest of weather and during the day it may change to snow, rain, dense fog and very likely to fine weather again. At the same time the weather only a few miles distant may be altogether different. I also noticed that the stormy fall weather occurred almost a month earlier in the proximity of Crowsnest pass than it did at the 'Gap,' and just beyond Livingstone range still later.

Another feature which I could not help noticing was the large flow of water in the creeks for the small area of watershed. The dimensions of a creek may not be any greater for a certain area of watershed in the moutnains than on the flats, but the current is so rapid that at least twice the flow would be recorded if such a record were taken.

On leaving the mountain work I moved to township 13, range 2, by way of the 'Gap,' southeast to the Walrond ranch and then straight north to township 13. The weather was altogether different here, almost no snow, but fine, cold weather. I did the work here which I was instructed to do, and then completed the subdivision as far as possible. I then proceeded to run the east boundary of township 12, range 3, but after getting this line cut two miles, found that it was running into the hills and that I would be unable to produce it any farther at this time of the year.

APPENDIX No. 41.

EXTRACTS FROM THE REPORT OF H. W. SELBY, D.L.S.

SURVEYS IN NORTHERN ALBERTA.

My first work was to run the east outline of township 72, range 2, and the north outline of township 71, range 1, west of the fifth meridian, to subdivide such portions of these townships as were occupied by squatters and to traverse Lesser Slave and Athabaska rivers through them. Both of these rivers have been accurately and fully described in previous reports, and it would seem unnecessary to say anything further about them. It may not be out of place for me to make a few remarks upon their changing conditions. Lesser Slave river, which is the outlet of Lesser Slave lake in section 7, township 73, range 5, flows in an easterly direction to its confluence with Athabaska river in section 22, township 71, range 1. The fall from the lake to the Athabaska, a direct distance of about thirty miles, is over one hundred feet. Seventy-five feet of this fall occurs within the easterly twelve miles, that is to say, from the top of the rapids to the Athabaska. Into the upper part of Lesser Slave river fall three streams, each about seventy-five feet wide, Saulteux, Otauwau and Prairie rivers, and Eating creek about fifty feet wide. Frequent rain-storms, in addition to the large volume of water coming into the lake, causes Lesser Slave river to rise several feet. At these times large quantities of sediment, trees, logs and brush are carried from the lake, the rivers and creeks into Lesser Slave river, and thence down the Athabaska. This causes much erosion of the banks of the rivers. The building of wing dams on the easterly part of the river and the excavation of a channel which is being dredged is freeing a large quantity of sediment. All these things combined make a wider channel for the same volume of water, and at the same time cause the formation of bars in the Athabaska, resulting in a shorter period for navigation. Dredging portions of the upper part of Lesser Slave river would be a great benefit not only for the purposes of navigation, but for the reclaiming of large swamps which lie north and south of the upper part of the river, and which are now about on a level with the surface of the water and must remain wet swamp in which timber will not grow to any size, nor grass for hay or pasture. The banks of this part of the river are seldom high enough to keep the water within the channel at times of freshets. The banks are from five to ten feet high, but the land rises from the banks in benches to a height of from one to six hundred feet above the level of the rivers through ranges 1 and 2, west of the fifth meridian. On the tableland, except where drained by rivers, large areas of wet land are found where the timber is too small to be of any commercial value. Along the rivers the land is dry and the soil good.

Some excitement was caused by the discovery of placer gold in a gravel ridge on section 23, township 71, range 1, but the extent and value has not been ascertained. Mirror Landing is a telegraph station on section 22, township 71, range 1. There is also a store, a stopping place for travellers by the steamer, and a warehouse belonging to the transportation company. The Government telegraph line from Edmonton has been completed to a point six miles west of Mirror Landing. This is a great convenience, and it is hoped the line will be continued to the west end of Lesser Slave lake next season. Saulteux landing on section 25, township 72, range 3, is the point of departure of the steamer up to Lesser Slave lake. Here is a warehouse and stopping place.

On June 7, having surveyed all the land on Lesser Slave river which is occupied, or likely to be for some years, I left for my next work west of Winagami lake.

There is a road shown on the Department maps from the the Peace river road near Lesser Slake lake to Smoky river, but this was only for winter travel. No wagons had ever been taken through from Winagami lake to Smoky river. I widened, corduroyed and changed the position of the road around large hay meadows, so that now there is a fairly good wagon road through the townships surveyed.

I subdivided townships 77, ranges 20 and 21, township 78, range 21, and portions of townships 77 and 78, range 22, and ran the outlines, and established the correction line across range 21 by running the east outlines of ranges 21 and 22. There is scarcely any part of these townships composed of waste or useless land. The land is high and gently undulating, with good drainage. A large portion of it has been burnt over, the last time in 1904, only poplar bluffs and willow bunches being left. Since then willow brush and small poplar have sprung up over portions of it. What appears to be at the present time wet and swampy is made so because there is no free outlet for the melted snow and rainfall, except by gravitation over the surface to the two creeks forming the drainage outlets to this large tract of as fine land as can be found within the unsurveyed portions of the Dominion lands.

The country through ranges 15 and 16 shows much improvement, numerous farm buildings being erected and many fields of grain were harvested this year as far west as section 16, township 76, range 16. Upon this latter fine crops of wheat and oats were seen growing.

The main road passes through the central portion of range 17, where there is a prairie of probably one hundred acres in extent. It is from a half to three-quarters of a mile east of South Heart river and is occupied by five lodges of Indians from the Sturgeon Lake band. They have built several log stables and houses, have a number of cattle and horses and have made about one hundred loads of hay on the south shore of Winagami lake, but they do very little breaking, except for a few potatoes. This is a very fine piece of land and if occupied by settlers, much of the lightly timbered land around it could be easily cleared and would make several good farms.

About two miles south of the twentieth base line on the southwesterly side of Winagami lake there lives, with his family, James Prudens, an English-speaking half-breed, who has houses and barns, several head of horses and cattle, all kinds of implements and a fenced clearing for garden purposes. He puts up about one hundred loads of hay from the meadow land situated on the south side of the lake.

About two miles north of the northwesterly arm of Winagami lake there lies a body of water called by the natives 'Round lake.' It is not shown on any map that I have seen. The northeast corner of section 36, township 77, range 20, touches the southerly shore of this lake which appears to be about three-quarters of the size of Winagami lake.

There are three creeks, Peavine, flowing westerly through townships 77, ranges 20 and 21, 'Round lake' creek, flowing from 'Round lake' into section 36, township 77, range 21,, and entering the Peavine in section 16, and Hunting creek rising in section 4, township 78, range 21, and flowing northwesterly through section 23, township 78, range 22, into Smoky river.

Reed creek is another small water-course flowing westerly and southwesterly from Reed lake in the northeast part of township 79, range 21, and crossing the north boundary of section 36, township 78, range 22, enters Hunting creek about a mile and a half west of section 26, township 78, range 22. These creeks having their origin in large depressions into which the melted snow and rainfall finds its way by gravitation, are not permanent, the flow of water having practically ceased in August, but pools of water were found in them all during the time the survey was being made. The water is invariably good with scarcely any alkaline taste.

Explorations for railway lines have shown that the most feasible line between Edmonton and Peace river giving an easy grade and with the least mileage for bridging, would pass through these lands, crossing Smoky river at the head of navigation, where the banks are stationary. Above this point the banks are composed of a succession of land slides, and the country south of Little Smoky river is cut up with numerous creeks within deep coulées, all more or less heavily timbered.

A noticeable feature of the weather was that very few showers of rain fell during daytime; rain being more frequent at night and gradually clearing with the rise and heat of the sun. The snow which fell early in October did not remain long, but on November 5 it came to stay. On November 8 the temperature went down to 15° below, and on the 12th to 20° below zero.

It might be surmised from the lateness of the spring and the cool summer, that the crops would have been a failure, but such was not the case. Wheat, barley and oats were harvested in perfect condition, and potatoes planted in June were a fine crop. The ice did not entirely leave Lesser Slave lake until June 5, and the snow was from eighteen to twenty-four inches deep in the woods in April, yet strawberries were picked on July 5, and great quantities of other varieties of berries were found ripe and not frosted on September 6.

On November 3, I moved to Lesser Slave river, where there was some traversing to be done near Saulteux landing. After the traverse was made, I began the survey of a timber berth on Athabaska river, which I finished on November 26.

APPENDIX No. 42.

EXTRACTS FROM THE REPORT OF J. N. WALLACE, D.L.S.

SURVEY OF PART OF THE FOURTH MERIDIAN.

We reached Lloydminster early in the morning of March 22 and on that day travelled thirty-five miles to Onion Lake by sleigh. Next day we left there and reached the Hudson Bay company's post at Cold lake after two days' journey; on the fourth day after leaving Edmonton the outfit was moved about twenty miles northeasterly from this post, and we camped on the fourth meridian where work was to be begun.

There is a fairly large settlement at Onion Lake, an English and a Roman Catholic mission, post-office, telegraph office and Indian schools; and the Hudson's Bay company have a well-supplied store. The district appears to be a very good one and is rapidly filling up with settlers.

From Onion lake to Cold lake the road passes around the south and west of Frog lake. There is not much settlement after leaving the neighbourhood of Onion lake, but the country is very open and it will be only a short time before the land is all taken up.

About ten miles before reaching Cold Lake Hudson's Bay post, which is eleven miles south of the lake itself, some settlement is again met with. There is an extensive Roman Catholic mission, a large Indian population and several settlers. In addition to the Hudson's Bay company's store, which is on the south side of Beaver river, there is another general store on the north side of the river. Between Beaver river and Cold lake, a distance of ten miles, there is a very attractive looking country.

We reached the fourth meridian on the south shore of Cold lake on March 26. Between this date and April 21, the meridian was surveyed to the north shore of Primrose lake, a body of water about ten miles north of Cold lake and not hitherto shown on any map. This was a total distance along the meridian of twenty-six and a half miles, and in addition a tie line, eight miles long, was run from the extremity of the seventeenth base line on the west shore of Cold lake to connect with the meridian. Between the two lakes the country is heavily timbered, and as I had not come prepared for the existence of Primrose lake, there was some fear, while making the survey, that we might not be able to get the line cut out through the ten miles of heavy timber between the two lakes in time to survey the meridian across Primrose lake before the ice became dangerous. However, this fear proved groundless as the ice was quite safe for ten days after we completed the line across the lake, which was accomplished on April 21. The previous winter had been very severe, the ice was three feet two inches thick on this lake and was sound up to May 1

The summer road goes around the west shore of Cold lake and is very fair, but between this lake and Primrose lake the road is really fit only for sleighs, although a load of half a ton can be taken over it in wagons in the late summer. Even with pack horses we had a lot of trouble, and it was only the frost deep down in the ground which kept the horses from going out of sight occasionally.

There is a fairly good road following the north shore of Primrose lake. It was cut out by the Indians for a pack trail, but we widened it and bridged the streams making it passable for wagons as far as the intersection with the meridian, a distance of about six miles from where the road from Cold lake touches Primrose lake.

Cold lake is of a fairly round shape, about twelve miles in diameter, with a total area of about ninety thousand acres. The meridian runs across it a little to the east of its centre. The shores of Cold lake are generally high and dry. There is a great deal of sandy beach, and unless along its easterly side, I do not think there is any swampy area around its shores. There is a great deal of good land around the west side and the east shore appears to be heavily timbered.

The part situated between Cold lake and Primrose lake is generally hilly and thickly timbered with poplar, birch, spruce and jackpine. The soil is generally heavy clay except on the local pine ridges where it is very sandy. Sometimes, indeed, these ridges are formed of pure sand.

Primrose lake is about forty miles long. It stretches northeast and southwest, and is divided into two parts by narrows about two miles wide. The shores around the southwesterly part are high and dry and timbered with poplar and birch with some spruce and jackpine. There are some fine stretches of sandy beach around its southwesterly extremity and the northeasterly shores of the lake are reported to be low and swampy. The area of the whole lake would probably be about one hundred and ten thousand acres, and there are at least four islands in it.

From Primrose lake to township 70, a distance of about seventeen miles, the country is generally rolling or hilly. There is a large extent of poplar-covered land and many of the low lying sections are covered with willow bushes, and have good soil. There is practically no open land over the whole district through which the meridian was surveyed last season.

Much trouble was caused by swampy land impeding the making of a pack trail for the horses, and also by the great scarcity of grass, a large proportion of the surface being covered by moss. The trail cut out by ourselves was our only means of communication with the south throughout the whole season, and it soon became cut up by the frequent passing back and forth of the horses. Towards the end of August it became absolutely impassable over a large part of its length. We were then camped forty-four miles in a straight line, and about sixty by trail, from the north side of Primrose lake and sending back men to fix the trail meant serious delay, but it became a necessity to do so.

For the first seventeen miles north of the lake we had not had any very great difficulty in finding a route in the bush for the pack trail, but north of this local swamps became very numerous. Over the first seventeen miles, ending about the middle of township 70, the country is rolling and hilly and there is a large proportion of poplar-covered land which always had a hard surface for horses, but to the north of here poplar country is very rare. The prevailing aspect, from here right to the end of the line at the north of township 80, is a series of local depressions covered with a dense growth of small spruce separated by dry sandy ridges with jackpine. Some tamarack bogs exist, but spruce and pine are very much the commonest timber.

There are no extensive and continuous areas of wet land in the whole district through which the meridian was surveyed last season. The swamps are all local and due not so much to want of general fall in the surface as to want of outlet through the numerous local ridges which enclose each wet area and form a succession of basins. In many instances swamps and bogs occur within a few hundred yards of large streams, the surface of the water in the swamps being many feet higher than in the streams, but small intervening ridges cut off the drainage.

Another of the small troubles we had was the very great distance we were from the nearest post-office. This was at Onion lake, which was ninety miles south of us when we began work in March, and when we ended in November it was two hundred and forty miles by trail from our camp. We managed to get a mail about once every three weeks; the Hudson's Bay company sent an Indian with the mail bag to the supply house on Primrose lake, a distance of one hundred and twenty miles, and I sent back one of the party to meet him there on certain fixed dates to receive the incoming mail and to transfer to him our own outgoing mail. With both men it meant many nights spent in the trail alone, and in some instances a considerable shortness in supplies.

During the absence of so many of the party who had been sent back to repair the pack trail, progress on the survey of the meridian was very slow, but by September 1, when they returned, we had the meridian surveyed up to the middle of township 75, a total distance run of seventy-two miles. We were now getting so far north that I had to detail half of the horses for continuous work on the trail bringing supplies from the house on Primrose lake to a second house I had built on Calder river. Although this last was only thirty miles north of Primrose lake in a straight line, it took a full week for the horses to make a round trip. Two men and eight horses were at this work continuously from September 1 to October 23, never coming into camp till the latter date, by which time we were thirty-five miles north of the most northerly of the houses, the meridian being then surveyed up to the middle of township 78, a total distance of ninety miles.

During August and September we put up about seven tons of hay cut by ourselves with a scythe, and gathered with home-made forks and rakes. Most of this was cut along Clatto river, where there are some very good stretches of grass. The grass turned colour early in September, and after September 15 it was useless to cut any more, as once it turns colour in the north there is no nourishment left in it. The grass does not cure before the frost touches it as it does in southern Alberta. Green grass first occurred about June 5, and its growth was very rapid in June. All over the north it will grow about an inch a day during the later part of June and the first half of July, but after September 15, it is practically all withered, and of very little value as feed.

As far as the middle of township 74, all the streams crossing the meridian ultimately flow back southerly to Primrose lake. North of this there are two main streams flowing northerly. These are Dillon river (Buffalo river) and its tributary Clatto river. The former rises in township 74 and flows northerly, keeping to the west of the meridian, and then crossing it to the east in township 78. It then flows northeasterly and after a course of about eighty miles empties into Buffalo lake, north of Isle a La Crosse. Clatto river, flows northerly on the east side of the meridian and joins Dillon river in the southeast of township 78, range 26. There are many beaver still on Clatto river and they were working on their dams continually all last summer. The chief tributary of Clatto river is Manny river, which comes in from the southeast and joins Clatto river in township 76, range 26.

The great divide between the waters flowing to Athabaska and Churchill rivers, that is between the watershed of Hudson bay and the Arctic ocean, crosses the meridian in the south of 78. North of here all the streams are tributary to Clearwater river which joins the Athabaska at McMurray.

North of this divide there is a very marked improvement in the quality of the soil. It is quite unlike the very sandy soil met with to the south, and is generally a heavy clay subsoil with a surface of black loam. As already mentioned there is a good deal of poplar country for the first seventeen miles north of Primrose lake. This generally has a hard clay soil. North of this section poplar is very rare, nearly all the higher lands being composed of sandy ridges with jackpine. The intermediate levels are wet but not swampy, and are covered with a dense growth of small spruce. The surface is nearly all mossy and below this moss is a depth of two to twelve inches of black soil with a subsoil of a very sandy nature, sometimes pure sand. The lowest areas in this district are very swampy and wet with about the same order of soil. The best areas over nearly all the district are the intermediate levels. They require clearing, but once cleared they will nearly all exhibit good soil.

It would appear as though the whole country was originally formed by sand. The higher parts have remained in about the same condition, the small amount of surface vegetation having been continually burnt off by fires so that the surface has only lichens and creepers growing on bare sand. The intermediate levels have been more protected from fire and in the course of ages decayed vegetation has had a chance to accumulate and form the black soil now lying everywhere between the sand subsoil and the mossy surface. This would be equivalent to saying that the fertile part of the soil is entirely of local origin. In the lowest depressions the lands have been so continually wet and flooded from want of outlet that surface vegetation has not grown so abundantly as in the intermediate levels. It is not probable that when drained these wet swamps would afford such good soil as the spruce lands. It may, however, be taken as a general rule that in this district from about township 71 to township 80, a large part of the dry land is too sandy for agriculture, and that while the wet land can afford good soil, it must first be drained.

Along some of the streams, notably along Clatto river and Dillon river, there is, however, another class of very good soil. It originates from the silt carried down by the water and deposited over the neighbouring lands by successive floods. In such localities the soil is of external origin; especially along Dillon river below the junction of Clatto river is this the case. The valley is here nearly a mile wide and is composed of willow bushes with large open grassy spaces. This wide valley extends at least for fifteen miles down the course of the river from the junction of Clatto river and probably right down to Buffalo lake. The same class of soil occurs, although on a much smaller scale, on Landels river, a stream which flows northwesterly through townships 78 and 79, range 1, and which ultimately empties into Athabaska river. Graham creek has very good grass along its course but it is swamp grass, the stream being too slow and its course too short for any quantity of silt to be carried down.

Except around the numerous lakes and some of the streams there is practically no grass to be found anywhere. Around the lakes sometimes swamp grass and sometimes upland grass is found. The former is much the commoner and some of the lakes have no grass at all around their shores. There is reported to be extensive areas of good slough grass all around the north shore of Primrose lake and there is plenty of the same around many of the smaller lakes, notably around two lakes occurring in township 74, range 26. As to the streams all the larger ones have at least a narrow belt of grass, enough to keep survey horses and, as already mentioned, Clatto river north of township 75 and Dillon river, have enough to allow hay to be put up. There is good upland grass along parts of Calder river and Farrier creek and around the mouth of Shaver river on the north shore of Primrose lake. Apart from the larger streams and lakes the whole district north of township 70 is generally covered with moss.

A regular line of levels was taken along the meridian, using a fourteen-inch dumpy level, from the north shore of Primrose lake which occurs in section 25, township 67, to within one mile of the twenty-first base line at the north of township 80, being a total distance of seventy-eight miles.

The idea was to ascertain only the general broad outlines of the surface and for this reason elevations were taken only at every quarter of a mile along the line. In addition, however, readings were taken on all lakes and streams. The elevation of the surface of the ground was taken at the foot of all section and quarter section posts and a bench-mark left as near each post as could be arranged. In the majority of cases these bench-marks are on trees, but where a firm rock or large boulder could be found it was always utilized instead of a tree, a broad arrow being cut on the rock with a cold chisel. A bench-mark on a tree is objectionable on account of the liability of the tree to be burnt or blown down. A second independent line of levels was run, generally in the opposite direction, as a check, although for about twelve miles at the start the system of double turning points was used. I do not favour the use of double turning points, more especially in the case of an initial meridian as the elevations of these base lines subsequently run off the meridian are wholly dependent on the accuracy of the levels taken along the meridian. The taking of levels along meridians and base lines is of great importance, and I believe it is well worth checking such levels by the most satisfactory method that can be found.

As mentioned already, levels were not taken between Cold lake and Primrose lake but from readings of the aneroid it would appear that Primrose lake is about one hundred and sixty feet higher than Cold lake. Martineau river, a large stream, drains Primrose lake into Cold lake. The distance in a straight line between its ends is about twenty-four miles, but measured along the bends of the river its length is much greater. I believe water-power could be developed along this river.

Primrose lake drains the whole country for about twenty-five miles to the northwest. Cold lake does not appear to have many rivers flowing into it except Martineau and Medley rivers. This lake empties into Beaver river by a stream flowing out of the extreme northeast corner of the lake.

The altitude of the surface of the water in Primrose lake, where the lines of the level were commenced, was assumed at 2,100 feet above sea-level and all elevations are referred to this as a basis.

As the meridian goes northerly from Primrose lake there is a general steady rise for thirteen miles to the north of township 69, where the elevation is 2,462 feet. After leaving the immediate vicinity of Primrose lake the lowest elevation recorded in this thirteen miles is at the crossing of Shaver river, the water of which is at an elevation of 2,176 feet. This stream flows in the valley about one hundred feet deep. Assuming its length to be about twelve miles from the meridian to its outlet on Primrose lake, this would indicate a fall of about six feet to the mile. Its current is generally swift.

North of township 69 the country along the meridian is undulating and high for about twenty-two miles to the north of section 24, township 73. In this distance the lowest elevation encountered is the crossing of Calder river in section 1, township 73, at an elevation of 2,312 feet. As this river flows easterly and then southerly to Primrose lake, after a course measured along the river of about sixty miles, it is seen that the average fall is about three and a half feet to the mile. There are many rapids in the upper part of its course, and the fall is probably much greater there and a good deal less in the last twenty miles or so before reaching Primrose lake.

To the north of the last mentioned district, that is north of section 14, township 73, there begins a very marked and rapid rise. At the end of four and a half miles this has amounted to a rise of 212 feet near the centre of section 13, township 74, where the elevation is 2,541 feet. From here there is a rapid descent, the surface being much broken, until the north of section 1, township 76, is reached, where there is a creek at an elevation as low as 2,078 feet, or twenty-two feet lower than Primrose lake, the surface falling 463 feet in the ten miles between section 13, township 74, and section 1, township 76.

From the foot of the descent just referred to at the north of section 1, township 76, the surface is very irregular, but falling steadily as a whole as the meridian goes north until the end of the survey is reached at the north of township 80 where the elevation is 1,874 feet. In this distance the highest point reached is on a sharp spur crossed in section 24, township 76, where the elevation is 2,121 feet and the lowest elevation is that of the end of the line which is 1,874 feet, or two hundred and twenty-six feet below the surface of Primrose lake.

The elevations of all the lands along the meridian south of section 1, township 76, are higher than that of the surface of Primrose lake, while north of this point the lands are all lower than this lake.

The high land occurring in township 74 forms about the northerly limit of the water flowing back southerly to Primrose lake. As, however, this lake empties into Cold lake and the latter into Beaver river, a stream which also drains the country north of this high land, this divide is really only a local one, the whole country south of township 78 being in the watershed of Churchill river.

The great divide between the Hudson bay and the Arctic ocean crosses the meridian in section 1, township 78. North of here all the streams flow northwesterly to Athabaska river. The elevation on the meridian near this divide is 2,000 feet.

The following are the elevations of some of the more noteworthy topographical features along the fourth meridian between Primrose lake and the north of township 80:—

Feature.	Locality.	Elevation.
Primrose lake	Sec. 1 Tp. 68 Rg. 1	2100
Summit of land	" 1 " 69 "	2285
Shaver river	" 1 " 69 "	2176
Summit of land	" 36 " 69 "	2478
Surface of lake	" 1 " 70 "	2399
Farrier creek	" 13 " 70 "	2400
Surface of lake	" 25 " 70 "	2405
Summit of land	" 12 " 71 "	2472
Victor creek	" 25 " 71 "	2397
Creek	" 36 " 71 "	2343
Surface of lake	" 12 " 72 "	2382
Summit of land	" 13 " 72 "	2411
Surface of lake	" 24 " 72 "	2359
Calder lake	" 1 " 73 "	2312
Summit of land	" 13 " 73 "	2350
Neath creek	" 24 " 73 "	2319
Summit of land	" 24 " 74 "	2564
Creek	" 12 " 76 "	2078
Clatto river	" 12 " 76 "	2075
Summit of land	" 24 " 76 "	2123
Surface of lake	" 25 " 76 "	2045
Creek	" 25 " 77 "	1961
Summit of land	" 36 " 77 "	2110
Dillon river	" 1 " 78 "	1960
Summit of land	" 24 " 78 "	2096
Creek	" 25 " 78 "	2009
Creek	" 1 " 79 "	1909
Summit of land	" 1 " 79 "	1960
Low land	" 25 " 79 "	1911
Summit of land	" 36 " 79 "	1970
Graham creek	" 1 " 80 "	1854
Summit of land	" 13 " 80 "	1996
End of levels	" 25 " 80 "	1874

Perhaps one of the most notable results of taking levels along a survey line is the evidence it affords that nearly all the wet lands can be easily drained. It is generally known that very many of the swamps in the north are due more to want of outlet than to want of fall, but I do not think it would have been surmised till levels were taken, that the water in the streams was often so much below the level of the standing water in neighbouring swamps.

Of course it some times occurs that a stream will be met with flowing with full banks slowly through a swampy region doing its best to drain the surrounding land, but unable to do much on account of want of fall, but the rule is that the swamps exist because the surface water is shut in by surrounding small ridges and can not reach the lower level of the streams. A comparison of the description of the lands as shown in the field notes with the profile of the surface along the meridian will show that swamp land is nearly always at a very much higher elevation than the water in the neighbouring streams. A short ditch cut through some small ridge will often enable thousands of acres to throw off the surplus water.

Probably the impediment offered to the flow of water over the surface by moss and other obstructions has also a good deal to do with the large area of swampy land met with in a timbered country. Whatever the reason, there is little doubt that large areas of land, which at first sight might be thought useless, can be drained without any very great difficulty, but it would appear that such drainage should be carried out on a more general scale than can be done by separate owners of land. During the survey of the fourth meridian last season many areas of swamp land were noticed, but there were very few indeed which could not be drained with comparative ease by a well-devised system of ditches planned independently of separate ownership.

On October 8 the first snow fell, being enough to whiten the ground. On the 21st this increased to three inches, but subsequently nearly all melted off until November 6 when we had a fall of four inches. On Nevember 10 the temperature fell suddenly to about thirty degrees below zero and winter had arrived in earnest. The line was continued on, however, although difficulties in regard to the horses and the great distance from supplies were rapidly increasing, as we all wished to get as far as the twenty-first base line, the north of township 80. Although on several occasions it looked as though we would never get so far, we finally managed to survey the line up to this base on November 22, having extended the meridian one hundred and six miles north of where we began work in March.

The next day we started homeward, but as half of the horses had left camp on November 8 to get supplies and oats from Primrose lake, now nearly one hundred miles south of us, we had to double trip for the first few days, and I was beginning to wonder how we could ever get back at such a slow rate before our supplies and oats gave out, when at last we met the packers returning. The temperature was then twenty degrees below zero and the snow fourteen inches deep; the packers had gone through a very severe trip and they were as glad to meet us as we were to see them. It saved them having to camp out, and the arrival of the additional horses with supplies and oats meant a great deal to us. This last round trip from camp to the supply house on Primrose lake had taken the packers three weeks, and as this house was itself over fifty miles from even the nearest Hudson's Bay post, one hundred and twenty miles from the nearest post-office, and one hundred and fifty miles from a railway station, some idea of the isolation of our last camp may be formed. Yet it is remarkable in how short a time settlement may follow after surveys are made. Places in other parts of Alberta where a few years ago, while surveying the preliminary lines, I used to wonder how I could keep the party from starvation, are now dotted over with settlements, and houses, post-offices, stores and hotels cover the country where there was no sign of human life within a hundred miles of our camp.

APPENDIX NO. 43.

EXTRACTS FROM THE REPORT OF J. WARREN, D.L.S.

MISCELLANEOUS SURVEYS IN SOUTHWESTERN ALBERTA.

We went easterly from Cowley to a bridge near Pincher, then along the north side of the river by the most direct trail to our work in township 14, range 2, where we arrived safely on June 2.

We proceeded with the survey of the east boundary of township 14, range 3, and completed the work in township 14, range 2, after which we proceeded to complete the survey of the easterly boundary of township 15, range 3. This work was finished on June 30, and we moved to High River to proceed with our work in the mountains. On my arrival there I received instructions directing me to make some surveys in township 20, range 4. west of the fifth meridian. We arrived at that township on July 3, and completed the required subdivision on the 13th. We left Canmore on July 20, and arriving at our camping ground on the 21st, we proceeded with the subdivision required, which we completed on September 9.

We next proceeded to Morley, having to go that way as there was no trail crossing the mountains to our work in township 20, range 5.

From Morley we went southerly along what is known as the 'Stony trail,' to the north branch of Sheep creek in township 21, range 5. From here we went west to the sixth base line which we retraced across range 5 and produced across range 6 and part of range 7.

We then resurveyed some villa lots near Calgary in section 14, township 24, range 1 which we completed on November 8.

APPENDIX No. 44.

REPORT OF A. O. WHEELER, D.L.S.

EXAMINATION OF LANDS IN THE RAILWAY BELT, BRITISH COLUMBIA.

CALGARY, ALTA., February 28, 1910

E. DEVILLE, Esq., LL.D.,
Surveyor General, Ottawa.

SIR,—In accordance with your instructions of April 22, 1909, three sub-parties were placed in the field to continue the classification of undisposed lands, within the railway belt of British Columbia, commenced in 1908. One was in charge of M. P. Bridgland, D.L.S., another in charge of A. J. Campbell, D.L.S., and the third in charge of R. D. McCaw, D.L.S., chief assistant of my own party. In addition to the work in connection with my own sub-party, the other two were under my personal supervision and were visited from time to time to see how the classification was progressing and to ascertain the nature of the country in which they were working.

General reports of their operations by these gentlemen are attached hereto. Full detailed reports, schedules of descriptions by section, township and range, schedules of areas, tables of temperatures and lists of squatters, accompanied by maps showing in colours the various classes of land, have already been forwarded to you.

My instructions called for a division of the land examined in five classes, viz:—

(1) *Fruit land*—Comprising any land with a suitable soil for growing trees, and of low altitude.

(2) *Farm land*—Comprising land which either on account of quality, altitude or other reasons is not suitable for fruit but is adapted for cultivation.

(3) *Grazing land*—Comprising land which is neither fruit nor farming land, with grass growing on it.

(4) *Timber land*—Comprising land which is neither fruit nor farming land, with timber growing upon it.

(5) *Worthless land*—Comprising land whch is not fruit or farming land, with neither grass nor timber growing upon it.

It is a somewhat difficult matter to classify lands fit for fruit growing, as, in the present early stages of its culture in the railway belt, only the low-lying lands have been experimented with and climatic conditions are greatly varied. It was found by observation during the past two summers that around the larger inland lakes, such as Shuswap, Adams, Mara, Mabel, Kamloops, etc., the moderate climatic conditions evolved by the heated water surface through late September, October and November prevent, to a very considerable degree, early frosts, and that, on this account, lands surrounding them and in their vicinity are specially adapted to fruit culture and farming. Moreover, the deep beds of these lakes, resembling fjords, act as troughs to conduct moisture laden clouds and, consequently, the rainfall is sufficient without being supplemented by irrigation.

It was also observed that the climatic influences referred to extend to an altitude of about 1,200 feet above the water surface, as indicated by the height at which the warm air rising from the surface condenses and forms an overhanging cloud-belt. The altitude limit, therefore, of farming lands was set at 1,200 feet, and for fruit land at 800 feet above the surface in the vicinity of such water areas. Away from such climatic conditions, it is not thought that fruit can be grown successfully at nearly so great an altitude, and 400 feet above the main valley bottoms, such as those of the Shuswap, North Thompson, South Thompson and Salmon rivers, is probably the limit, although in certain cases, owing to local conditions of climate or soil, it may be grown to advantage at higher altitudes. For general farming, however, vegetables, fodder crops and, in some instances, grain for fodder purposes, can be grown at much higher altitude, reaching even as high as 1,800 or 2,000 feet above the main valley bottom. Apart from the influence of these large lakes and main waterways, particularly on the high lands of the Kamloops plateau, the lands not covered with timber are only suited for grazing, although, where it is possible to apply water by means of irrigation, they become very prolific through rapid growth and maturity in the summer months.

All the lakes named lie in deep troughs and are enclosed, for the most part, by steep rocky hillsides, clad with timber or showing nearly perpendicular rock faces. The waterways also are in narrow, or comparatively narrow valleys with sides of similar formation and, consequently, the areas suited for cultivation are very limited as compared with the whole area involved.

Not far westerly from Little Shuswap lake open grass lands begin to appear, and from there to the west end of Kamloops lake, on the north side of Thompson river, and to Kamloops on the south side, these areas of grass land become more extensive. Apparently the same class of land continues westerly towards the valleys of Thompson and Bonaparte rivers, but these points named are the farthest to which the surveys of last year were carried.

In the valley of Shuswap river and at the head of Mabel lake some areas of fruit land were located, but along that stream and in the valley of Salmon river, south to the railway belt boundary the best lands have been disposed of.

The timber found on the various classes of land is set forth in the schedule of description accompanying the detailed reports. Timber land, as defined above, is necessarily indefinite as to area. It extends all over the high lands of this section of British Columbia, and to travel over such areas for the purpose of examination would take years, owing to the difficulties of such travel and transportation. The results, moreover, would give little definite value, except with regard to quality and quantity as most of the land is beyond the zone suitable for cultivation. All the land seen, other than fruit, farm and grazing lands, was covered by timber that reached to the summit of the high lands. In the grass land belt most of the summits are timbered and no worthless land, as defined above, was noticed, except in small patches, and then only in the form of rock steeps and precipices, which cannot well be shown on a small scale map, owing to their being nearly vertical.

The detailed reports and schedules of description of individual parcels of land in conjunction with the maps accompanying them, deal fully with the classification of the undisposed lands in the section of the railway belt covered by the examination

As a datum for altitudes, the average elevations of the respective water surfaces of the several lakes above sea-level were used. Where such a datum was not available the elevations are referred to the main waterways traversing the respective areas of lands classified. A list of the datum levels used will be found attached to each map.

Mr. Bridgland first completed the examination of the Columbia river valley from Donald to Beavermouth and down that valley to the railway belt limit. There is a narrow area of farming land along the river, chiefly on the west side, and a larger area near the belt line. For the most part the lower land is flooded and has been classed as grazing land. If suitable drainage could be applied, it is likely a lot of the flooded land could be reclaimed as farm land. There is no access yet by road to this portion of the valley and navigation is prevented during low water by rapids. At high water navigation would be possible, but would be expensive, owing to the swift current.

It is thought that none of this land is suitable for fruit growing as, owing to the early and heavy snowfall, there is an advanced winter and a late spring; the late spring frosts, moreover, combined with the hot sunshine of the middle day, have a very injurious effect upon the trees, because when the sap commences to flow during the day and then freezes at night, it causes the bark to peel, ultimately killing the trees. These conditions have been observed at Golden, twenty-eight miles up the valley from Beavermouth.

Mr. Bridgland also, while here, made an examination up Beaver river valley as far as Mountain creek, but, practically, with no results. He next examined the Shuswap valley to Mabel lake and north of that lake up the valley of Frog creek. Thence, moving westward, he covered the ground lying between the railway belt boundary, Shuswap lake and South Thompson river, and the west boundary of range 12, west of the sixth meridian. His maps, detailed report and schedule of descriptions show full particulars.

Mr. Campbell joined his party on June 17. The party commenced work in the valleys of Tonkawatla and Eagle rivers on May 23, Mr. McCaw taking charge of the examination until Mr. Campbell's arrival. Nothing of any account was located until well down Eagle river valley, when some fruit and farm lands were classified. The special climatic conditions surrounding Shuswap lake extend for a considerable distance up this valley and should enable fruit to be grown to advantage. In the upper reaches it is thought the early heavy snowfalls will create conditions prohibitive to successful agriculture. The valley is narrow and the area limited.

On completing the examination of Eagle river, Mr. Campbell transferred his party to Shuswap and examined all the territory bounded on the east by the west boundary of range 12, on the south by the railway belt boundary, on the west by the west boundaries of townships 17, 18 and 19, ranges 18, 17 and 16 respectively, and on the north by South Thompson river. Full particulars are shown by his maps, detailed reports and schedules of descriptions.

The third party, in charge of myself and Mr. McCaw, made the examination of the territory north of the Canadian Pacific railway, and within the railway belt boundary, as far west as the valley of Deadman river, which joins the South Thompson a short distance below Kamloops lake. Work was commenced at Blind bay on Shuswap lake, where it had been discontinued the season before. It was now carried up the valleys of Scotch creek and Adams lake, and westerly as stated. During the summer this party was divided into two, and one section of it made an examination of lands on Adams lake and Salmon arm of Shuswap lake. This was done in order not to delay the progress westward by the withdrawal of the full party to make the examination in these isolated parts. It had been found earlier in the summer, while the party was working in the vicinity, that the water of Adams lake was too high to enable surveys to be advantageously made to locate the lands classified. Detailed information will be found in the reports and maps already submitted.

On these maps are shown by several colours the respective areas classified. To each map is attached a statement of the datum levels from which the altitudes given in the schedules of description are computed; and also of the areas of the various classes shown by colours on the said maps.

Generally it may be said that the fruit and farm lands are found in and along the sides of the valleys, and that the highlands are, for the most part, grazing and timber areas. This will account for the relatively small area of land suitable for cultivation as compared with the total area that has been examined.

The following is a summary of land classified by all the parties:—

	Acres.
Total area classed as fruit land	60,748
Probable area fit for cultivation	43,248
Total area classed as farming land	97,391
Probable area fit for cultivation	59,509
Total area classed as grazing land	243,124

By far the largest portion of the remainder of the area involved is land covered by timber, and what then remains is water surface and worthless land, the latter rock exposures and land at too great an altitude to be accessible.

I have the honour to be, sir,
Your obedient servant,

ARTHUR O. WHEELER, D.L.S.

EXTRACTS FROM THE REPORT OF M. P. BRIDGLAND, D.L.S., ON THE EXAMINATION OF LANDS IN COLUMBIA RIVER VALLEY.

Camp was pitched on Bush river about one mile from its mouth, where it remained till June 15. During this period all the land here was examined, light camps being taken out to the more distant sections. A compass and stadia traverse was made of Cygnus lakes, of about thirteen miles of Bush river and of four miles of Gold creek, and these traverses were connected with the nearest survey posts. The traverse was for the purpose of locating the lands examined. The party then started back examining the lands on both sides of the Columbia and reached Beavermouth on June 23.

The last days of June were spent in looking over the benches between Donald and Beavermouth and in Beaver valley. There was very little land here of any agricultural value, so not much time was spent over the work.

On July 1 the whole party moved by train to Sicamous Junction and at once started to examine the lands in the vicinity of Mara lake and Shuswap river. From then to July 29 we worked in the valley between Sicamous and Enderby. Very little land of any value was found on the east side, but on the west in township 20, range 8, and townships 19 and 20, range 9, there is a considerable area of rolling land 1,000 to 1,200 feet above the river, much of which is probably suitable for settlement. In township 18, range 9, there is some land above Enderby, but it is not suitable for cultivation though of some use as grazing or timber land. Considerable good land was found here lying chiefly on the south side of the river. Most of it is well timbered and all is included in timber berths 237 and 238.

From August 26 to September 26 was spent looking over the land around Mabel lake. While here a stadia traverse was made of that portion of the lake lying within the railway belt, and one week was spent on a trip up Frog creek. The shores of Mabel lake are steep and rocky and not suitable for cultivation, but there is considerable good land, probably about three thousand three hundred acres in the valley of Frog creek in townships 20 and 21, range 5.

On October 1 camp was moved from Enderby to Deep creek valley. Twelve days were spent in the valleys of Deep creek and Canoe creek, and on October 12 camp was moved down to township 17, range 10, where there is some land still untaken on a high bench to the west of Armstrong, some of which may be of use for farming.

On October 15 the examination of lands along the Salmon river valley above Glenemma was commenced. Very little land suitable for cultivation was found, but in township 17, range 11, township 18, range 12, and the southwest corner of township 19, range 12, many slopes, principally those facing south, were found to be suitable for grazing. Most of the slopes facing north were covered with thick underbrush. This part of the work was completed on October 28.

The next day work was started below Glenemma, and we were engaged till November 10 examining the lands along the Salmon river branch of Shuswap lake. On the east side of Salmon river in township 18, range 19, there is very little land of any use except for grazing, but on the west, in township 18, there is considerable good land.

The remainder of the season was spent working west through townships 21, ranges 10, 11 and 12, to Shuswap along the valley of Tappen creek. Considerable land suitable for cultivation was found in these sections and much rough partially timbered land which would be of some value for grazing. The valley of Chase creek in township 20, range 12, was also examined, but very little good land was found.

EXTRACTS FROM THE REPORT OF A. J. CAMPBELL, D.L.S.

ON THE EXAMINATION OF LANDS IN EAGLE RIVER VALLEY AND SOUTH OF THOMPSON RIVER.

My first work was to examine and classify the lands in the Eagle river valley; this was completed July 19. Owing to the thickness of the bush, the number of swamps, and the frequent crossings of the river, the work was not completed in this section as soon as expected.

After completing the work in the vicinity of Sicamous, a move was made to Shuswap on July 20. The examination of lands lying west of range 12 and between South Thompson river and the southerly limit of the railway belt was then commenced.

From July 20 until August 20 the lands adjacent to South Thompson river in range 13 were examined, also the lands in a small valley to the east of Martin mountain down to the valley of Bolean creek, up this valley to its head, and over the divide down the valley of Paxton creek to Summit or Monte lake.

From August 20 until September 6, the lands in the vicinity of Summit lake in range 14, and those in the valley of Salmon river in ranges 13 and 14, to the boundary of Monte Hills forest reserve were examined.

From September 6 to September 24, the work was carried on in the valley of Monte creek and along South Thompson river in ranges 14 and 15. During this period considerable wet weather was experienced which delayed the work to some extent.

From September 24 to October 23, we examined the lands in the upper valley of Robbins creek in range 15, and those in the vicinity of Campbell lake in range 16, also those adjacent to Campbell creek in the same range. On October 23 camp was moved to Trapp lake, and from then until November 25 the work was carried on in the vicinity of Trapp, Napier and Shumway lakes in ranges 16, 17 and 18.

EXTRACTS FROM THE REPORT OF R. D. McCAW, D.L.S.

ON THE EXAMINATION OF LANDS NORTH OF SOUTH THOMPSON RIVER.

From May 22 until June 17, I was engaged upon the examination of lands between Revelstoke and Taft, in the vicinity of the Canadian Pacific railway. Camp was moved to Taft on June 12. A short compass traverse was run south from Three Valley lake in the South Pass valley.

Work was then commenced along Adams river and carried north to the south end of Adams lake, including lands north of Little Shuswap lake. Work was continued westerly along South Thompson river on the north side, and between that river and the Niskonlith forest reserve. Kamloops Indian reserve was reached on July 26 and on the 27th camp was moved to a point opposite the town of Kamloops.

Work was then proceeded with along the north shore of Kamloops lake and in close proximity to the lake until Savonas was reached on August 30. Camp was then moved back to a place opposite Tranquille where the boats were stored until needed. From Savonas we moved camp northerly to lac DuBois, and the work was carried easterly towards North Thompson river.

North Thompson valley was the next base of operations. Work was carried north to the limit of the railway belt on the west side of the river, and then south on the east side of that river to Hefferly creek, which was reached on September 28. During the latter part of September we were hindered on account of heavy rains.

The work was now carried east into the valley of Louis creek, where bad weather was again experienced for a few days. Before returning to North Thompson river the lands lying west of the Niskonlith forest reserve were examined, as far as the steep slope to that river. On October 20, camp was moved down to North Thompson river and the remaining land between Hefferly creek and the Kamloops Indian reserve examined.

During the remainder of the season operations were carried on north of Kamloops lake along Tranquille river, Copper creek, in the Red lakes district, and along Deadman river to the east limit of township 23, range 22, where work was completed for the season.

APPENDIX No. 45.

EXTRACTS FROM THE REPORT OF W. H. YOUNG, D.L.S.

RESURVEYS IN SOUTHERN ALBERTA.

I moved to Stirling following the Alberta Railway and Irrigation company's line and a very good, though rough, trail which leads from there along the north side of Etzikom coulée to township 6, range 17, west of the 4th meridian. I retraced all lines in townships 6 and 7 which had not been previously retraced.

My next work was to retrace all lines in township 7, range 1, west of the fifth meridian, and to traverse both banks of Crowsnest, Southfork and Oldman rivers within the township.

On account of the high water, I was greatly retarded in the work, more especially in the traverse, and it was impossible to ford any of these rivers till the survey was almost complete. The northeast corner is cut off from the rest of the township by the north fork of Oldman river, with no bridge for miles. However, owing to the kindness of Mr. Hugh Ritchie, who was employed gauging rivers in southern Alberta, all were enabled to cross on his cable and car.

After completing the work in this township, I moved up Southfork river to survey certain lines in townships 6 and 7, range 4. These townships are extremely rough and mountainous. The south boundary of township 6 is heavily timbered, and also the west boundaries of both townships; in fact a number of timber berths cover a portion of these townships.

Fires have done a great amount of damage in the western sections, but many of the dead trees are still quite sound. West and south of the burned area extensive forests of spruce and pine are still growing. Even if these townships were cleared the sections where the good soil is will never be of use for agriculture as there is a very severe frost in all months of the year. A very good trail follows along Southfork river to township 6, range 4, but it can be travelled only after the middle of July, when the water is low. The trail along the north side is very rough and hilly and so is not a desirable road to follow. The main trail follows the river south, and has been graded on the hillsides and at the river crossings, as far as section 34, township 5, range 4, where a company was preparing to bore for oil. In section 12, township 6, at the mouth of Link creek, a graded trail now leads to a coal mine opened during the past summer in section 15.

After finishing the work in this township I moved through Frank and Blairmore to section 23, township 7. On completing the work in the eastern part of the township and a few miles in the west, I was forced to cease operations on account of the deep snow and stormy weather.

PLATE I.

Sorcerer Mt. Photo by P. A. Carson, D.L.S.

PLATE II.

Sunbeam Lake. Photo by P. A. Carson, D.L.S.

PLATE III.

Caribou on Mt. Sentry. Photo by P. A. Carson, D.L.S.

PLATE IV.

Mt. Sir Sandford (11,600 feet). Photo by P. A. Carson, D.L.S.

PLATE V.

Valley of Hay River. Photo by A. H. Hawkins, D.L.S.

PLATE VI.

Photo by A. H. Hawkins, D.L.S.
Roche Miette and Fiddle Creek Range.

PLATE VII.

Photo by H. S. Holcroft, D.L.S.

Moose Creek, Government Repair Station.

LATE VIII

Battle River Valley. Photo by H. S. Holcroft, D.L.S.

PLATE IX.

Battle River Valley. Photo by H. S. Holcroft, D.L.S.

PLATE X.

Photo by H. S. Holcroft, D.L.S.

Dried Meat Lake on Battle River.

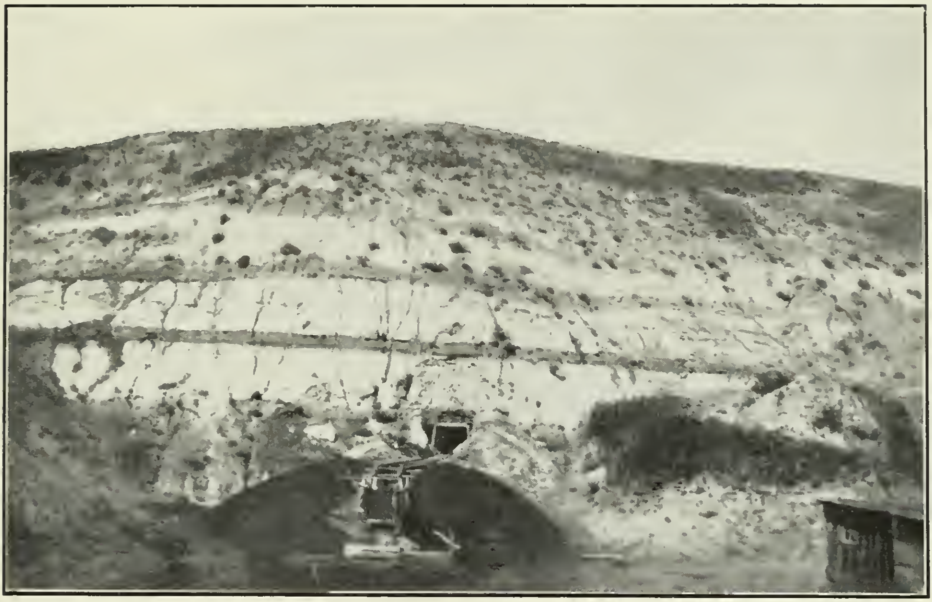

Photo by H. S. Holcroft, D.L.S.

Zaczouskis Coal Mine, near Wanda.

Photo by H. S. Holcroft, D.L.S.

Bed of Wild Roses in Battle River Valley.

A "butte" in Battle River Valley. Photo by H. S. Holcroft, D.L.S.

Dam on Adams River. Photo by J. E. Ross, D.L.S.

PLATE XV.

Foot of Canyon on Adams River. Photo by J. E. Ross, D.L.S.

PLATE XVI.

Head of Canyon on Adams River. Photo by J. E. Ross, D.L.S.

The Invar Base Line Instrument.

Taking readings on the Invar Base Line Instrument.

The Invar Base Line.

ANNUAL REPORT OF THE DEPARTMENT OF THE INTERIOR FOR THE FISCAL YEAR ENDING MARCH 31, 1910.

REPORT

OF

DR. P. H. BRYCE

CHIEF MEDICAL OFFICER

APPENDIX TO REPORT OF THE SUPERINTENDENT OF IMMIGRATION

OTTAWA
PRINTED BY C. H. PARMELEE, PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1910

[No. 25c—1911]

APPENDIX TO REPORT

OF THE

SUPERINTENDENT OF IMMIGRATION

PART II, ANNUAL REPORT, DEPARTMENT OF THE INTERIOR

REPORT OF THE CHIEF MEDICAL OFFICER

OTTAWA, March 31, 1910.

The Superintendent of Immigration,
Ottawa.

SIR,—I have the honour to transmit my annual report relating to the medical inspection of immigrants.

The inspection carried on in past years at the various seaports has been continued and has been extended through making Prince Rupert a station having its agent and medical officer, and facilities for the regular inspection of the increasing number of immigrants arriving at that port. The monthly reports received since October, 1909, indicate the importance of the inspection at this port, which is the gateway to the Skeena River district and other settlements in the vicinity. The medical officer reports that the town, which in June, 1909, had some 500 inhabitants, has now a population of 5,000. The incomers consist of settlers from the United States, many of whom have money and have invested in property, while others are mechanics, miners and labourers from Great Britain and northern Europe. This officer mentions the fact that immigrants from southern Europe are especially needed, in view of the labour supply, required in railway construction, quoting the chief railway contractors to the effect that these men, required for labouring on the railway grade, are superior to Americans, Canadians or northern Europeans.

It is interesing to note that the steamship companies trading from United States ports to Prince Rupert cause all Prince Rupert passengers to be examined at such ports as Seattle, by medical officers, before selling them transportation, thereby lessening the cost of carrying back rejected persons.

Besides this extension of inspection there has been an increased supervision of immigrants at all points along the American border, the necessity for which has been referred to in previous reports.

As was remarked in my last report regarding the inspection at points in British Columbia, 'other questions both moral and social are intimately associated with the physical health of a class of immigrants who have been essentially drifters from one mining camp to another or one railway to another in the United States.' 'As the class of labour supplied by them is there constantly in demand, it would appear that until supplied from elsewhere, the situation requires that through inspection the unfit and undesirable should be weeded out.'

In addition to the customs officers who are, under the Act, ex officio immigration officers, some 40 additional inspectors have been appointed to operate at the different railway and steamboat crossings between the United States and Canada. They are not medical men and are especially empowered to inspect regarding civil and social qualifications; but they are also further required, as under the Quarantine Act, to take action in any case where for physical reasons an immigrant might be undesirable. In such cases they detain the person until he has been examined by some medical officer of the department.

The routine medical inspection established since 1903, at Quebec, Halifax and St. John, has been carried on during the past year with increasing exactness and effectiveness. The organized efforts to insure that from the medical standpoint only the physically fit shall become citizens of Canada are found to have extended to the farthest confines of Europe, and the arrangements which exist from the eastern limits of Germany to Italy to sift immigrants, are of the most remarkable and complete character. While it has been always recognized that perhaps the most active agents in stimulating emigration have been the steamship companies, yet it is equally plain that countries such as Germany and England through which emigrants pass on their way to America, are equally interested on the one hand to see that contagious diseases are not introduced during transit therein, and on the other hand that the great financial interests engaged in the shipping trade shall not through any act or negligence on their part cause restrictive legislative measures to be taken in those countries to which the emigrant goes, which would injure a business, so difficult to build up and yet so profitable when once established. This position is fully illustrated by the splendid conveniences existing at Antwerp, Rotterdam, Bremen, and especially at Hamburg, for the protection, housing and supervision of emigrants. At present relatively few German emigrants come to America; but instead there is a continuous stream through these ports of Russians, Poles, Roumanians and other peoples. At the borders of Germany are detention houses on both sides of the boundary, and the first examination, medical and civil, of emigrants is begun there. In all there are depots at 14 different points on the German border where inspection takes place.

Those admitted are all transported to a central depot at Ruhleben, not far from Berlin, where they are re-examined and distributed for transportation to the several seaports from Hamburg to Antwerp.

The emigrant barracks in Germany are especially fine, the steamship companies, as the Hamburg-American, having, by direction of government, to obtain ground, erect buildings and equip them in every way for the residence of intending emigrants. At Hamburg, the residences consist of a series of permanent separate buildings of one story, well constructed with adequate lavatory and sanitary conveniences, and simply but adequately furnished, in which the various nationalities and classes of emigrants are carefully separated. The floors are of the most sanitary character, the sewage is all gathered to one septic tank and carefully disinfected before delivery into the River Elbe, while each arrival of emigrants is treated to a spray bath and their clothing disinfected in a superheated steam apparatus. A daily inspection by expert medical men is made of every emigrant awaiting his ship, both as regards his general health and the condition of his eyes. Unvaccinated emigrants are vaccinated, so far as possible, while any cases of contagious disease are at once sent to the several wards for different diseases in an isolation hospital, on ground apart from the general emigration buildings. Superior buildings are also erected for second-class passengers, these having separate family quarters and conveniences in modern dressing rooms, where every reasonable comfort is provided. Pretty lawns and flower gardens adorn the grounds, while even a band is constantly on the grounds to regularly entertain, day by day, the emigrants awaiting their ships. The usual charge to an emigrant is 50 cents

Class of Disease.	Cause of Detention.	Number Detained.	Number Released.	Number Debarred.	Number still in Hospital.
VII.—Digestive system.	Hernia	20	5	14	1
	Enteritis	2	2	...	...
	Diarrhoea	2	*2	...	...
	Jaundice	1	1	...	...
	Gastritis	1	1	...	...
	Totals	26	11	14	1
VIII.—Genito-Urinary system	Syphilis	5	...	5	...
	Gonorrhœa	1	...	1	...
	Hydrocele	2	2	...	...
	Totals	8	2	6	...
IX.—The skin	Psoriasis	3	1	2	...
	Disease of skin	7	7	...	...
	Scabies	6	5	1	...
	Impetigo	5	4	1	...
	Tinea	7	7	...	...
	Eczema	3	3	...	...
	Sycosis	4	3	...	1
	Totals	35	30	4	1
X.—Malformation and diseases of old age and infancy	Senility and debility	9	6	3	...
	Abscess	12	12	...	...
	Deaf and dumb	7	5	2	...
	Club foot	1	1	...	...
	...	8	3	5	...
	Totals	37	27	10	...
XI.—Accidents	Dislocation of hip	2	2	...	...
	Lameness	1	1	...	...
	Fractured hip	2	2	...	...
	For operation	1	1	...	...
	Loss of leg	4	2	1	1
	Fracture of arm	1	1	...	...
	Injury to spine	2	2	...	...
	Broken leg	3	1	...	2
	Fractured patilla	1	...	1	...
	Injured on board	5	4	...	1
	Loss of hand	1	...	1	...
	Totals	23	16	3	4
XII.—Ill-defined causes.	Physical debility	13	3	10	...
	High temperature	21	17	4	...
	Disease of hip	2	...	1	1
	Sick	1	*1	...	...
	Otitis	3	2	...	1
	Ankylosis	1	1	...	...
	Totals	41	24	15	2

* Died.

The above table may be regarded as a barometer of immigrant health, and an index of the thoroughness with which inspection, whether at foreign ports or Canadian, is carried on, the increase in the detentions on account of disease being 50 per cent over the last fiscal year.

The detentions in Class I. show the generally effective character of the inspection prior to sailing and of subsequent inspection at the Canadian quarantine. One case of smallpox, not included in the list, was detected at Quebec after having passed quarantine, and was sent back on the ship to Grosse Isle. Measles has commonly occurred in children detained with parents for some other cause, and while few in number these cases very well illustrate how amongst children exposed on shipboard and not detained, there is always danger of their carrying disease to inland points, as occurred this spring at Winnipeg.

As regards Class II. of constitutional diseases, the total cases in a young and vigorous lot of immigrants, who have been already inspected, will always be small, alcoholism having 10 and tuberculosis 12. The latter is less by 6 than last year. Obvious cases of tuberculosis are thus seen to be very few, and while the very general prevalence of the disease in all temperate climates makes it certain that cases of this disease will be discovered, in proportion to the minuteness of the examination, it is evident that great care is being exercised at European ports to prevent evident cases of this disease from taking passage.

Class III. contains eye diseases, and the 824 cases of trachoma detained, as compared with 456 last year, show that in spite of the inspection in Europe, the number of cases discovered at the end of the voyage is very considerable, being 1 in 161 passengers. These figures only accentuate what has been already said regarding ship conditions, since with the trachoma are associated 227 cases af conjunctivitis. That, however, many of the cases of trachoma were chronic is found in the fact that 413 cases of trachoma were debarred owing to the length of time their treatment would take. It is further noted that a large number were sent to hospital for observation of eyes, which would place most of them under the heading of conjunctivitis. In all 445 persons were debarred on account of eye conditions.

Class IV., which has an ever-increasing interest, shows that abroad as at our own seaports, great care is exercised to prevent persons of this class of insane or feeble-minded from emigrating. This year, although the total immigration has been much greater, there have been only 15 or the same as last year of insane detained, of whom 11 were debarred. Of the allied class of feeble-minded, more, however, have been detained, there being 52 as compared with 37, of whom 31 were debarred. Of epileptics detained, 2 were debarred.

Under Class V. there were debarred 5 only of 8 cases of heart disease, and 1 case of goitre, while of the diseases of respiration in Class VI., 24 were detained but only 2 were bebarred.

Class VII. showed a quite unusual number of cases of hernia, 20 in all, of whom 14 were bebarred, but very few other cases, while diseases under Class VIII. were exceedingly rare in so large a number.

Class IX., including diseases of the skin always indicates in the number held the measure of strictness in European inspection. Not fatal diseases, it might be supposed that medical inspectors there would view them with indifference; but for diseases that are usually obvious to the eye, 35 is a very small number, and there was not amongst them one case of favus. Similarly, only 37 were detained on account of physical defects, as malformations, &c., under which heading is placed 'abscess,' improperly, perhaps, of which there were 12 cases.

Only 3 persons were debarred on account of senile debility, 2 for deafness and 5 for spinal curvature.

Class X., including accidents, and Class XI. ill-defined causes, contain their usual quota, of whom only 3 were deported for accidents and 10 for physical debility; 5 only of all detained are reported as having died.

How secure Canada has been made by the second line of medical inspection after the outer quarantine, may be judged from the following table, showing the total cases of detained during six years on account of acute contagious diseases.

Disease.	1904-5.	1905-6.	1906-7.	1907-8.	1908-9.	1909-10.
Scarlet fever					1	
Diphtheria		2				
Quinsy		1				
Chickenpox			1			2
Measles	1	19	4	18	10	17
Erysipelas				1	3	1
Typhoid			1	2	1	1
Mumps			1	1		
	1	22	7	22	15	21

It is remarkable testimony to the thoroughness of the inspection, that until the past year, when there was one, not a single case of smallpox had gained admission in six years through the line of medical inspection to the interior of Canada. This is all the more remarkable inasmuch as the quick passage from Great Britain makes it easily possible for an inoculated person to have arrived in Quebec well, and to have even reached Winnipeg, before the incubation period of the disease has passed. The generally vaccinated character of the British population and the re-vaccination on shipboard of all immigrants, materially assist in explaining this immunity. It is unfortunate that as yet no such methods of securing immunity have been evolved for measles, the cause of the greater part of the mortality among the children of immigrants.

The total deported for medical reasons in 1909-10 was 212, as compared with 464 in the previous year, as shown by the following statement:—

—	1908-1909.	1909-1910.
Deafness	4	
Rheumatism	15	8
Tuberculosis	54	30
Mentally weak	1	9
Physically unfit	11	4
Epilepsy	22	8
Heart disease	13	4
Insanity	113	95
Varicose veins	6	
Cripple	11	
Paralysis	4	3
Imbecility	35	1
Insomnia	..	1
Defective sight	11	
Bladder trouble	1	1
Syphilis	4	2
Bronchitis	1	
Trachoma	1	2
Hernia	2	
Muscular atrophy	..	2
Cancer	2	
Blindness	3	
Alcoholism	27	
Diabetes	2	
Abscess	2	2
Injured	6	1
Senility	10	3

—	1908-1909.	1909-1910.
General debility	86	23
Bright's disease	3	
Curvature of spine	1	
Fistula	1	
Cataract	1	
Malaria	..	2
Pregnancy	..	3
Rupture	6	
Potts' disease	2	
Paresis	1	
Anaemia	1	
Eczema	1	6
Idiocy	..	2
	464	212

The fact that there were 252 fewer deportations in 1909-10 than in 1908-9, amply justifies the conclusion that from the moment of the initial step taken by the intending emigrant, whether in Great Britain or on the continent, the inspection carried out whether by transportation companies, foreign government medical officers, or those of the Canadian Immigration service, is such as to bring into Canada a class of immigrants who, so far as disease is concerned, will compare more than favourably with any similar number of our population. The study made of the insane in immigrants last year demonstrated this very fully, as indeed a similar study in 1908 showed the remarkable freedom from tuberculosis in immigrants resident in this country less than two years. Unfortunately, the studies made, whether of Jewish, Italian or Polish immigrants in the United States, show that in the great cities at least seventy-five per cent of these people were crowded, and that their declension in the matter of health and notably in the increase of tuberculosis is both rapid and fatal.

It does seem as if the duty of society at large in Canada, in regard to the immigrant, whether in the city or rural part, who has come to add to our wealth through his industry, requires to be more widely comprehended, and that the potency of sympathetic interest in him as regards his education, housing and fair treatment by employers toward making him a good citizen, should be more widely realized; while the evils that may grow out of a large number of persons domiciled amongst us of alien birth and speech, having social customs foreign to those of Canadians and ethical standards deemed lower than those of our own people, must be recognized by the citizens of Canada generally, if we are going to produce the highest national life of our people, in which it will be seen by next year's census the foreign born forms a notable percentage of the total population of Canada.

Your obedient servant,

PETER H. BRYCE,

Chief Medical Officer.