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REPORT OF
THE CANADIAN FORGING INDUSTRY
TECHNICAL MISSION
TO WESTERN EUROPE

Prepared by N. M/Switucha Materials Branch

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FOREWORD

While the basic principles involved in the forging process have been handed down from remote antiquity, the forging industry continues to be one of the most technically interesting sectors in the metalworking field. Many new refinements continue to be introduced in the design of equipment and in making the products more economical and more reliable in critical service applications.

To meet the need for a continuing assessment of this technology and of the competitive abilities of the Canadian forging industry, the Department of Industry, Trade and Commerce sponsored this industrial Mission to Western Europe.

It is hoped that this Mission report will be of value to the forging industry and will foster further improvement of this industrial sector in Canada.

R.D. Hindson, General Director, Materials Branch.

1. INTRODUCTION

1.1 ORIGIN AND OBJECTIVES OF THE MISSION

In line with the overall objectives of the Department of Industry, Trade & Commerce, and in close consultation with the Canadian Forging Association, the Department sponsored in November 1968 an industrial Mission to Western Europe with a view to assessing at first hand the prevailing trends and future prospects of forging technology.

Canada's peculiar geographic position, economic relationship with the United States and, specifically, our dependence on imported technology in some of the metalworking fields, usually assure a relatively realistic assessment of the technological status and competitive strength of the Canadian industry with respect to that of the United States. In the absence of direct, continuous and intimate contacts with the European steel forging industry, it was necessary to take special steps to gain the insight on which a well-founded assessment could be made. The main tasks of the Mission were, therefore, as follows:

- to observe at first hand the current state of the steel forging technology in Western Europe;
- to assess the advances made in the equipment, plants, methods and procedures employed;
- to evaluate the effects of the prevailing practices in marketing, labour relations, management and other fields;
- to determine the nature and scope of the trade or industry associations' activities and the degree of cooperation between forging industries in individual European countries:
- to establish a basis for better understanding and closer future liaison between individual Canadian and European firms and between national forging industry associations.

1.2 COMPOSITION OF THE MISSION

The Mission consisted of seven senior, technically qualified representatives of the Canadian drop-forging and open-die forging firms, with a representative of the Department of Industry, Trade and Commerce as Secretary. Their diversified backgrounds and interests helped to achieve a well-rounded assessment of the forging industry in Western Europe. A complete list of Mission members will be found in Appendix 1A.

1.3 ITINERARY OF THE MISSION

To accomplish its tasks within the limited time available, the Mission followed a tight itinerary, visiting on the average two plants each day. The selection of the firms was based on a broad review undertaken within the framework of the Canadian Forging Association, taking advantage of the past contacts by individual firms and utilizing the information provided by the Canadian Trade Commissioners Service.

In establishing the final itinerary a certain degree of compromise was necessary in order to take into account the diversified interest of the Canadian forging firms, the specialized activities of the European firms, their willingness to engage into this exchange of information, as well as many practical problems arising from scheduling individual appointments and overcoming significant distances.

In this connection it should be noted that members of the staff of the national Forging Industry Associations in the United Kingdom, Germany and France extended their full cooperation and assistance in many practical ways, thus making a significant contribution to the successful completion of the otherwise strenuous tour.

A complete list of firms and industrial associations visited by the Mission will be found in Appendix 1B. Visits to the Spanish firms were made by one member of the Mission, who has kindly consented to have his observations incorporated in this report.

1.4 SCOPE OF THE REPORT

This report, reflecting the opinions and observations of the Mission as a group, is essentially a product of individual contributions by each delegate. Part I of the report presents general observations and impressions of the Mission on the state of forging industry in Western Europe under individual section headings dealing with various aspects of technology, marketing, labour relations, etc. Part II summarizes information on the individual firms visited, their equipment capabilities, main products and special interests, if any. Part III consists of the Appendices.

Throughout this report units of foreign currency have been converted to Canadian dollars using an appropriate rate prevailing at the time of the Mission's visit.

1.5 ACKNOWLEDGMENTS

The success of this Forging Industry European Mission would not have been possible without full co-operation of the Forging Industry Associations in the United Kingdom, Germany and France and the management of the individual firms in all countries visited.

Their assistance in planning a detailed itinerary, in providing all of the information requested and in extending warm co-operation and hospitality is gratefully acknowledged.

2.0 SUMMARY AND CONCLUSIONS

2.1 STATE OF THE FORGING TECHNOLOGY IN EUROPE

The forging industry in Europe as in North America is engaged in a fiercely competitive business. The growth within the industry has not kept pace with the overall industrial growth of the countries.

The effect of the automotive industry requirements can be seen in the relative prosperity of the more competitive plants in England where most of the automotive forgings are produced by independent forge shops. This can be compared with the depressed state of the independent forge plants in France, where the main automotive forging requirements are met by captive shops.

United Kingdom, Germany and France all have very active Forging Industry Associations which appear to be working energetically to stimulate the industry. Their main activities are centred around distribution of various publications, collection and distribution of statistics and the various technical committees set up to study problems in the industry.

The type of forgings produced in the plants visited by the Mission ranged from very large open die parts, such as propeller shafts and rudder stock to small hand tools. A number of companies were producing parts by cold forging methods and a cautious interest in this advanced technology was evident everywhere.

Various methods of maximum manpower utilization and of maximum equipment utilization were observed. It was interesting to note that one of the companies — Garringtons in England — who had applied a maximum of manpower to their conventional equipment in order to achieve full utilization, had also installed the Hatebur machine. This machine must represent almost the ultimate in automation and hence serves as an example of minimum manpower requirement.

In looking for a general trend toward more sophisticated equipment, which is obviously available, it was evident that industry was not racing ahead with the installation of this equipment. The slow growth of the forging industry could account for this.

Generally, product quality was high. The customers appeared to demand a clean forging and most forgings were ground after trimming. Very little off-die condition was seen.

Material handling in some plants was somewhat behind the average North American shop, although the Mission witnessed some very efficient systems in operation. Raw material was generally stored nearby in a convenient location for shearing. In many plants the feed racks were placed outside the building, in or near the general storage area. The shears were inside the shop, with stock fed through the wall.

Die making methods ranged from largely manual die finishing to the use of Electrical Discharge Machining (E.D.M.) and Electro-Chemical Machining (E.C.M.) methods with a minimum of hand finishing. E.D.M. appeared to be an increasingly popular method.

The wide variety of lubricants used in different shops indicated that no one lubricant has yet been found with very definite advantages over all others. Lubrication techniques ranged from the use of willow sticks or sawdust to the use of automatic spray systems. The industry was still searching for a really reliable automatic spray unit.

Steel heating methods covered the whole range of equipment from furnaces using either oil or gas fuel to induction and resistance heaters. Induction heating was a very popular method

in the press forge shops. Many novel adaptations were observed aimed at increasing the productivity of furnace equipment and decreasing the requirement for labour.

Heat treating methods, although different in some aspects of equipment, design and utilization, did not have any advantage over methods common in North America.

Safety practices were below North American standards in respect to use of protective clothing, eye glasses, helmets and ear muffs.

The more competitive forging plants were enjoying an increasing amount of business, particularly high volume automotive business. The efficiency of these plants had been increased or maintained at a high level by innovation and close attention to almost every aspect of the business from raw materials to finished parts.

On the other hand, competition for this lucrative business appears to be tough in each of the European countries visited. The continuous increase in costs with which the forging industry is confronted has not been balanced by an adequate level of drop-forging prices. The resistance to price increases by the powerful buyers of the automotive industry can only be expected to increase with a pronounced trend towards mergers between the European carmakers. This is evidenced by the formation of the British Leyland Motors Corp. (B.L.M.) (merger of Leyland Motors and British Motor Holdings Ltd.), the acquisition of Krupp's truck building operations by Daimler-Benz in Germany and the link-up between Italy's Fiat and France's Citroen.

It should be noted that the European automotive manufacturing industry, as the largest consumer of carbon and alloy steel forgings, now rivals in size that of the United States, while each of the countries visited individually exceeds the Canadian annual output of the motor vehicles

Thus in 1968 the total motor vehicle production in Germany was 3.1 million units, in U.K. and France approximately 2.1 million units each and in Italy 1.6 million units, while Canadian domestic output has reached an all time high of only 1.2 million units. Furthermore, most European motor vehicle manufacturers continue to expand their export penetration on a world-wide basis, sometimes by establishing assembly operations in overseas countries. Such operations will become important consumers of the European-made automotive parts, including forgings.

2.2 CONCLUSIONS

Not unlike their counterparts in North America, the European steel forging firms continue to face similar pressures associated with rising equipment and labour costs, strong competition from other technological processes combined with a challenge from the consuming industries to provide a better quality product at a lower cost.

The rising standards of living in all countries have significantly contributed to the pressure for higher wages and fringe benefits to the point where the past differential between the North American and the European labour costs has substantially narrowed down.

The European forging equipment producers are making a substantial contribution to the struggle of the forging industry to remain competitive by designing new and radically different equipment capable of high productivity on a massive scale. Labour productivity, at least is some countries, is high by any standard. Advanced technological concepts, such as EDM and ECM, cold forging, transverse rolling and others are being adopted by many progressive firms.

There is little doubt that this tour of the Canadian Forging Industry Mission provided the management of the Canadian forging firms with a valuable exposure to the prevailing technological trends and assisted in a realistic assessment of the competitive strength of the Canadian industry in domestic and export markets. It has also demonstrated the potential benefits which could be derived from a varied scope of activities of the industrial and technical associations.

PART 1

3.0 FORGING INDUSTRY ASSOCIATIONS

3.1 NATIONAL ASSOCIATION OF DROP FORGERS AND STAMPERS

This Association, with a membership of about 90 British drop-forging firms, representing over 90 percent of the drop forging production in the United Kingdom, has been in existence for over 50 years.

Its Birmingham headquarters serves as a centre for technical, commercial and general information exchange not only within the British industry, but also with overseas forging firms who maintain associate membership status in the Association. There were 52 Associate Members in 1968. The Association collects trade statistics, organizes training programs for various grades of employees, and encourages safety measures in the drop-forging plants.

The technical side of the Association's work includes:

- a) provision of a technical service to all member firms which deals with enquiries on manufacturers' specific problems;
- b) provision of a technical service to users on the feasibility of drop forged products;
- promotion of co-operation between individual manufacturers faced with the same technical problems;
- d) introduction of new developments to the industry by means of meetings, lectures and publications;
- e) representation of the industry on national technical committees;
- f) dissemination of information on the drop forging technology by means of lectures at universities, technical colleges and professional bodies;
- g) furtherance of technical co-operation on an international basis with drop forging associations in the other countries.

The Association has an active publication program with most of the publications being accessible to the associate members.

Annual output of drop-forgings in Great Britain reached a peak of 662,000 tons in 1965, but declined in the next two years to 556,000 tons in 1967. During 1968 there has been some improvement, but the outlook for the industry does not appear to be very optimistic. One of the problems appears to be the difficulty in maintaining adequate drop forging prices to secure satisfactory return on invested capital. The index of drop forging selling prices has increased in 1967 to 144.0 (1954 = 100), while the index of the replacement cost of drop hammers and forging presses has increased to 247.0 (1950 = 100). Competition for available business appears to be very keen, a factor which does not help to maintain satisfactory price levels.

The dependance of British drop-forging firms on the automotive industry can be seen from the following figures:

TABLE 1

Tonnage of drop forgings shipped to the automotive industry, expressed as percentage of total shipments.

Year	Percent		
1962	69		
1963	72		
1964	77		
1965	75		
1966	75.5		
1967	75.5		

In spite of the factors outlined above, one of the significant elements of strength of the British drop-forging industry appears to be its ability to preserve independence from large international automotive manufacturers while building up highly productive and competitive manufacturing facilities.

While the total export volume of British-made drop forgings and open-die forgings is unknown, it must be very considerable both in terms of direct and indirect exports. Table 2, showing drop forging tonnage delivered to the various consuming industries from 1963 to 1967, highlights the significance of the individual manufacturing sectors.

TABLE 2
Deliveries of Drop Forgings in the United Kingdom
ANALYSIS BY MARKETS

MARKET	1963		1964		1965		1966		1967	
ANALYSIS	L Tons	%	L Tons	%						
Ship Building	5,520	1.0	3,860	0.6	5,296	0.8	7,452	1.2	5,560	1.0
Mines	15,456	2.8	16,720	2.6	15,226	2.3	15,525	2.5	12,788	2.3
Railways	4,968	0.9	7,717	1.2	7,944	1.2	4,968	0.8	7,228	1.3
Motor Vehicles) & Ag. Tractors)	395,232	71.6	496,397	77.2	496,500	75.0	468,855	75. 5	419,780	75.5
Mechanical Eng.	39,192	7.1	38,580	6.0	48,988	7.4	47,817	7.7	30,580	5.5
Aircraft	5,520	1.0	6,430	1.0	10,592	1.6	7,452	1.2	7,784	1.4
Forgings for own use	54,096	9.8	37,296	5.8	39,720	6.0	31,050	5.0	27,800	5.0
Others	32,016	5.8	36,000	5.6	37,734	5.7	37,881	6.1	44,480	8.0
TOTAL, long tons	552,000		643,000		662,000		621,000		556,000	

3.2 DROP FORGING RESEARCH ASSOCIATION

Cooperative research in the drop-forging field is carried out in the United Kingdom by the Drop Forging Research Association in Sheffield, whose present membership of 53 ordinary and 28 associate members represents about 75% of the total British output of drop forgings. The establishment of an independent cooperative Research Association was initiated in 1961 by the National Association of Drop Forgers and Stampers, with a view of qualifying for the Ministry of Technology annual grants in support of the research work. The Research Association presently employs a staff of 30 to 33 people, of which 7 are scientific and engineering personnel.

3.2.1 Budget

The Association's budget for the year ending December 31, 1967 was £54,100 (Can. \$143,000), of which about £23,000 (Can. \$61,000) was derived from direct subscriptions by members, £15,130 (Can. \$40,000) as a direct grant from the Ministry of Technology and another £13,470 (Can. \$35,700) came from contract work sponsored by the Ministry of Technology.

Government sponsored grants are conditional upon the willingness of the private industry to finance a share of the research budget.

1967 was the first year of the new grant conditions, which are offered by the Ministry of Technology quinquennially. For the period 1967 to 1971, the Ministry offers to the industrial research associations a grant at the rate of 65% of industrial income. This is subject to a minimum income from industrial sources of £25,000 (Can. \$66,250) and to a maximum grant of £30,000 (Can. \$79,500).

While the Ministry reserves the right to withhold the whole of the grant, in 1967 they have paid grant at 65% of the actual industrial income of £23,277, (Can. \$61,500). This means that the current grant is only half of the maximum grant that the Ministry would be prepared to pay, if the industry could see its way to providing higher direct contributions.

Direct expenditure on research in 1967 amounted to £35,388 (Can. \$94,000), including £7,075 (Can. \$18,700) spent on equipment. Administrative expenses were additional £4,746 (Can. \$12,500) or 11% of the total.

3.2.2 Facilities

The Association has recently completed its own forge building at a cost of £17,206 (Can. \$45,500), which was officially opened in April 1968. In the past, research work was performed on the nearby premises of the British Iron and Steel Research Association (B.I.S.R.A.), but, apparently, this close association was considered to be impractical. However, B.I.S.R.A. continues to provide general and administrative services, and the nationalisation of the steel industry in the United Kingdom did not appear to affect this arrangement.

The experimental forge is equipped with a drop hammer, a friction screw press and a high energy rate forging machine in addition to various types of furnaces, including induction heating equipment.

Other facilities include a small laboratory, a library and general offices.

3.2.3 Research Administration

Initially, separate Research Committees were established to provide guidance on various projects. This system, however, proved to be ineffective and at the present time one Research

Committee supervises all projects. One third of the membership of this Committee is drawn from the Governing Council, one third from the staff of the drop-forging firms, who supply practical advice and general directive, and one third from the universities mainly for the purpose of technical and scientific assistance.

The initiative for new projects usually comes from the Association's staff, with member firms exerting influence on the selection of appropriate activities and on the method of financing. Projects are normally reviewed at least at 5-year intervals in consultation with the industry. However, the Research Committee meets several times during each year to review progress and direction of each project and to insure that the results are communicated and interpreted to the industry.

3.2.4 Research Projects

The Association's staff presented the Mission with a reasonably detailed listing of all current projects. A brief review of those projects, considered to be of interest to the Canadian forging industry, is given in the subsequent subsections of this report.

a) EROSIVE DIE WEAR

The erosive wear resistance of die materials is assessed by measuring the amount of metal worn from the surface of flat test dies used to upset 2000 hot mild steel slugs.

The slugs, which are $\frac{1}{2}$ in. diameter x $\frac{3}{4}$ in. long, are fed to an induction heating coil and then to a press where they are upset to .200 in. thick discs before being ejected from the press. The whole cycle of operations is automatically controlled by an electro-pneumatic system.

More than fifty potential die materials have been tested, and those which showed promise in the laboratory tests are being evaluated in works trials. Good agreement has been indicated between test results and service performance.

b) CRACKING OF DIES

Studies are being made of the resistance of die materials to cracking caused by high-strain fatigue in the presence of notches. The method employed uses cantilever loading of notched specimens.

Initiation and crack growth are studied with a microscope, and the following variables are presently being investigated:

- (1) Material
- (2) Stress level
- (3) Hardness of material
- (4) Temperature of material

Knowledge gained from the above investigations is being used to select the most suitable die material for a given application. As a long-term objective the program may lead to the development of new die materials which give maximum performance at minimum cost.

c) HIGH ENERGY RATE FORGING DIE WEAR INVESTIGATION

The Association has undertaken an investigation, sponsored by the Ministry of Technology, into the effects of high energy rate forging upon die life. To this end, works trials are

being conducted using three different types of component — a gear blank, a flanged component and a gear casing. These components are being produced commercially on both a high energy rate forging machine and conventional forging machines.

Preliminary conclusions are that actual erosive wear of the dies is not very greatly different under high rate forging conditions. However, either cracking of the dies occurs sooner, or a given degree of cracking more easily causes a stuck forging in the high rate machine than when using conventional equipment.

Laboratory tests are being carried out on the die wear machine developed by the Association, and simultaneously on a Petroforge suitably modified for these tests. Four die materials, En40C, 5% Cr steels, 12% Cr steel and No. 5 die steel are being investigated, using forging stock of En57 (stainless steel), En24 (alloy steel) and mild steel.

Using the data obtained from the works trials and laboratory tests, a comparison of die steel performance on high energy rate machines and conventional machines will be made.

d) HIGH ENERGY RATE FORGING

An experimental, gas driven, high rate forging machine has been built to determine the value of high tup velocities to the forging process. A feature of this machine is that blow velocity and energy can be varied independently. The machine is relatively small and simple in construction, but is capable of delivering a blow with energy of 10,000 ft-lb. This energy compares with that of a 1 ton drop hammer which, with maximum fall, will deliver about 8,000 ft-lb. Tup speeds can be varied between 20 ft. per sec. and 150 ft. per sec. compared to 1 ft. per sec. to 20 ft. per sec. for presses and drop hammers.

Tests performed on the experimental high energy rate machine involved cold forging of aluminium into a conical cavity with a single blow of the tup. The full range of velocity and energy was used, showing that tup energy, as opposed to velocity, is the criterion of die filling.

Another series of tests involved forging hot steel into complex cavities, and revealed that, for complex forgings, the performance (on an energy rating) of the high rate machine exceeds that of the drop hammer.

A technical and economic evaluation of high energy rate machines and of the process itself has been made.

e) WARM FORGING

Potential technological advantage of warm forging is in producing high strength components from inexpensive material, by utilizing the work hardening engendered at these temperatures. Tests have indicated appreciable increase in yield strength of forged components produced by warm forging. Experiments are continuing to determine accurately the effect of the forging temperature on the mechanical properties of forged parts.

The main factors affecting the economics of the process are being studied. These include the forging load and energy for various steels forged between 500° C (930° F) and 1200° C, (2190° F) the heating cost, lubrication requirements, and the cost of using heated dies.

Experiments have established that a moderate reduction in forging temperature is effective in enabling components to be produced with far superior surface details than their hot forged counterparts. Forgings in medium carbon steel, produced at 850°C, (1560°F) exhibit good scale-free surface finish, free from defects and decarburization.

The feasibility of producing complex components in the warm temperature range has been studied. A micrometer frame, which represents a complex assymmetrical component, has been forged at temperatures as low as 600°C (1112°F). Simulated spur gears have also been formed at 750°C, (1380°F) but various pre-forming techniques are being investigated in order to obtain complete filling of the gear teeth.

It seems likely that warm forging would be an attractive process for components such as hand tools, where a good appearance is required, for small automobile components, where a good surface finish would increase the fatigue life, and possibly enhance mechanical properties and smaller amount of machining would reduce the cost.

f) AXIAL ROLLING

An axial rolling machine, developed originally by Henry Wiggin & Co. Ltd. for dumbbell shapes, has been used by the Association to produce pre-forms for a tube-end forging. Originally, it was thought that this machine could be used to roll any shape of pre-form. However, frictional restraint imposes a length to diameter limitation of about 4:1. Development of the machine is continuing, to assess whether this limit can be increased.

Three other axial rolling machines are commercially available, the Erfurt Transversal Rolling Machine, the Czech Two-Roll Machine and the Russian Skew Rolling Machine. Of these, it is considered that the Russian Skew Rolling Machine is the most promising for development into a pre-forming machine, and it is hoped that one of these machines will be available to the Association for evaluation trials.

Present pre-forming methods of reducer rolling and fullering on the side of a die cannot make accurate pre-forms. These methods produce large variations in size, forcing the average pre-form weight to be increased to allow the smallest pre-form to fill the die. Accurate pre-forms are needed to conserve material which represents about half the cost of an average forging. On the average about 30% of this material is wasted in excessive flash.

With axial rolling methods an accurate shape is formed, as there is no slip between the hot metal and the rolls similar to that which occurs on reducer rolls. As the finishing die is then presented with a preform having correct cross-sections along its length, it appears to be possible to reduce the excess of material to less than 15% above the net weight of the forging.

3.3 GERMAN DROP-FORGING ASSOCIATION

The Mission visited the offices of the German Drop-Forging Association, "Verband Deutscher Gesenkschmieden," in Hagen-Emst for discussions on the state of the German drop-forging industry and on the activities of the Association. Membership of the Association at 224 companies included 90% of the German drop-forging firms accounting for 80% of the drop-forging output, the balance being produced by captive automotive plants and some small local drop-forging firms, who are not, as yet, members of the Association.

3.3.1 Statistics on German Drop-Forging Industry

Germany went through a period of decline in economic activity, reaching its low point in 1966-67 and extending into 1968. This had a negative effect on the activity level in the

drop-forging industry, which is heavily dependent on such industrial sectors as the automotive, machine building, and railway industries.

Table 3 shows the rate of decline in the activity of the drop-forging industry in terms of steel consumption, production and shipments:

TABLE 3

	RATE OF DECLINE, PERCENT		
	1966 compared to 1965	1967 compared to 1966	
Steel consumption, tonnage	9.8	16.0	
Drop-forgings production, tonnage	10.0	17.0	
Drop-forgings shipments, tonnage	8.5	14.9	
Drop-forgings shipments, value	7.3	16.3	

According to the Association's annual report for 1967, the average revenue per ton of drop-forgings sold decreased from DM 2,016.00 (C\$ 543.30) in 1966 to DM 1,981.00 (C\$ 533.90) in 1967, i.e. by 1.7%. Orders received during 1967 were down by 17.0% in comparison with 1966 and amounted to DM 970.3 million (C\$ 261.4 million) in comparison with DM 1,168 million (C\$ 314.8 million) in 1966.

German imports of drop-forgings were 8,231 m. tons in 1967, down from 11,494 m. tons in 1966.

Direct exports of drop-forgings increased from 88,947 m. tohs in 1966 to 107,938 m. tons in 1967, valued at DM 243.2 million (C\$ 65.5 million). Additional significant quantities of drop-forgings are exported under the end-use designation (e.g. vehicle parts, machine parts, etc.) as well as components of finished assemblies.

In 1965, which was the record year of the last two decades, the German drop-forging industry employed an average of 32,193 hourly-paid and staff employees (27,453 in 1967), consumed over 872,000 m. tons of steel (vs. over 660,000 in 1967), produced over 712,000 m. tons of forgings (vs. over 532,000 in 1967), shipped 655,000 m. tons valued at DM 1,304 million (C\$ 351.4 million) (in 1967: 510,630 m. tons valued at DM 1,012 million or C\$ 274,000,000).

Table 4, shows the distribution of drop-forging tonnage shipped to consuming industries as a percentage of total shipments from 1961 to 1967.

Table 5 illustrates increasing profitability of the German drop-forging industry in the last two decades. It should be noted that the figures represent the average revenue on the sale of all products manufactured by the companies belonging to the German Drop-forging Association: drop and open-die forgings, steel balls and grinding media, steel flanges, solid and tubular fittings, roller bearings and axles.

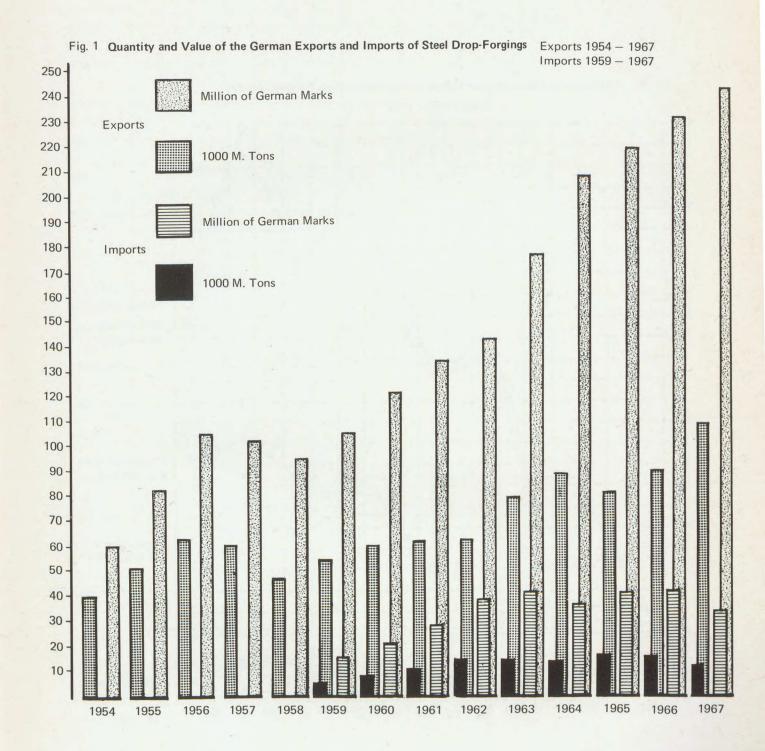
Further statistical data on the German drop forging industry are shown in Fig. 1 to 3.

TABLE 4
Distribution of Drop-Forgings in Germany to Consuming Industries

INDUSTRIAL	1961	1962	1963	1964	1965	1966	1967			
SECTOR		PERCENT OF TOTAL SHIPMENTS								
Automotive	54.9	56.1	57.9	59.5	63.4	62.5	58.6			
Machine Building	11.7	10.6	9.0	9.0	9.7	8.7	8.2			
Railways	8.6	7.4	6.7	7.6	5.1	4.2	6.3			
Mining .	4.8	3.6	5.4	3.7	3.3	3.1	2.8			
Shipbuilding	1.3	1.1	1.0	1.0	1.0	1.1	1.0			
Aircraft	0.1	0.1	0.1	0.1	0.1	0.1	0.4			
Own requirements	3.8	3.5	3.2	3.9	2.9	2.4	2.4			
Miscellaneous	14.8	17.6	16.7	15.2	14.5	17.9	20.3			
TOTAL, per cent	100	100	100	100	100	100	100			

TABLE 5
Average revenue per metric ton of products

Year	DM (German Marks)	C\$	Index
1950	1053	284.0	100
1952	1510	407.0	143
1954	1504	405.4	142
1956	1579	425.5	150
1958	1650	444.8	157
1960	1698	457.7	161
1961	1812	488.4	172
1962	1888	508.9	179
1963	1883	507.7	179
1964	1866	502.9	177
1965	1990	536.3	189
1966	2016	543.3	∙191
1967	1981	53 <u>3</u> .9	188



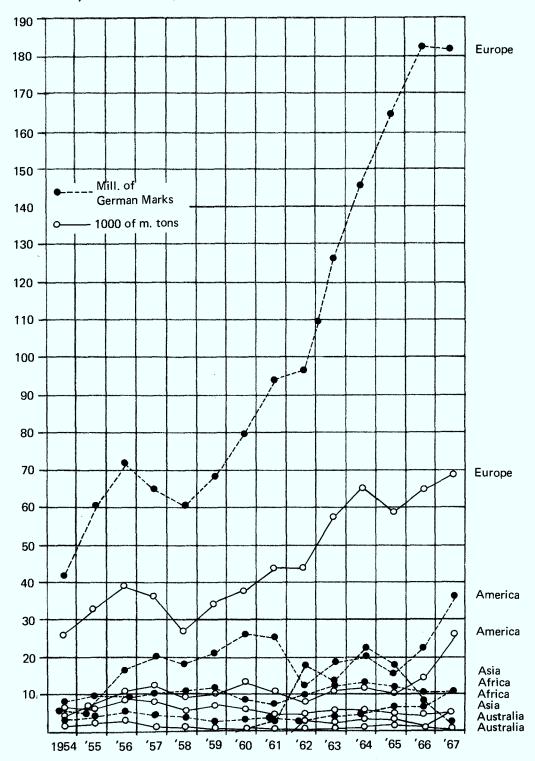
Production and Consumption Indices in the German Drop-Forging Industry Index (1950 = 100)Annual production Annual steel consumption Production in kg per man hr. Д ם Production in tons per man/year Working hours per employee

'52['] '53['] '54['] '55['] '56['] '57['] '58['] '59['] '60['] '61['] '62['] '63['] '64['] '65['] '66['] '67

70-

Fig. 3

Quantity and Value of Exports of German Drop-Forgings by Continents



3.3.2 Economic Activities of the Association

The Economic Committee of the German Drop-Forging Association has undertaken a number of projects, the most prominent of which are the following:

- a) cooperation with management of the consuming firms in establishing a mutually acceptable standard for "sales and delivery conditions for drop-forgings";
- assessing the effect of the German Supreme Court ruling regarding the supplier's liability for damages to third parties, if caused by defects in components supplied;
- reviewing long-range effects on the drop-forging industry of the introduction by the Government of a value-added tax;
- d) making representations to the steel industry and the European Coal and Steel Community regarding prices of rolled steel in Germany. It was noted that French prices for bar steel delivered into the German market were, in 1968, 10.6% and Belgian prices 4.6% lower than German domestic prices. Since German domestic rolled steel prices were stated to be above the world average, it was suggested that the German steel industry helps the foreign competitors of German drop-forgers by adapting its export prices to the world market level.
- e) undertaking on a confidential and voluntary basis an industry-wide comparative study of the capital structure, sales figures, indices of production, turnover and financial liquidity of the drop-forging firms.

3.3.3 Technical Program of the Association

In 1967 the Association sponsored several technical lectures and seminars, prepared an illustrated pamphlet "Reshaping Steel by Drop-forging", and continued to make available its colour film "Steel—drop-forged". It continued to circulate copies of its periodical publication "Forging Technology News" to all German technical colleges and institutes, and to provide opportunities for lecturers and students to augment their knowledge of the drop-forging technology through direct contacts, plant visits, and participation in technical seminars.

The Association is supporting efforts to have the subject "drop-forging" incorporated into the "Engineering Technician" course of a leading German technical correspondence school.

Special technical reports presented at the Association's meetings included such topics as noise abatement in forges, comparative studies of forging hammers and presses, deviations in dimensions and shape of steel drop-forgings.

To further technical knowledge in the drop-forging field the Association currently sponsors projects at several research centers, the most important of which are as follows:

- Research on forging technology at the Hannover Technical College.
- b) Vibration measuring technology at the Kurt Risch Institute of the Hannover Technical College.
- Studies of noise reduction at the Institute for Noise and Heat Protection (Prof. Dr. W. Zeller) in Essen-Steele.

Furthermore, there are a number of projects underway dealing with preparation of the new, and review of the old, technical standards in such matters as dimenional tolerances, machining allowances, etc. and recommendations for ordering forging equipment and evaluation of its performance.

The German Drop-Forging Association maintains a separate research section, which, at the end of December 1967, employed 9 scientists and 9 other staff members, for a total of 18

people. This section conducts basic and applied research in the drop-forging field, publishes a series of research reports, a periodical "Forging Technology News", and translates and evaluates forging technology literature published in other languages around the world.

More detailed description of the research projects and of the other activities of the German Drop-Forging Association may be found in the Association's Annual Report for 1967.*

3.3.4 International Cooperation

The German Drop-forging Association cooperates closely with other members of Euroforge in the formulation and acceptance as "Euronorm" (i.e. European standard) of industrial standards on such matters as tolerances, test regulations, etc.

* English language translation of this Annual Report is available from the Materials Branch, Department of Industry, Trade and Commerce, Ottawa.

3.4 FRENCH FORGING ASSOCIATION

3.4.1 Organization

The French Forging Association, "Syndicat National de l'Estampage et de La Forge", consists of some 100 members, with the largest employing over 1,000 people. The total annual turnover of the Association's members is about Can. \$85 million. About 25% of the independent French forging firms and all of the captive forging plants do not belong to the Association.

The Association's objectives include studying the economic and technical aspects of the forging industry, diffusion of information to members, collection of industry's statistics and representation in negotiations with Government bodies. The Association assists in the preparation of the Government's five year economic plan in co-operation with the French steel Federation.

The Governing Council consists of 7 permanent members elected by the General Assembly. The Association maintains offices in various regions of France and participates in labour negotiations on a regional basis. The annual contribution of each Association's member depends on his annual turnover and amounts to 2½ francs per 1000 francs of annual sales.

3.4.2 Statistics

The Annual report of the Syndicat National de l'Estampage et de La Forge for 1967 reveals some further interesting facts about the independent French drop-forging industry. It must be understood that the figures quoted describe only the activities of the Association's members.

In 1959, which may be considered a depressed year for the French economy, total employment in the drop-forging industry dropped to 9,277 people, wages and salaries to 61.4 mill. Fr. francs, steel consumption to 140,650 m. tons and that of non-ferrous metals to 1,945 m. tons and the total gross sales of the industry stood at 265.8 mill. Fr. francs.

In the next seven years, ending in 1966, the forging industry registered an upward trend increasing its gross sales to 425.3 mill. Fr. francs, steel consumption to 190,800 m. tons and non-ferrous metals usage to 3,193 m. tons. However, while employment remained practically constant at 9,234 people, total expenditure for wages and salaries increased in seven years by over 60% to 99.5 mill. Fr. francs.

In 1967 the level of business activity again decreased with steel consumption reaching only 183,494 m. tons and gross sales 422.7 mill. Fr. francs. While a further decrease in employment to a low of 8,839 people reflects a lower business volume, the total wage and salary bill continued to rise reaching a record high of 101.7 mills. Fr. francs. Direct wages accounted for about 70% of this amount.

The distribution of 183,494 m. tons of steel used in 1967 by consuming sectors is shown in the following table:

TABLE 6
Usage of Steel Forgings by Consuming Sectors in France in 1967

Consuming Sector	Metric Tons	Percent of Total
Internal Consumption	15,174	8.2
Automotive Industry	49,378	27.2
Agricultural Implements	18,672	9.8
Public Works	9,950	5.5
Mining Industry	6,618	3.6
Machinery Industry	13,376	7.2
Aircraft Industry	393	0.2
Miscellaneous Applications	49,130	27.0
Sub total — drop forgings	162,691	88.7
Open-die forgings	19,770	10.7
Cold forming	1,033	0.6
TOTAL	183,494	100

3.4.3 Business Conditions

One of the main problems facing the French forgers is the difficulty in obtaining subcontracts from the automotive industry, since all four French automotive manufacturers have their own captive forging shops. While several years ago independent forgers produced approximately 42 percent of their total output in the automotive parts, in 1967 the proportion has been reduced to 27 percent. Most of the sub-contracting done by the automotive industry is a stop-gap measure. When the automotive manufacturers decide to reduce their own output by only 10%, they may cut off 80% of the independent forgers' business. This results in widely fluctuating production levels of the independent forgers coupled with the need to absorb much higher risks associated with the installation of new equipment. The profitability of the independent forgers is estimated to be only 1½ percent of sales.

Wages in the forging industry vary from one region to another, averaging about 8 francs per hour, with fringe benefits amounting to additional 65 percent of the basic wage.

Capital funds for investment purposes are currently available from French banking institutions at an average annual rate of $8\frac{1}{2}$ percent. The prime bank rate for industrial loans is $7\frac{1}{2}$ percent. Corporation taxes applicable in the forging industry amount to a flat rate of 50 percent of gross profits.

The captive automotive forging shops are technologically far advanced, having installed sophisticated modern equipment. Their machine utilization rate is high, combined with high productivity per man-hour. In conclusion, independent forgers have no prospects in the automotive industry.

Other technologies, such as casting and welding, offer tough competition. There is a strong evidence of market stagnation in the last five years. Competition from malleable iron foundries, while not yet too strong, is expected to grow. It was suggested that, in future, a large percentage of the automotive crankshafts may be produced from cast malleable iron, being more economical than forgings.

The French Forging Association attempts to combat the inroads of other technological processes by advertising forging capabilities in technical publications and by assisting independent French forgers in obtaining sub-contracts from the automotive industry.

3.5 ASSOCIATION FOR THE TECHNICAL DEVELOPMENT OF THE FRENCH FORGING INDUSTRY

The need to strengthen the position of forging technology in the metalworking industry and to assist individual firms in solving their technical problems led to the formation of this technical association known as "Association pour le Developpement Technique des Industries de L'Estampage et de la Forge".

3.5.1 Administration

The governing body of the Association is the Board of Directors consisting of 19 members elected at annual meetings. The office of the President, elected for one year term by the Board, is currently filled by Mr. Louis L. Faure, Vice-President of the Societe Ardennaise de Forge.

The Association's income is derived from membership contributions equal to 1 percent of annual gross sales.

3.5.2 Activities

The activities of this Association are designed to meet the objectives of providing individual services to the member firms and general services to the whole industry in matters of common importance. They include:—

- a) organizing technical seminars and conferences aimed at studying practical problems such as heat treating of forgings, analysis of production costs, advanced dropforging techniques, etc.;
- Visits to individual forging firms to assist in determining the choice of tools, the utilization of forging equipment and training of forging technicians;
- c) conducting research studies on forging technology, such as forged vs. cast dies;
- d) preparing and publishing technical articles in French and foreign technical periodicals;
- conducting refresher courses and lectures for forging plant personnel and for the users of forged products;
- f) sponsoring technical committees on dimensional standards for steel forgings, on production norms, etc. French production norms have been now accepted as a standard in the European industry.

As a joint project with the Syndicat National de L'Estampage et de La Forge and with the Chambre Syndicale de la Boulonnerie et de la Visserie Forgees, the Association publishes a monthly journal "Estampage, Forge Et Boulonnerie". In the last five years, two volumes of the Forging Technology Handbook by A. Chamouard have also been published (Publisher: DUNOD 1964 and 1966).

3.5.3 Research

In 1967, steps have been taken to establish a Research Centre at the Ecole Nationale Superieure des Arts et Metiers in Paris. An agreement to this effect has been signed with a para-government organization CETIM (Centre Technique de l'Industrie Mechanique), which receives a compulsory annual fee from all firms at the rate of 1 Fr. franc per 1000 francs of sales. Current research budget in the forging field is reported to be about 1 million francs (approximately \$180,000), derived from 90 member firms.

3.6 EUROFORGE

Euroforge started as an informal cooperative organization of the British, German and French Forging Associations. At the present time, Belgian and Swedish Forging Associations are full members, while Spain and Italy are expected to join in the near future.

Since 1953, the main activities of Euroforge concentrated on organizing international forging conferences, of which two were held in the United Kingdom, two in Germany, one in France and the last one in 1968 in Washington, D.C. The next International Forging Conference to be held in Europe will be jointly organized by Belgian and Swedish Forging Associations, assisted by Italy and Spain.

Another traditional annual activity of Euroforge is a meeting of the Presidents of the National Forging Associations for purposes of exchanging reports on the state of forging industry in their respective countries. In addition, special committees have been formed to study specific subjects, the most prominent being the Committee on costs and the Technical Committee.

The objectives of the Euroforge Technical Committee to establish common European forging specifications have been achieved by adoption by the European industry as a whole of the common ISO standards as a result of three years of active cooperation through the initiative of the National Association of Drop Forgers and Stampers. Euroforge Technical Committee

also intends to establish forging equipment standards covering such features as lubrication and safety.

The Committee on costs established a common forging costs accounting method and prepared a detailed comparison of forging costs factors.

As a result of an understanding between the members of Euroforge, each national forging association undertook last year to study and report to other members on one specific project. The German Association studies forging materials specifications such as bars and billets and examines safety standards required in connection with the use of compressed air in the forging plants. The British Association conducts a study of heating methods. The Belgian Association covers shearing and cutting methods, Swedish studies die wear problems, while the French Association investigates reduction of die costs and dimensional specifications of the finished forgings.

Another successful joint Euroforge project was carried out in October 1967 when a group of 27 industrialists, representing steel forging industries in the United Kingdom, France, Germany, Sweden and Belgium visited Japan on a joint technical mission conducted with full cooperation of the Japanese Drop Forging Industry Association. Each national delegation subsequently published a report for the benefit of other drop forgers in their country.

4.0 CORPORATE RELATIONSHIP AND MARKETING

4.1 UNITED KINGDOM

A significant feature of the British drop forging market, in contrast to the other countries of Western Europe, is that the automotive manufacturers do not supply a major share of their own forging requirements from captive forging plants. In fact, the British automotive industry, dominated by five major manufacturing companies, — the British-owned British Leyland Motor Corporation and Rolls-Royce Ltd., and the American-owned Ford of Great Britain, Vauxhall Motors Ltd. (General Motors) and the Rootes Group (Chrysler), rely on the independent automotive component suppliers to a significantly higher degree than in any other highly industrialized country.

Consequently, the assurance of long-term, large-volume business in the main consuming markets of the drop-forging industry provided a strong incentive for such large British conglomerates as Guest, Keen and Nettlefolds (G.K.N.) to establish the most modern and highly productive drop-forging facilities, of which Garrington's Newton Works at Bromsgrove is a prime example.

Members of G.K.N. Forging group are:

Garringtons Ltd.

Smethwick Drop Forgings Ltd.

Forgings and Presswork Ltd.

Smith Clayton Forge Ltd.

Scottish Stamping & Engineering Co. Ltd.

Birfield Extrusions Ltd.

Precision Forgings Ltd.

It is estimated that G.K.N. Forging group supply up to 2/3 of the total British dropforging requirements, with Garrington's share estimated at about 25% of the total. The output of Bromsgrove plant is reported to be about 8800 long tons per month. In addition to supplying forging requirements of the five major British automotive companies, Garrington's ship about 10% of their production overseas. Their volume of forging business from the United States automotive producers is reported to be in excess of one million dollars annually.

Smethwick's Kidderminster Works, like Garringtons, concentrate heavily on automotive forgings, with 90% of their monthly output of 1,600 long tons being shipped to the British automotive industry. Exports from this plant are, as yet, negligible. G.K.N. international sales force solicits business for this and the other G.K.N. associate companies.

Firth-Derihon Stampings Ltd., an associate company of Firth Brown Ltd., with facilities to produce forgings from 8 oz. to 800 lbs., has a broader market base and a wider range of products, including super-alloy and non-ferrous forgings. Their own sales force of three sales representatives and two sales engineers solicit orders for drop-forgings destined to the passenger car industry (45% of the total) heavy automotive (25%), aircraft (10%) and general engineering (20%) industries. It is for the aircraft and general engineering requirements that aluminum, titanium and super-alloy forgings are made.

Bescot Drop Forgings Ltd. is even less dependent on the automotive industry, supplying only 12 to 15% of the plant's output to the automotive truck manufacturers, 15% to the mining industry and 30% to the agricultural implement and off-road equipment producers. The

balance of the production goes to the domestic general engineering trade, and a small percentage is exported to the Scandinavian countries and to North America.

The most widely diversified, in terms of market penetration, is Elliot Lucas Ltd. supplying 50% of their hand and edge tools to some 80 countries and territories, with the balance being sold in the British domestic market through a network of distributors. The export business is handled by their own marketing agents T.E. Elliott Overseas Ltd. with warehousing facilities in many countries.

It is notable that the other British hand tool producer visited, the Staffordshire Edge Tool Co., does not rely on export market to any significant extent.

British open die forging plants visited by the Mission are parts of large integrated steel producers selling their products throughout the world, using their own sales forces as well as local agents. English Steel Forge and Engineering Corp. Ltd., being part of the Middland group of the state-owned British Steel Corp., supplies large solid and hollow forgings up to 175 long tons in weight on a world-wide basis. Their extensive forging shop, including 9,600 ton hydraulic forging press, and large, sophisticated machining facilities enable them to compete for orders on large ship's crankshafts and rudder shafts, components for power generating stations, for heavy industrial plants, etc., which only a few companies can supply.

The drop-forging department of the English Steel Corporation sells 78% of its products to the automotive industry, with additional 4.0% being exported. The balance of the plant's output goes to the aircraft and general engineering industries (landing gears, turbine blades, shafts, etc.) and a small percentage of precision forgings in super-alloys to the British Atomic Energy plants.

Firth Brown Ltd. Atlas Works in Sheffield, a subsidiary of Thomas Firth and John Brown Ltd., produce approximately 55,000 long tons of solid and hollow forgings annually on hydraulic presses ranging from 600 to 6,000 m. tons capacity. The company's marketing is conducted mainly by their own direct sales force. Hollow forgings can be produced up to a maximum forged outside diametre of 13 ft. 6 in. Typical applications range from large hollow drums for power station boilers, pressure vessels for chemical industries to large solid gas turbine rotors and heavy marine forgings.

4.2 GERMANY

In Germany, the dependence of the drop forging firms on the automotive industry is significantly lower than in the United Kingdom. While independent German drop-forgers supply approximately 60% of their output to the automotive firms, in the United Kingdom this figure is as high as 75%.

Of the six drop-forging plants visited by the Mission, the Bochum Works of Friedrich Krupp Huttenwerke A.G. is the largest in Germany, being capable of producing parts ranging in weight from 2 lbs. to 1,500 lbs. Equipped with numerous hammers and presses in a wide range of sizes up to 6,000 tons capacity, and relying on corporate expertise for the supply of many grades of carbon and alloy steels, this plant ships over 3,500 m. tons of forged products per month. About 8% of this output represents direct exports. The products include huge crankshafts, camshafts and connecting rods for large Diesel engines, gearwheels and pinions for general engineering applications, front and rear axles, wheel drums, parts for heavy trucks, valve bodies, rings, discs and a multitude of other components for the automotive, railway, shipbuilding, construction and heavy engineering industries.

All products of Krupp's diversified divisions are sold through the corporate sales force. Many closed-die and open-die forgings find their way into the export markets as components in the machinery and equipment as well as in the various makes of German cars shipped throughout the world.



Members of the Canadian Forging Industry Mission with the corporate management of the Fried Krupp Huttenwerke A.G.

The other five drop-forging plants visited in Germany varied from the captive automotive drop-forging plant of Daimler-Benz in Stuttgart to specialty tool producers supplying a variety of industries.

C.A. Schlemper Company markets 80% of its 700 m. tons monthly output to the automotive truck manufacturers and the balance to the general engineering trade with very little direct exports. Twenty percent of their customers account for 80% of the business. The company relies heavily on agents, rather than on their own sales force.

Essentially the same product mix exists at Stahlwerke Bruninghaus, GmbH. for its 2,000 m. tons monthly output. Such heavy automotive components as wheel hubs for trucks, crankshafts and connecting rods appear to account for a very significant proportion of their total husiness.

Belzer Werke in Wuppertal, originally established as a wholesale distributor of hand tools, now produces some 30,000 different items in the higher priced, specialized tool lines used in the assembly and maintenance of aircraft, automobiles, machine tools, etc. Of these, some 7,000 are made as stock items and sold through wholesalers and agents on an exclusive basis. Their own wholesale distribution outlets in Germany and abroad account for up to 25% of the total sales. Export sales of approximately 40% of the total production led to the establishment of two subsidiary plants: one near Belfast, Ireland and the other in Sao Paulo, Brazil, thus helping to overcome high import duty levels in the respective market areas.

From their two plants in Solingen, Walter Gott Company supplies the domestic market for automotive, agricultural implement and construction equipment components as well as what appears to be a low-priced hand and edge tool line, sold mainly through agents. This family owned business relies on exports for up to 18% of their hand tool production. Domestic automotive accounts, such as Volkswagen, and the agricultural equipment manufacturers are served by company's own sales force.

Heuer-Hammer, a relatively small private firm owned and operated by three brothers, specialize in crane hooks with lifting capacities from 5 to 250 m. tons and lift truck forks, both produced on open die hammers. The ingenuity of the partners and the availability of adequate machine shop facilities led to the broadening of company's product line to include a special cable gripping device used for mine elevator cars.

Another company's product is a cold heading machine capable of producing machine screws and small bolts from two to ten millimeters in diameter. In view of the specialized nature of their products, sales in Western Europe are handled by their own sales force and elsewhere through agents.

4.3 ITALY

A limited exposure of this Mission to the drop-forging industry in Italy does not permit a broader evaluation of the marketing trends in this country. Of the three plants toured, two are engaged mainly in open-die forging, while the third, one of the SKF nine operating plants in Italy, specialize in the production of bearings. SKF is owned by the Swedish firm Aktiebolaget Svenska Kullanerfabriken, operating some 58 plants in 13 countries and generating over \$700 million in sales. Over one third of SKF products is sold to the automotive industry, with FIAT being the largest customer, followed by Volkswagen, Vauxhall and Volvo. The SKF Villar Perosa plant produces about 80,000 bearings daily, a majority of which is destined for FIAT,

while 8 to 10 percent is exported. SKF corporate sales force handles all sales and marketing activities.

Italsider's Lovere Works, one of 10 plants owned by this large Italian integrated steel producer, is equipped to manufacture steel forgings in any shape weighing up to 30 tons, in rough or machined conditions. Its open-die facilities produce shafts, rudder stock, piston rods and connecting rods for the shipbuilding industry, carbon and non-magnetic steel rotor and turbine shafts for the hydro-electric power plants, high alloy steel rolls and other components for the heavy equipment industry, drive shafts, axles and various truck and trailer components as well as a great variety of other open-die and drop-forged products. A significant tonnage is accounted for by the railway rolling stock including solid car wheels (approximately 1000 per day), finished axles (approximately 300 per day), rolled wheel centers and rims for the domestic railways and for export (about 50%).

Italsider's marketing organization maintains offices in eight large Italian cities, while the foreign business is handled by their export agency Siderexport with headquarters in Genoa. The corporation operates several subsidiary and associate companies, such as Cosider, which specializes in the design and construction of industrial plants. This arrangement, undoubtedly, assists in increasing the demand for Italsider's forged products.

The second open-die forging plant visited by the Mission, Carlo Raimondi & Co. near Milan, is a relatively small size, family-owned firm, melting their own steel in a 35 m. tons electric furnace. The company specializes in forged and cast valves, flanges, and fittings for the petroleum and gas industries throughout the world, with direct exports representing about 35% of sales. Valves up to 2 in. are forged and above 2 in. diameter are cast in their own foundry in cast iron, stainless steel and non-ferrous alloys. In addition to their own sales force, distributors with warehousing facilities are used and the company's products find their way into most parts of the world as components in pipelines, oil and gas storage facilities, water pumping stations, etc.

4.4 FRANCE

The Billancourt plant is one of the two captive forging facilities operated by Renault to produce their own and Peugot's forged automotive components. With the output of up to 2,500 m. tons of forgings monthly, Renault's operations are a good example of a very pronounced trend towards self-sufficiency in the French automotive industry with respect to the supply of steel forgings. While a few years ago the independent forging firms supplied approximately 42% of the automotive industry requirements, now this proportion has been reduced to 27%. Corporate ties between the automotive producers, such as Renault and Peugot, encourage rationalization of their operations by decreasing or eliminating any duplication of facilities and supplying all requirements for specific components from the same captive source. These developments leave the future of the independent French forging firms in doubt.

Forgevis, a subsidiary of Simca-Chrysler, is another outstanding example of the trend outlined above. Operating two forging plants at Sully-sur-Loire and one at Vieux-Conde, the company is well equipped to supply forgings from 4 oz. to 55 lbs. in weight for diverse applications. Some of their typical products are: crankshafts, connecting rods, rocker arms, rear axle, gear box and transmission parts, wheel hubs for cars, tractors and trucks, railway car suspension parts, track links, conveyor links and many types of forged gears produced under

licence by a patented process developed in Germany (Bayerische Leichmetall Werke, Munich). While up to 70% of their 30,000 m. ton annual output is shipped to Simca, the balance is divided between Massey-Ferguson, International Harvester, FIAT in Italy, Chrysler in Detroit and other export markets. Sales and marketing activities are in the hands of Simca-Chrysler corporate sales force.

The two Bar-Lorforge plants visited by the Mission are forging divisions of an integrated steel producer, Societe des Acieres de Pompey, who accounts for less than 2% of the French steel output.

The Bar-sur-Aube plant, concentrating on the production of drop-forgings of various metals and alloys for the aircraft, petro-chemical, railway, farm implement and defence industries, consumes about 500 m. tons of raw materials monthly, including steel, aluminum and non-ferrous alloys.

The Custines plant consists of an open die forging shop with monthly production of 900 m. tons and a drop-forging shop with an output of 1500 m. tons per month mainly for the automotive and agricultural implement industry.

With a capacity of 35,000 m. tons annually in drop-forged and open die forged products, this company ranks among the largest French suppliers, selling directly through their own sales force.

4.5 SPAIN

The Spanish forging industry appears to be making good progress in narrowing the technological gap which existed in the past by adopting manufacturing methods and product standards developed in the more industrially advanced countries of Western Europe. Independent forgers are faced with a need to make heavy capital investment, regardless of the fluctuation and uncertainty of business, in order to keep a fair share of the domestic market from captive forging plants. While low labour rates place Spanish forgers in an advantageous competitive position, lack of skilled tradesmen and of technical personnel and shortage of investment capital hinder the development of the industry.

Of the two plants visited by a member of this Mission, Patricio Echeveria S.A. is an integrated steel mill with arc melting and induction melting furnaces producing carbon, alloy and specialty steels and supplying forged parts for the automotive, machinery, aviation, mining and other applications. Their hand tool line, including hammers, files and rasps, is supplemented by garden tools such as spades, shovels, plough shears and discs. The company relies on its own sales staff and on distributors to market its products.

The other, much smaller firm, Irimo S.A. is a manufacturer of mechanics' hand tools, such as wrenches, slip joint pliers, centre punches and sockets. With good quality products and low wage scales, the company is competing in domestic and export markets.

5.0 THE FORGING PLANTS

5.1 BUILDINGS

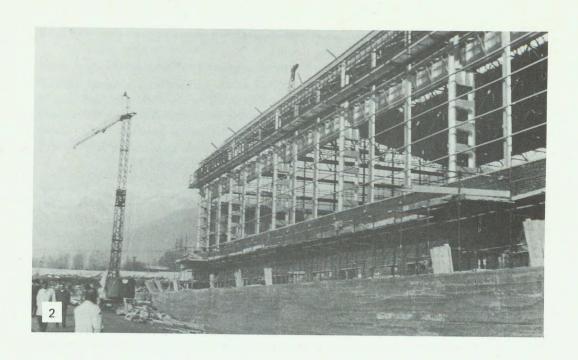
The general appearance of the forging plants visited by this Mission ranged from new, modern brick-enclosed or steel-siding type buildings to old, partially deteriorated structures housing a conglomeration of old-fashioned equipment. Large progressive independent companies, the forge shops of the large stèel makers and the captive shops of the automotive producers maintained their plants in a good physical condition and their housekeeping level was good. Some of the other plants visited did not meet the normally expected standards of maintenance and repair.

A good example of a modern, brick-enclosed forge shop under construction is illustrated in Photos 2 and 3.

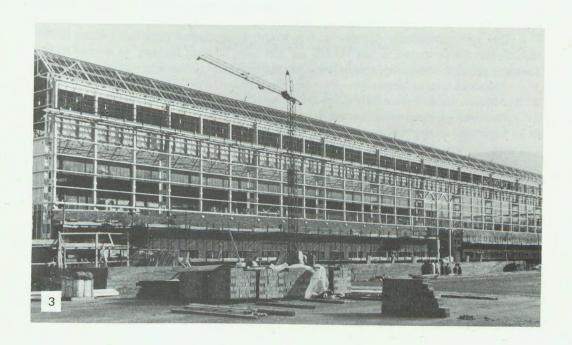
5.2 WORKING CONDITIONS

The variation in the quality of forge shop buildings inevitably was reflected in the working conditions. The better quality plants provided adequate lighting, cooling and ventilation. The older shops, however, did not appear to be concerned with these factors and provided only a minimum of service to their employees.

The most striking difference noted in the European forging plants in comparison with the North American standards was a general absence of protective equipment, such as safety helmets, vizors and goggles. Even on the most hazardous operations, such as that of a hammerman or a pressman, no safety vizors or protective face masks were worn. It would appear that the wearing of adequate safety clothing and protective equipment was not as yet accepted as an integral part of the employment conditions in the forging plants.



New forge shop being built at RIV-SKF in Villa Perosa, Italy.



6.0 HEATING AND TRIMMING FACILITIES

The Mission observed many types of heating methods adapted for a particular requirement of a given plant. The choice of the method depends on the availability and cost of electricity or fuel (gas or oil), the required rate of heating, usually determined by the capacity and desired productivity of the forging equipment, and the capital investment cost. Consequently, a method which may be extensively used in one plant, may not be economically justified for a plant in another location producing a different line of products.

6.1 INDUCTION HEATING

Induction heating methods were used in 7 out of 25 plants visited, including four in England, one in Germany, one in Italy and one in France. In one of the British plants the entire induction heating system was of their own design and manufacture.

6.1.1. Type of Equipment

- a) "Birwelco" (with A.E.I. Generator), manufactured by Birwelco Limited, a subsidiary of G.K.N. Engineering Limited, Newport, Monmouthshire, England;
- b) "A.E.C. Elotherm", employing a "walking beam" transfer principle through the coil, which appeared to be very effective;
- c) "A.S.E.A.", Sweden, (manufactured by Allmanna Svenska Elecktriska Aktiebolaget). The first two were the most commonly used types.

The Elotherm unit employs a "walking beam" transfer through the coil which appeared very effective. After ejection of the heated slug the transfer system reversed in order to take the next slug back into the coil thus avoiding a cold end.

One cost comparison available from a British plant quoted induction heating at 70s (\$9.25) per ton compared to 35s (\$4.60) per ton using oil fired furnaces. In spite of higher operating costs, the following benefits were quoted:

- 1. Reduction in scale formation
- 2. Reduction in downtime (downtime of only one percent on induction heating)
- 3. Improved working and housekeeping conditions
- Significant increase in heating rates.

6.1.2 Rate of Heating

Several plants quoted heating rates at about 5 lbs per kwh. One British plant stated that their new Birwelco models will be capable of heating 6.8 to 7 lbs. of steel per kwh., which is a higher rate than generally attainable. One plant in Italy quoted a heating rate of 3 kilos per kwh., equivalent to approximately 6.6 lbs. per kwh.

Induction heating coils were generally imbedded in a refractory cement. Slugs were transported through the coils either by pushing along water cooled rails or by using popular walking beam units manufactured by A.E.C. Elotherm. In this case the slugs were walked through the coil and the leading slug released. Then the transfer unit reversed itself to walk the slugs back one step, thus eliminating the possibility of a cold end on the next slug. Helically-wound coils were made from high-conductivity copper tubing to permit water cooling.

6.1.3 Generator Rating Relative to Press Tonnage

The requirement to heat a given tonnage of steel in a given time determines the power requirement of the induction heating equipment. One drop forge plant in England established a standard of 400 kw capacity induction unit for presses up to 1800 tons. A 2500 ton press in this plant was equipped with a 600 kw unit. These figures appear to be typical of the induction equipment capacity observed in other plants.

6.1.4 Frequencies

The induction frequencies used ranged from 1000 cycles to 10,000 cycles. Some plants used equipment in several different frequencies depending upon the application. One plant in Italy had standardized on 1000 cycle equipment. One British plant had a very large dual frequency unit for heating slugs for crankshafts. The unit utilized a 50 cycle pre-heat, followed by a 1500 cycle unit. This was also the only induction unit used for heating material to be subsequently forged on a hammer.

6.1.5 Methods of Feeding

Generally, the induction units were normally fed from the back of the coil. However, several novel methods of automating this operation were observed. One method involved elevating the slugs to the induction unit by means of a vibrating spiral feeder, thus eliminating the need for an operator. Slugs were dumped into the main bowl of the feeder from a skid, vibrated up to the required height, then fed down a gravity chute into the coil.

Another method was to elevate the slugs from the skid by means of an electro-magnet on a hoist. The slugs were deposited in a hopper and fed into the coil by a vibrating feeder.

In several plants the induction heating equipment was elevated to allow gravity feeding of hot slugs to the rolls and presses.

6.2 ELECTRIC RESISTANCE HEATING

Electric resistance heating was used only on a limited basis. Higher heating costs by this method limit its application only to those cases where very high productivity is desired.

An outstanding example of resistance heating application was observed at Garrington's Bromsgrove plant where a Birwelco resistance heating equipment supplied hot bars to the Hatebur 1201 Automatic Forging machine. Capable of heating steel bars from 1 9/16 in. to 2 3/8 in. in diameter in less than a minute, this equipment operated in conjunction with a radiant tube holding furnace.

Another application was seen in the Daimler-Benz plant in Stuttgart where a friction screw forging press was operated together with two resistance gathering machines. A ball was upset on the end of the bar and then finished forged on the press.

Birwelco reportedly favour induction heating over resistance heating, although the induction system is more capital expensive than the direct resistance type. This disadvantage is offset by the fact that the resistance system is said to be limited to the current input of 280 kwh per ton as compared to 380 to 400 kwh per ton for induction heating. Direct resistance heating also places high intermittent peak loads on the electrical supply system and frequently requires a radiation-type holding furnace to equalize temperature variations if the full length of a bar is to be heated.

It is also reported that the maintenance costs of a resistance heater are higher, partially because of rapid rate of wear on the resistance contacts, necessitating frequent stoppages for inspection and replacement.

6.3 CONVENTIONAL OIL OR GAS HEATING

A common method of steel heating was in conventional manually-loaded pusher type furnaces, which were either oil or gas fired. Some were activated by hand-cranking, while others were motorized. Furnaces of various shapes and sizes were in commercial production depending on application, with the smaller ones used where pre-shaped slugs for hand tools were being heated for forging. One slot-type furnace employed top level loading with billets rolling to the heating area where they were unloaded by hand.

Pot type furnaces with molten lead were utilized to heat aluminum slugs for forging.

In some instances gas fired furnaces with multi-holed fronts were observed, permitting bars to be heated individually only at the ends for upsetting purposes.

With regard to operating cost, one plant using manufactured gas quoted variations in the cost factor from \$5.00 to \$15.00 per ton relative to the weight of forgings, which varied from 5 lbs. to 2000 lbs. each.

In several plants visited, future plans involved converting to natural gas when it became available.

Gas or oil-fired rotary type furnaces were quite common throughout Europe. These furnaces are so constructed that their output can be gravity fed or conveyed to the auxiliary units prior to final forging. Unloading of billets by water-cooled tongs were observed in some shops. In Germany, an unusual type of rotary furnace was in operation consisting of four individual slot furnaces mounted on a rotating table. While one slot furnace was being unloaded, the preceding empty ones were being loaded. In many instances furnaces were temperature controlled. Furnaces employing automatic ejectors were also observed, but in most cases the loading and unloading was manual.

6.4 TRIMMING PRESSES

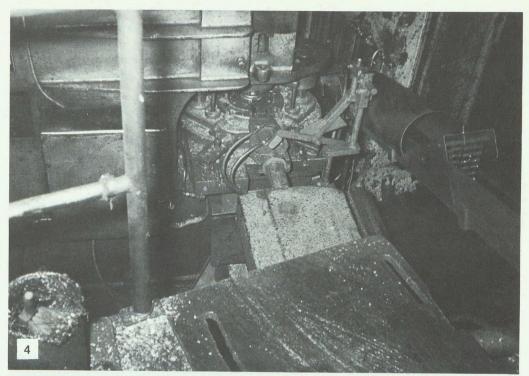
Trimming presses were often used for purposes other than trimming, for example for rounding square billets, pancaking steel, descaling billets and pre-shaping. Wide-frame presses were in operation, such as Wilkins & Mitchell*, which are comparable to the Canadian-manufactured Warco, Bliss and Minster. These types of presses can be used to perform a number of operations such as sizing, padding, trimming and punching.

In most cases conveyors were used to supply the presses and to remove the forgings and flashings. One highly productive unit was seen where the flashings were ejected by means of air-jets.

Trimmers were saw cut and welded with Stellite or comparable materials. Some split trimmers were used in cases where the opening was insufficient to receive the forging permitting the trimmer to make a complete forward and reverse movement.

In summary, the presses observed were in most cases similar to those used in Canada and the working procedures were almost identical.

 Wilkins & Mitchell Limited, Darlaston, Staff., England.



Trim press automatic unloader, capable of gripping a trimmed flash with forging on top, withdrawing it from the press, rotating 180° and knocking the forging free with the flash dropped in a separate chute.

7.0 DIE MANUFACTURE

7.1 MATERIALS

7.1.1 Die Blocks

Die blocks were referred to as #5 die steel and were of the familiar Ni-Cr-Mo composition known in Canada as Atlas Steels' XLO, Crucibles' Crudi, or Vanadium Alloys' Vasco.

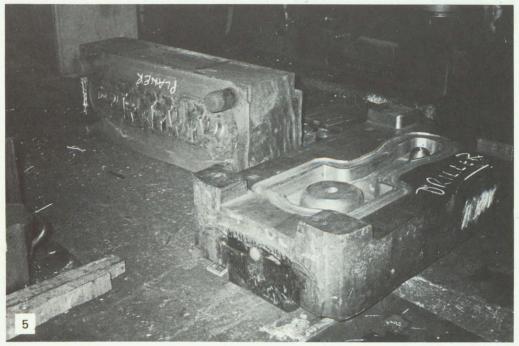
Die blocks were normally bought in the pretreated hardness ranges from 1 to 3. The #1 hardness running from Rockwell C 41 to 45 and used for shallow impression dies. The #2 from 36 to 40 Rockwell C used for the majority of the impressions. The #3 from 32 to 35 Rockwell C used for the larger impressions and for holding dies for inserts.

An exception to using pretreated blocks was Stanley Works in England, where dies were purchased in the annealed state and machined and then heat-treated to Rockwell C 45.

Stanley Works of course produced mostly shallow impression forgings in the hand tool line.

Fried Krupp Works in Bochum, Germany made their own die steels and produced dies for the general trade as well. For their own dies #5 die steel was used, excluding Ni content. This was done to improve the weldability of the blocks, used for the manufacture of very large forgings in order to facilitate repair by welding.

A typical large drop hammer die block is shown in Photo 5.



Drop hammer forging die blocks at English Steel. Rear die has guide pins which are being discontinued because of safety reasons, in favour of machined corner locks seen on front die.

7.1.2 Inserts

Material for inserts, both in presses and hammers varied from company to company, anywhere from a 5% Cr to a 11-12% Cr steel; with one company — English Steel in Sheffield, England, using a high nickel content nitriding steel.

The high carbon, high chrome materials were either quenched by air or oil and tempered to Rockwell C 48-52.

Cast to size dies, made by the Shaw process, were being used experimentally in some of the plants visited. One German plant made a steering knuckle with cast dies successfully, obtaining a life of 15,000 to 20,000 forgings as against 12,000 forgings from #5 die steel.

7.1.3 Trim Dies

Material for cold trim dies ran the complete range from carbon tool steel — water quenched — through oil quenched tool steel — to the high carbon, high chrome steels either — oil or air quenched.

Hot trim dies were used more extensively throughout those plants visited and these were generally made from a mild steel base with a welded cutting edge using predominantly Stellite Alloy C or Hastaloy welding rods.

7.1.4 Piercers

Material for piercing ranged from water quenched high carbon steel to high carbon, high chrome alloys, oil or air quenched.

The straight carbon water quenched steels were being used on simple cold piercing jobs while the high carbon, high chrome were used on the more difficult cold piercing work and also on hot work. These were also being repaired with a Hastaloy weld.

7.1.5 Cold Forging Dies and Punches

The information obtained on cold forging die materials is limited. One French firm employed #Z200 C12 AFNOR (equivalent to AISI-D4) for cold forging dies and #Z80 WDV AFNOR (similar to AISI-T1) for cold forging punch.

7.1.6 Reducer Rolls

Rolls were made from EN 8 material. This is a .4% carbon steel giving a life of approximately 100,000 pcs. Blanks are supplied as forged rings.

7.2 DIE IMPRESSIONS

7.2.1 Milling

It is estimated that 75% of the dies seen in plants visited by this Mission were sunk by conventional milling.

Some impression work was done on plain vertical mills without tracer equipment and a couple of Pratt and Whitney Die sinkers with oscillating heads were observed.

By far the majority of milling machines were equipped with 180° depth control. In England most of these machines were Cincinnatti Hydrotels, with the shops doing small work using the small Cincinnatti Toolmasters with 180° depth control. Plants doing large work had both large Hydrotels and Kellers.

The Swiss machine "Rigid" was seen in England and a few of these had a mirror image copying feature so that both left and righthand impressions could be made from the same master.

Generally, the same single spindle machines were used in a number of German plants. One seen in Germany made by Nasovia had 2 spindles — one either side of a centre tracer, which was hand guided and three dimensional. Other Nasovia machines seen in Germany were all single spindle, the majority having 180° depth control and automatic pick feed.

Droop and Rhein single spindle machines with 180° tracer and automatic pick feed were also used where larger dies were being made. In larger shops, where several of these automatic machines were used, two or more machines would be controlled by the same operator.

In one German plant five "Rigid" single spindle automatics were operated by two men.

German and French shops doing small work commonly used K12 Dekels for sinking die impressions.

One of the Italian plants visited did not make their own dies, while the second was a very large open die shop making railway axles and wheels. Closed impression dies for wheels were made on boring mills because of the large size.

The third Italian plant specialized in round work — inner and outer bearing rings — and their impressions were all cut on lathes, the larger ones on cross bed lathes. This type of lathe was used on round work in the larger plants in England and Germany as well.

7.2.2 Electrical Discharge Machining

In the plants visited by this Mission approximately 20% of die impressions were sunk by EDM.

In England, machines were Erodomatic made by A.C. Wickman and a Swiss machine called Agitron, both using graphite electrodes. These were produced on single spindle pantograph-type equipment.

In Germany, a producer of hand tools and automotive forgings in the smaller sizes, Walter Gott (Photo 6 & 7) in Solingen, has been using 3 AEG Elotherm EDM machines for the past 10





Electro-discharge machining operations at Walter Gott Co. in Germany.

Side view of a hobb and a hobbing press used to finish a die impression, roughed out by electro discharge machining, in a plier forging die block at Walter Gott Co. in Germany.

years. Forged copper electrodes are used to rough the impressions, which are finished by cold hobbing on a Sack & Kiesselbach hydraulic 315 ton capacity hobbing press.

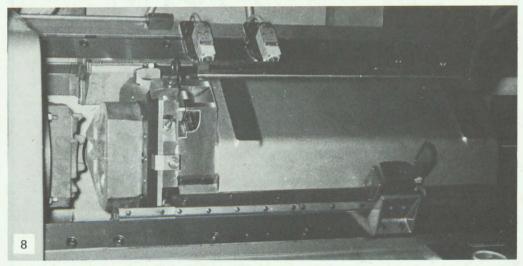
Another large user of EDM equipment in Germany was the Daimler-Benz plant in Stuttgart, with 5 machines - 3 Nasovia, 2 Charmilles. These used copper electrodes made by casting and cold coining to size on a 315 ton Sack & Kiesselbach hydraulic hobbing press.

The Renault Plant in Paris, France was doing all impression work by EDM and ECM. Five EDM machines were in use at Renault, 4 Languepin and 1 U.S.E.M./SA. This is Russian equipment built under license in France. Graphite electrodes were used on all machines.

Renault was the only company visited by the Mission which had an ECM machine. This was an American Anocut producing punches for a cold forging job, using a copper electrode and a sodium nitrate electrolyte. Dimensional tolerance of 0.0008 in. was reportedly held on this part.

Another plant operating EDM equipment was Forgevis, at Sully-sur-Loire, France, with two of the Russian U.S.E.M. machines. The most interesting was a U.S.E.M. machine for producing electrodes by a vibratory process. (Photo 8.) This was the only machine of this type seen by the Mission. A master required to produce finishing electrodes was made by milling or EDM. When made by milling it was finished by EDM to give a rough texture which acts as the cutting surface to form the electrode. All flat surfaces of the master are cross-hatched to form sharp points on approximately 3/32 in. centres. This acts as the cutting surface to remove the graphite from the parting surface of the electrode. The machine resembles a lathe in that the master is held in the longitudinal axis in the head stock on the operator's left. This head stock imparts an oscillating movement to the master while the graphite blank is held in a sliding member or carriage which advances toward the master.

This assembly is covered and provided with an exhaust to remove the graphite dust during the work cycle. Masters are made with 1 mm. allowance per side to allow for oscillation, and fed into the blank at approximately 1 mm. per minute. Amplitude of oscillations is variable.



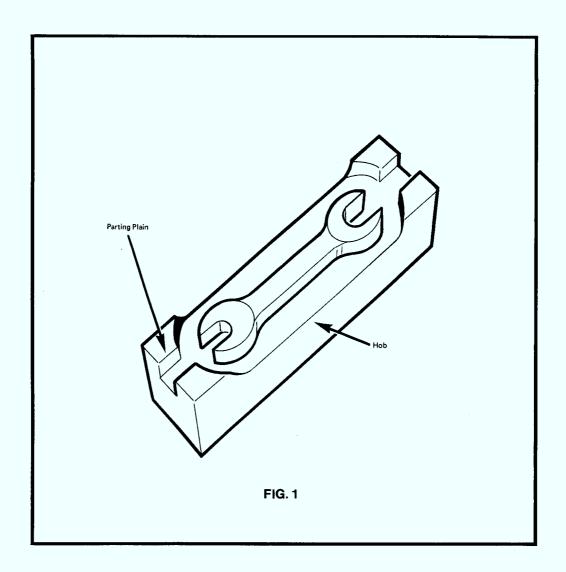
Recently installed at Forgevis in France a French manufactured, (U.S.E.M.) Russian designed machine for machining carbon electrodes used in electrical discharge machines. Female tool at right, with a finish similar to a coarse file, is advanced onto the oscillating graphite at left and cuts the electrode pattern similar to a filing action.

7.2.3 Hobbing

Abbey Drop Forgings, Churchbridge Works, specialize in small tools, pliers and open-end wrenches, requiring all shallow impression dies. A unique method of hot hobbing is used.

Impressions are hot-hobbed into 5% chrome insert material on a 2500 lbs. hammer. Hobs are also made from the same 5% chrome material by tracing from masters on small Cincinnatti Toolmasters with 180° depth control. The hob is machined to give approximately ½ inch clearance beyond the parting plain, with the four corners left standing at the parting level so that after hobbing they can be used as register points when the top of the die is cut off.

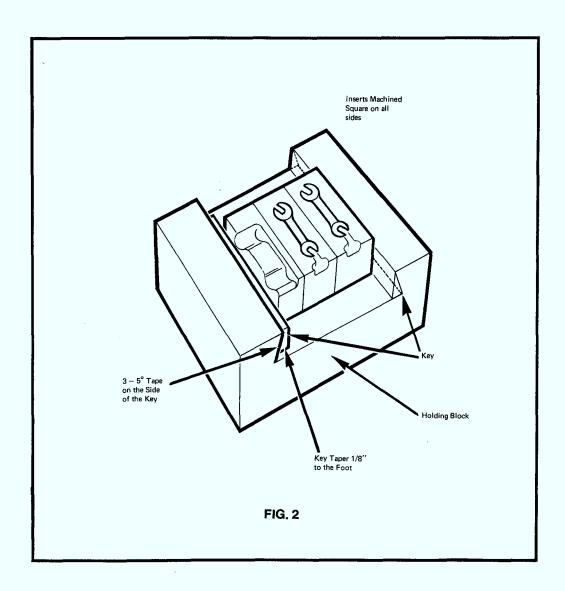
The die material is not contained in any way during the hobbing process, which is carried out at a normal forging temperature. (Fig. 1) The metal pulls away from the top of the impression all around the hob forming about 3/8 to 1/2 inch radius. This makes it necessary to



remove from 1/4 inch to 3/8 inch from the face to get back to a sharp impression at the parting line. The material for these inserts of course is made oversize to allow for this machining on the top face and also on the sides to allow for matching of one impression to the other.

This method of producing impressions also dictates that each impression will be in a separate insert so that if there is a blocker and finisher and edger there will be three inserts in the bottom and three in the top. (Fig. 2) These inserts are machined square with the only taper holding them down being on the key itself. Cardboard was used under the inserts and in some cases between them. As no dowels were in evidence the cardboard must also hold the dies from moving endways.

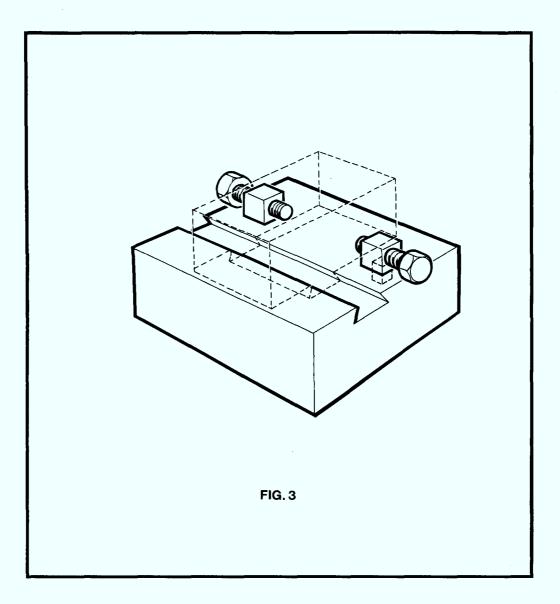
The only cold hobbing was observed at Walter Gott in Germany, where the impression had already been roughed out by EDM and was being finished by cold hobbing.



7.3 DIE DESIGN

7.3.1 Shanks and Dowels

In general, die shanks on solid blocks were similar in width and depth and angle to those used in Canada. Smethwick Drop Forgings in England employed a very narrow shank on the bottom die, this because of the method for holding dies in match endways. A large screw was used at each end of the die, threaded into a separate block which in turn was inserted into a slot milled into the sow block to allow enough metal for support around slots. The die notch was very narrow — approximately 5" wide — this allowed only 3 to 3½" for the shank width on the bottom die which was cleared on the bottom so dies would be certain to bear on wings. (Fig. 3)



The side dowel so common to our shops was only seen in one or two places. More common was a centre dowel, either rectangular or round. If it was round it was often in a rectangular slot in the die shank. Most of the dowels were found only in the top die in the majority of shops because they tend to use some method of dowelling or locking the dies themselves, to hold endways and often to hold sideways as well. On round work this was normally accomplished by leaving a shoulder of one inch to one and a half inches high all around the impression area. This method was also used on some small rectangular jobs where a round island was left standing to take the impressions. This requires a rather large die block for the size of the job being made.

Much more locking of dies to prevent mismatch was in evidence throughout Europe than can be found in Canada or the United States.

This is probably more necessary on the counter blow hammers used in these countries for the large type of work. There are two moving rams to guide, allowing twice the possibility for mismatch.

In one plant in England the normal die set with dowels that is conventionally used on forging presses was not being used.

All the members of the Mission were impressed by the absence of mismatch in any forgings examined throughout the tour.

7.3.2 Inserts

The use of die inserts in hammers is more widespread in Europe than in Canada. As an example, Smethwick Drop Forgings in England use inserts almost 100 percent in their hammers as well as presses.

On the hammer dies the holding die usually contained the edging and blocking impressions and only the finisher was inserted. Where the forging was small enough, blocker and finisher would be in the same insert.

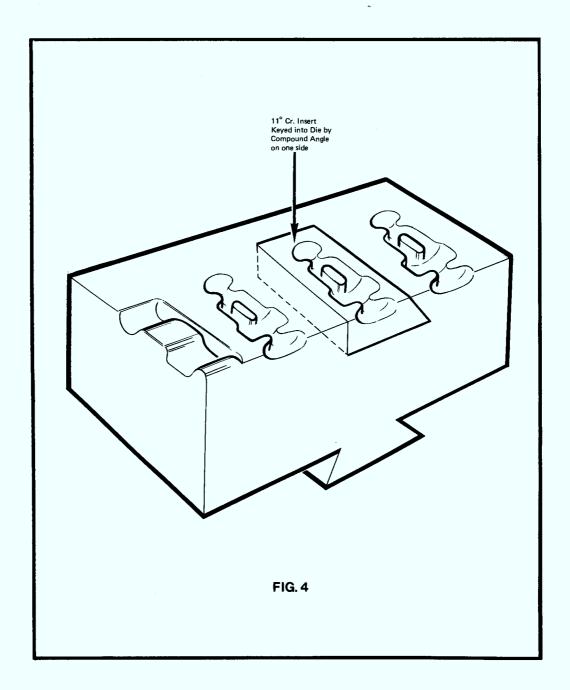
The inserts were held with a tapered key approximately 1/8" to the foot taper. Side angles on the insert were only 1°. A centre dowel was used to hold the inserts from moving endways.

At Stanley Works where nail hammers and ball pein hammers were being made with 3 impression dies the centre impression for finishing was inserted. This insert was made from 11% chromium steel. The pocket in the die for this insert did not go straight through the block but was dead-ended, and the insert was tapered and keyed itself into the block. (Fig. 4)

The largest inserts observed in hammer dies were at Stahlwerke Bruninghaus, Germany, where they were used on crankshaft dies. The die would normally be made solid and after wearing the finishing impression out it would be milled out and another finisher inserted. These were straight through inserts made with straight side walls and shrink-fitted to the holding die.

Another plant using the shrink-fitting technique for inserts in hammers was C.A. Schlemper, in Solingen, Germany. In this case the inserts were round and shrink-fitted to the holding die

In contrast to this, in another plant round inserts were fitted loosely and held with a round key with one flat side. The bottom of the insert had a mating flat, cut at an angle of 7 to 8° , while the key fitted into a hole drilled straight through the die block.

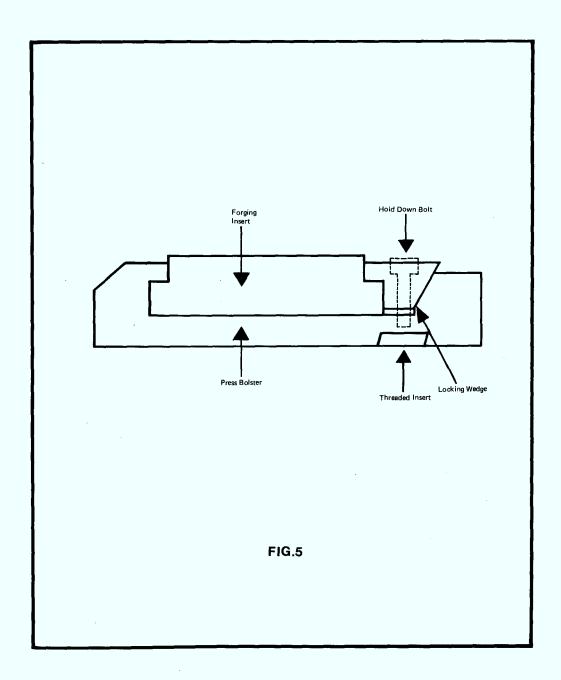


In France, Bar-Lorforge, at Custines, made much use of round inserts from 5-8" in diameter. These were held by force fit using a 1° taper. There were two 1%" holes through the holding die at each side of the insert recess where pins would be used to remove the inserts for replacement.

Most press shops using round inserts had backing plates made of H11 steel instead of the usual #5 die steel.

7.3.3 Press Inserts

Rectangular inserts at Forgevis in France were held by a ledge at each end for positive locating and locking in the press bolster, as shown in Fig. 5. Threaded inserts were used in the press bolster for the hold down bolts.



7.3.4 Trim Dies

Approximately 80% of forgings were hot trimmed. Trimming dies were made by conventional methods using shapers, vertical mills, band saws, and in some cases EDM. More solid (one piece) trimming dies were in use than is usual in Canada. This may be due to a more widespread use of EDM.

Multiple piece trimming dies were used more by the producers of hand tools and small parts which were trimmed cold.

Where weld was used for the cutting edge, the base material was roughed to shape and, after welding, either fitted by hand grinding or EDM. One plant was experimenting with a metallic spray for the trim die cutting edge.

The most notable difference between European cold trim dies and those used in Canada was the very narrow land on the cutting face. This extended only 3/32" from the cutting edge and top clearance was accomplished by milling or shaping a 15-20° angle from this land to the outside of the trim die material.

Invariably, multiple hot rimming dies were used where multiple forgings were being made. It was noted, however, that trimming was not always done in one stroke of the press, although the dies were of the multiple type. One job in particular was a nested connecting rod and the forgings each had their own impression, so that they could be trimmed independently.

Another interesting example involved trimming in the horizontal plain. In order to trim the flash from around the flange end of a long axle shaft it was placed horizontally into the press and a wedge on the ram moved the trim die horizontally toward the flange end of the shaft.

At Fried. Krupp Bochum Works, a sliding trim die was used where press head-room was not adequate for the job. This was a round forging with bosses extending both ways from the parting line making it awkward to place it under the press ram even if headroom was adequate. The trim die was slid manually toward the front of the press, loaded with this forging weighing approximately 100 lbs. then moved back under the ram of the press and trimmed; the trimmed forging falling through the press bed.

Another interesting trim and pierce combination was seen at Stahlwerke Bruninghaus, Werdohl, Germany; this was a gear blank about 5" in diameter being hot trimmed and pierced in one stroke of the press.

The piercer was fixed in the ram and passed through a floating combination punch and stripper.

The punch was guided by a sliding fit on the piercer, but its movement controlled by rods extending through the press bolster apparently with springs to hold the punch above the trim die.

In operation the forging would be placed on the trim die and the piercer would make first contact. This may have exerted enough pressure to trim the flash from the outside, but in case it did not the ram picked up the floating punch on the way down and trimmed the outer flash.

On the up-stroke the rods controlling the floating punch would hold it to strip the forging from the piercer.

7.3.5 Locking to Prevent Mismatch

While mention has already been made of the use of locked dies to prevent mismatch, this subject will be pursued further in this section.

This locking is necessary because of the construction of the European drop hammers. Side frames are fixed on the anvil and ram guide adjustment is made at the guides themselves. While this may allow for finer adjustment of running fit when everything is at running temperature, it does not allow for easy adjustment on cold startup. Consequently, hammers are probably run quite loose until they reach operating temperature. This would not be a problem on a three shift operation, which is not a common practice in Canada.

Several methods were used for locking the dies. On round work this was normally accomplished by leaving a shoulder of an inch to an inch and one-half all around the impression area.

This method was also used on small rectangular jobs where a round island was left standing to take the impressions. This practice requires a rather large die block for the size of the job.

Some very large dies were locked with two dowels at the back corners about 4'' in diameter — straight for 4'' — with about 1'' of taper to start them. Diameter clearance was claimed to be approximately .005 inches.

One plant using the round dowel method was gradually changing to four rectangles left standing at the corners of the die block to mate with recesses in the opposite die. This change was being made because of a serious accident occurring when one of the rund dowels dropped out of the die during operation.

In another shop where inserts were used the holding dies were locked by having a depression on each side of the insert notch with a projection on the mating die so that endways and sideways movements would both be restricted. (Fig. 6).

All of these methods depend on the use of much larger die blocks than would be required without locking, along with the extra machining time. The feasibility of the methods must be considered in the light of additional costs along with length of run, etc.

On large volume work it appears to have some advantage.

7.3.6 Further Comments

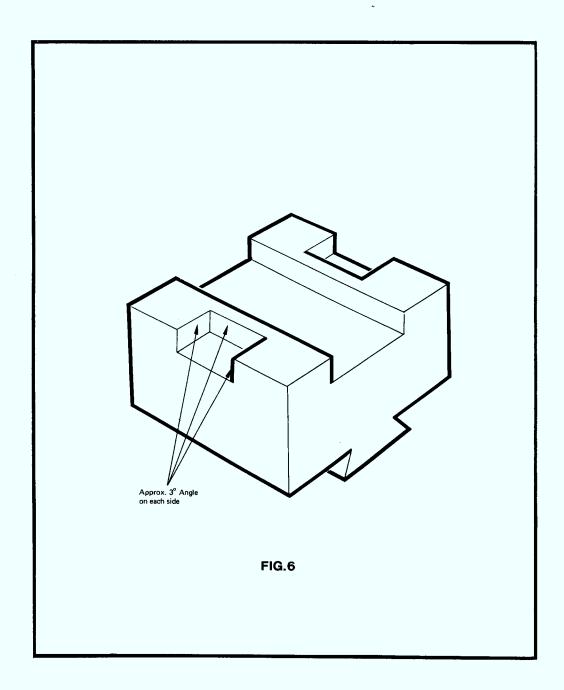
A very difficult forging was being made at Bescot Drop Forgings, in Wednesbury, England. This is a part for the universal joint of the Land Rover front drive. A split die technique was used. The part was forged to partial shape in conventional dies, trimmed and then forged again across the original parting plain.

The bottom die for the second operation was parted vertically and held together by a tapered recess in a large holding block. The top die or punch then formed the internal shape and filled the impression.

Another interesting job seen at Garrington's Bromsgrove plant was a rear axle shaft where stock had been gathered on an electrical resistance upsetter. The flanged end was being finished-forged in a friction screw press and, not having enough head-room for the long stem, the die was made so that it would tilt forward toward the operator while being loaded and then swung back under the ram of the press.

7.4 DIE LUBRICATION

Die lubrication methods observed by the Mission ranged from automatic die spray systems being used mostly on forging presses to a simple sawdust used on hammers.



Sawdust, however was found to be used more extensively than any of the other methods, and quite effectively so. Sawdust was used dry in some plants, dampened in others and just as it comes naturally by still others.

Some claimed it was used to prevent sticking, while others claimed it was used to prevent scale. In any case, the forgings seemed to come out of the die freely and scale did not appear to present a large problem.

Most of the shops using the sawdust method were on fairly large work and were not using a steady flow of low pressure air to blow scale such as is common in Canadian plants.

Most of the forging presses were using some form of spray equipment. Installations by Jaco and Graphoidal Developments were seen in several of the plants, while others used systems built to their own specifications. Some of these were of a travelling type that traversed between the dies spraying both top and bottom impressions at the end of each forging cycle.

At Daimler-Benz in Germany, a continuous spray was used on the top die only; runoff lubricating the bottom die. This firm was the only plant in Europe using "Molycote" lubricant for hammer dies. Generally, lubricants used in the spray equipment on forging presses included colloidal graphite and water, colloidal graphite and oil, and in several plants molybdenum disulphide ("Molycote") solution was used. Soluble oil was used on upsetters in one plant.

Garrington's, where much automatic spray equipment was in use, were gradually changing from graphite and water to a soda and salt solution.

Bonder-lubing was used for all cold forgings.

Some lubricants were applied to press and hammer dies by swab but in England the use of a willow stick to apply a light oil appeared to be more prevalent. This method appeared to minimize the amount of lubricant being applied at one time. Also, the willow stick could be allowed to be struck by the dies without undesirable consequences other than giving it a rather brush-like appearance at the end.

Bar-Lorforge in France employed a number of different lubricants in production of non-ferrous forgings, such as aluminum powder mixed with oil, sulphur and molybdenum disulphide and on most hammer jobs sulphur and oil.

There were no lubricants used in the plants producing shallow impression forgings such as hand tools.

7.5 DIE STORAGE

The most eleaborate facility for die storage was seen at the Daimler Benz plant, Stuttgart, Germany. Dies are stored on individual pallets in pigeon-hole type racks. A special die handler, made by Irwin Mehne of Heilbronn, runs on rails in the aisles between racks. The operator rides up and down with the platform of the handler equipped with forks which can lift a pallet from either side of the aisle. The operator then lowers the pallet with dies to a convenient height for transfer to a dolly or fork truck and moves to the end of the aisle where the transfer is made. When this machine moves to the end of the aisle rails, it can then be traversed at right angles on another set of tracks from aisle to aisle.

Another interesting die storage building was seen at Bar-Lorforge in France. The main point of interest here was that the support of the building itself were the die racks. These were made of 1½ in. pipe for vertical supports with 1 x 2 rectangular tubing used for horizontal members. The racks were made seven-high and dies were stored on individual pallets, handled by a hand-propelled hydraulic stacker. At the top of these racks a light truss work supported the roof and side walls which had translucent panels to admit light.

8.0 HAMMER FORGING

8.1 UNITED KINGDOM

The use of drop forging hammers in England is fairly extensive, with a large number of strap hammers in operation. Of the eight plants visited, four had their production built primarily around the strap hammer and two other plants had strap hammers as auxiliary equipment. One large company had converted 12 strap hammers (3000-5000 lb. capacity) to a single acting hydraulic operation ("Lasco")* but the remainder of the companies did not appear to have a program to update this equipment. In some plants, the larger hammers had chain links or rope pulls replacing the strap. Board drop hammers were in operation at one plant only.

The next most common type was the "C" frame ("Nasal") self-contained, double acting, air operated hammer. These hammers were primarily used for preforming billets prior to a hammer or press operation but in some cases were used to rough-forge simple cylindrical parts.

Two companies had old counterblow hammers, and although no new counterblow hammers were seen, there was one under construction at B & S Massey's plant. In discussion of this style of hammer, it was pointed out that it was doubly difficult to keep a forging on die because of the two travelling rams. However, the advantages mentioned are that the noise, vibration, and size of equipment are less than what would be expected in other styles of hammer to forge a comparable part.

The trend in new equipment appears to be toward the double acting hydraulic hammers and presses. On a visit to B & S Massey's plant, members of the Mission were favourably impressed with a demonstration of their "Hydrostamp". The hammer was very fast acting and had an easily adjustable power stroke.

The main supplier of hammers in the United Kingdom appears to be B & S Massey, although Chambersburg,** Erie,*** Lasco and Eumuco**** hammers were noted.

Garringtons Ltd. had the most modern plant in England with single and double acting air hammers from 3,000 to 20,000 pounds capacity.

Except for the hand tool forging production, almost all forgings were hot trimmed. All forgings were made from billets with very little descaling. Sawdust was used almost universally to prevent sticking or to blow the platter from the dies. The use of cardboard, asbestos or abrasive paper under the die blocks was not uncommon. One company used an insert for the finisher and resunk the finisher about three times before resinking the edger and the rougher.

Stanley Works (G.B.) Ltd. has the distinction of subordinating their forging plant to the requirements of their finishing operation. This is a relatively small forging operation with four 1100 lbs. air operated hammers producing as required by the finishing operation, with no stock of forged parts.

*Manufactured by: Langenstein & Schemann A.G. Machinenfabrik 8630 Coburg/BAY Germany.

- ** Chambersburg Engineering Co., Chambersburg, Pa., 17201 U.S.A.
- *** Erie Foundry Co., Erie, Pa., 16512 U.S.A.
- **** Eumuco A.G. Fur Machinenbau, 509 Leverkusen, Germany.

8.2 GERMANY

The forging industry in Germany appears capable and aggressive and overall was the most impressive of any of the countries visited. It is also the location of two of the main suppliers of forging equipment "Lasco" and "Eumuco" and, therefore, is well abreast of developments in new forging equipment.

The use of strap hammers in the shops producing small forgings is still prevalent, but new equipment such as hydraulic hammers of the "Lasco" and "Eumuco" types were seen. Some heavy counterblow hammers are still in use. The Mission saw two installations of a "Lasco" combination hydraulic press and hammer which could handle heavy or complex work quite easily.

One of the installations of the combination hydraulic press and hammer was at C.A. Schlemper. They produce axle shafts and similar hollow shapes on this equipment in diameters up to 8 in. and lengths up to 30 in. This machine had a hammer capacity of 18 tons and a press capacity of 630 tons. The Mission observed the production of an axle shaft about 24 in. long and 6 in. in diameter at the flanged end. The part was first preformed by extruding the shaft in the press cycle, and then using the hammer cycles. This was a programmed operation with the part being ejected automatically with an air jet after completion. At Daimler-Benz a similar machine was making a similar part in four stages on a 22 second cycle.

Daimler-Benz was the only plant in Western Europe to forge off the bar on their small hammers. In one hammer operation they were forging 4 in. gear blanks, 2 to a platter, from 1-1/8 in. round without any preforming.

Descaling was accomplished at Daimler-Benz by operating a relatively high speed narrow conveyor between the furnace and the hammer with about 18 in. high drop at the discharge end of the conveyor. This system seemed to be effective.

The hand tool producing companies, operating with contour cropped steel sheet blanks, descaled by running the heated blanks between two stationary wire brushes prior to forging.

8.3 ITALY

R.I.V.—S.K.F. plant in Villa Perosa near Turin used primarily forging presses, although they were making large rough cylindrical forgings on a "Kreuser-Wagner" steam hammer of rather unusual leg design. Another "Wagner" hammer was on order for their new plant and this was the only evidence of this manufacturers' equipment in Europe.

C. Raimondi & Co.'s forge shop was not of prime importance in their operation, as they only forged valve bodies up to 2 in. in pipe size. They preformed on "Nasal" air hammers and threw the part up to 30 feet for finish forging on double acting air hammers. Although this was a reasonably effective method of descaling, it appeared to be a time consuming and a tedious function.

8.4 FRANCE

In France, the Mission visited two captive automotive forging plants, Renault and Forgevis (Simca), and two general forge shops operated by Bar-Lorforge.

In the Renault plant located in Paris, the hammer operation was about to be phased out in favour of presses because of the noise factor. Each of the four 4,000 lbs. steam hammers was

operated by a crew consisting of a heater, two hammermen and a hot trimmer. The crew operated at a fast pace, but closed down at the end of each heat while the heater batch-loaded the furnace. Two furnaces were usually employed to reduce the waiting time. This type of heating operation was the only one noticed by the Mission as most other plants had a continuous furnace loading of some description. Ear muffs were used by the hammermen and this plant was the only one where ear protection was noted.

At Forgevis, the forging operation is entirely on presses. One 1,500 pound Erie board hammer was located in the shop but was not in operation.

Bar-Lorforge plant at Bar-sur-Aube is basically a small-run general forge shop, although substantial quantities of motorcycle connecting rods and crankshafts were produced.

Forging equipment consisted of nine screw presses, eight 1,000 lbs. to 10,000 lbs. strap hammers and three board drop hammers. On one hammer they were forging a lever from ¾ in. round by 6 in. long billet and the operator laid it loose in the edger and forged a small tong hold for use in the finishing die.

Square billets were used in a number of hammer operations, being heated in a rotary furnace, followed by rounding the corners in a light screw press, forging in a hammer and hot trimming. In producing an 8½ pound steering knuckle on a 3,000 pound Erie hammer the rate of output was about 240 parts per hour using a four man crew with this method of operation.

In producing a 50 pound wheel on a 10,000 pound Massey strap hammer, the operator rounded the corners and pancaked a 5 in. square x 10 in. long billet in a press, then transferred directly into a finisher on the hammer where it took eleven blows to finish the part. The output was about eighty parts per hour with a four-man crew.

There was a special set-up on one 1,500 pound board drop hammer for producing about a two pound steering spindle. In this set-up, the starting shape was a 1½ in. round billet "Bradleyed" down half the length to about ¾ in. It was then forged in the hammer, point down, using a water cooled bottom die. Ejection was achieved with the help of sawdust with no apparent sticking problem and the point was filled.

Bar-Lorforge in Custines produced larger forgings of a general nature including ring forging. Their hammer forging equipment consisted of four large air hammers up to 16,000 kg.-meters capacity, and three double-acting hydraulic hammers from 200 to 3,200 kg.-meters.

9.0 PRESS FORGING

During the tour of the forging plants in four European countries the Mission saw many types of press forging equipment being utilized in a variety of ways relative to layout, material handling and associated equipment.

Two basic management approaches were observed:

- (a) The first was to obtain a maximum possible equipment output by applying adequate manpower with only a minimum of automation.
- (b) The second was to invest capital in automation and material handling to eliminate excessive manpower.

The relative merits of these approaches being debatable, are subject to evaluation by the individual forge shops.

Horizontal forging machines (upsetters) were in use in a number of plants. These were both the vertical die and horizontal die types.

Forging rolls, both hand operated and automated, were being used for preforming operations.

Many of the press installations employed induction systems for heating of the steel stock for forging.

9.1 GENERAL UTILIZATION OF EQUIPMENT

Various combinations of machines were observed. Hammers would be tied in with presses, upsetters with presses, reducer rolls with upsetters, different size presses operated together. Typical examples of this would be as follows:

- (a) Preforming on 1600 ton forge press.
 - Finish forge on 600 ton forge press.
 - Return to the 1600 ton press for trimming and coining.
- (b) Preforming on a hammer or reducer roll and finish forging on a press.
- (c) Preforming on trim press.
 - Finish forging on forge press.
 - Return to trim press for trimming.
- (d) Preforming on forge press.
 - Bending in trim press.
 - Finish forging in forge press.
 - Return to trim press for flash removal.
- (e) Reduce sections in forging roll, pass to upsetter for upsetting flange.
- (f) Gathering in upsetter.
 - Finish forging in press.
- (g) In one case, two resistance gathering machines were being used to gather the ends for shafts which were then finish forged on a friction screw press.

9.2 HOT FORGING ON MECHANICAL PRESSES

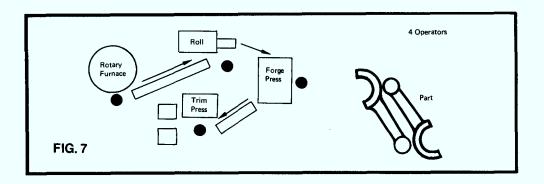
Various types of hot forging equipment are used in the European shops, and manufacturers of this equipment include North American, British and European companies.

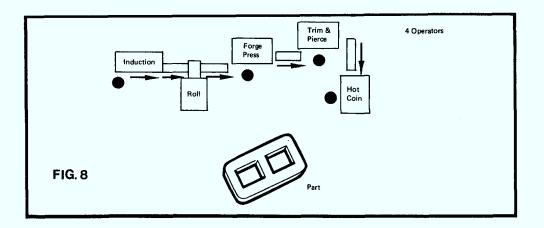
9.2.1 High Output Without Automation

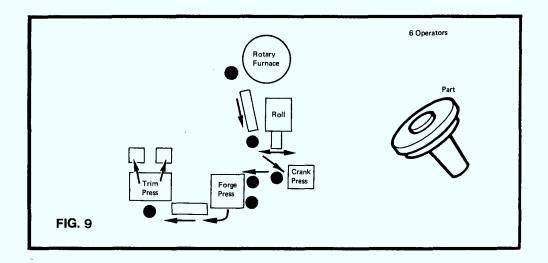
A high output can be obtained from a given press complex by applying manpower. The heating equipment must be capable of heating stock at a sufficient rate to keep up with the desired output. In the case of induction heating, this in itself represents a fairly high capital investment.

With press equipment, this concept was very evident in the British and French companies supplying the automotive industry. In a typical example, up to 3 operators would be utilized on a single forge press with additional men to operate the trim press, reducer roll, furnace, etc.

Operators would be stationed at the front and back of the forge press. A few typical layouts are shown in Fig. 7 to Fig. 9.







9.2.2 Reduction of Manpower by Automation

To effect a maximum reduction of manpower, the handling of material through each piece of equipment in a given press complex must be considered. This equipment may consist of heater unit, forging rolls, forging press, trim press and, in some cases, a second press. Hammer or upsettermay be used in conjunction with the main forge press.

Methods used to cut down manpower requirements were as follows:

- (a) Powered conveyors between machines within the press complex;
- (b) Automatic spray lubrication systems to eliminate the need for hand swabbing;
- (c) Automatic feed systems for both furnaces and induction heaters;
- (d) Automatic manipulators for the forging rolls;
- (e) Automatic transfer through the forge press with trim operation combined.

Generally speaking, the more automated the equipment, the longer the average run required in order to justify the setup.

Another general observation was that in the more automated plants, there was more equipment not operating at the time of the Mission's visit than in some of the efficient shops with less sophisticated setups. However, the Mission did observe many pieces of fully automated equipment which apparently operated very successfully.

9.2.3 Powered Conveyors

Powered conveyors were of various types, including the following:

- (a) heavy multiple chain conveyors, where the slug rode on the chain itself. In several shops, these conveyors appeared to be used as a type of descaler. This was achieved by running the chain very fast with plenty of slack so that the slug was tumbled along the conveyor.
- (b) steel slot type conveyors, chain driven.
- (c) conveyors, where the slug is carried up to a fixed chute by cross slats fixed to a double chain drive.

It was also noted that, in several cases, attempts had been made to eliminate conveyors while achieving the same results. This had been done by elevating certain equipment and relying

upon gravity chutes for the transfer of parts between pieces of equipment. The obvious reason for this was to eliminate a moving mechanism which can be a source of trouble.

9.2.4 Automatic Spray Lubrication Systems

In England, proprietary die lubrication systems supplied by Graphoidal Developments and by Jaco were in use. However, most of the systems appeared to be manufactured by the forging firms themselves or at least to their specifications.

There were two basic types: — One where the nozzles were traversed across the dies while the press was open, and the other employing fixed nozzles which were set to spray either continually or intermittently.

In the traversing type, which was used generally to lubricate long dies, the spray was often cut off between cavities.

Also hand swabbing of lubricant was sometimes employed along with the automatic spray unit to cover the need for extra lubricant in a certain part of the cavity.

9.2.5 Automatic Feed Systems

Automatic Feed Systems for furnaces and induction units were not in general use, but several different types were observed.

In one of the German plants an automatic furnace loader was employed on most of the furnaces. This equipment* consisted of a rotary magazine which was preloaded with slugs in vertical columns. The slugs were carried into the furnace by an automatic pick up arm which also removed a heated slug from the furnace and dropped it onto a conveyor.

Partially mechanized furnace handling equipment was also in use. An example of this was a modified pusher type furnace which still employed operators for loading but slugs were automatically ejected from the furnace and carried to the press by a powered conveyor.

Most induction equipment was hand-loaded but in two plants automatic loading was observed.

One method was to pick up slugs from a skid by means of an electro magnet on a pulley system and transfer them to an elevated hopper. From there they were oriented and passed to the heating coil by a vibratory bowl feeder.

Another unit which was just being installed during the Mission's visit consisted of an elevating spiral track. The slugs were dumped into an annular bowl and vibrated up the spiral to the feed track through the induction coil. (Photo 9)

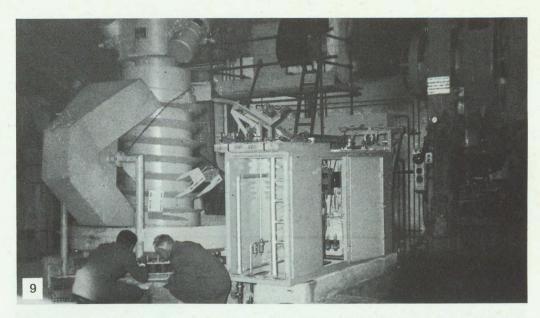
9.2.6 Automatic Manipulators for Forging Rolls

Both Keiserling and Eumuco forging rolls were seen equipped with automatic manipulators for handling the slug through the various passes. They both appeared to be working well and were timed to give 4 passes in 5 seconds, which was a great deal faster than required for the forging operation.

At one plant a fairly heavy slug was being handled by a semi-automatic manipulator which gripped the slug between jaws. In this case, the manipulator was pushed into the roll by hand.

Another plant had the roll mechanized but in this case only one pass was required and the slug was pushed through the rolls, by means of a hinged lever.

Manufactured by Erich Menzel, Industrieofen-, Feuerungs- und Brennerbau, 7301 Berkheim uber Esslingen.



New vibratory sorter-stacker of a vertical spiral type being installed at RIV-SKF in Italy for automatic feeding of billets to induction heater prior to forging.

9.2.7 Automatic Transfer Through the Forge Press

Several forging presses seen were equipped with an automatic transfer system. In each case, these were of the walking beam type. Both round and asymmetrical parts were being forged. A complete trimmed forging would be produced with each stroke of the press.

In one case, where a circular forging was being produced, the slug was picked up from the exit chute of the induction unit and automatically placed in the first die by a pair of reciprocating tongs.

With cold forging, the automated presses in one case had a walking beam transfer system, in another the transfer was by means of a swivel arm.

9.3 HORIZONTAL FORGING MACHINES (UPSETTERS)

Some upsetters were used in conjunction with other forging equipment and a few were used to produce finished forgings.

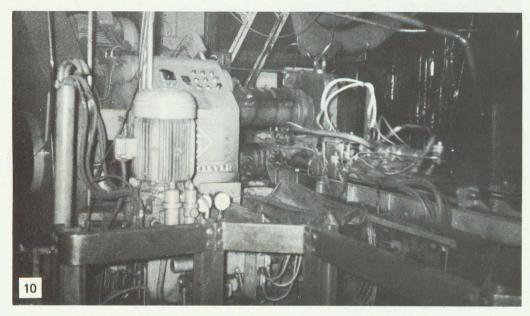
In only one case did the Mission observe an upsetter equipped with automatic transfer. This was a horizontal die machine fitted with a walking beam transfer system.

Drive shafts were being produced on this setup by running the bars through an automatic pass-through type forging roll and then transferring them to the upsetter. This transfer was effected by means of a swivelling pickup arm which lifted the part from the exit chute of the forging roll and deposited it in the first station of the walking beam.

9.4 FORGING ROLLS

Forging rolls were often used in conjunction with forging presses for preforming operations.

In one particular plant, two of these machines were fitted with automatic feeding devices which were capable of feeding the stock in and out of the roll the required number of times. These manipulators operated very quickly and were seen to make 4 passes in 5 seconds. (Photo 10)



Hasenclever reducer roll with automatic manipulator at the Forgevis plant in France. Forging which is fed automatically from the furnace to the manipulator can be seen re-entering rolls for next pass.

Another type of automatic roll was the pass-through type where the stock was run straight through a series of reducing rolls in one pass.

A conventional forging roll was running automatically on a single pass operation. In this case the stock was pushed into the roll by a hinged lever to the point where the roll dies picked it up and carried it through.

9.5 FORGING OF RAILWAY WHEELS

Large hydraulic presses up to 3600 tons in size were used for forging railway wheels and rims at Italsider's Lovere plant.

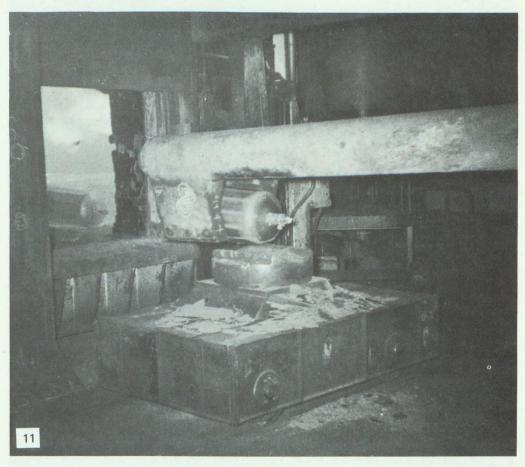
The large slugs for the forging operation were cut from a cast billet by parting in a lathe. The parting tool was taken to within a given distance from the centre — to leave a 3 inch diameter piece holding the slugs together. Slugs were finally parted from the billet by means of a hydraulically actuated wedge which was driven into the slots to break the 3 inch centre piece.

A manipulator picked up the slugs and placed them in a rotary hearth furnace and another manipulator took them out of the furnace when they had attained forging temperature. This manipulator was used for handling the heated billets in the forge press where, in a series of blows in the first die, the slugs were reduced to the thickness of the wheel. Scale was continuously blown off during this operation.

The ingot was then advanced to a closed die in the same press where it was forged to size. A third manipulator removed the forging from the press and transferred it to a rolling machine where the flange was rolled on.

Another manipulator was used to transfer the part to a second hydraulic double acting (ram within a ram) press for piercing the centre hole.

A sequence of operations in forging of railway car axles is shown in photos 11 to 13.



Billet for railway car axle being removed from furnace and placed on a rail-mounted transporter with swiveling cradle at Italsider.



Manipulator and hydraulic press just completing rough forging of an axle at Italsider.



Finish forging of an axle on a pulldown type hydraulic press.

10.0 MATERIAL HANDLING

The handling of materials at the various forging plants visited varied considerably according to the size and type of operation. The independent forgings manufacturers for the automotive industry and the captive forging plants of the automotive producers have developed the most sophisticated methods. Such plants as Garringtons in England, Daimler-Benz in Germany and the Forgevis plant in France exhibited a number of good material handling methods. In order to present a summary of the methods in some organized manner, the following is a review of the methods used from steel storage to storage of the finished parts.

10.1 STEEL STORAGE

Almost all of the forge shops visited stored their steel billets and bars outside and handled them off the railway cars and trucks with a travelling crane. Where possible, this crane also serviced the shears or cutting saws. Most shops stored the steel on the ground but where space was at a premium, "A" frame racks were used.

Garringtons used "A" frame racks, loading the racks with a travelling crane and unloading them with a side loader. Forgevis in France stored their steel inside and, to obtain a high storage density, the bars were stacked in bundles one on top of the other separated by "U" brackets about 2 ft. wide and with 1 ft. legs. This required cutting the straps of the bundle so that they would lie flat, resulting in very neat stacking with only a few inches between rows. The steel was moved by a travelling crane from storage to a raised shearing section fed by roller conveyors. One shearing line had an automatic unloader and powered roller conveyor but the unloader controls were operated by the shear operator. Three or four automatic unloaders were noted in other plants. Preheating of steel prior to shearing was not common.

Most of the hand tool manufacturers used strip steel and it was common to store the steel inside vertically. They used the available head room in this manner and handled the steel in and out of storage manually.

10.2 BILLET HANDLING

Almost all of the shops put their sheared or cut billets into tote boxes in most cases by gravity feed. If the shears were not elevated, the tote boxes were placed in recesses in the floor. Handling of the tote boxes was usually by fork trucks. At Forgevis the tote boxes were unloaded with a rotator attachment into a hopper which fed a descrambler, then on by a conveyor to the furnace. At Daimler-Benz an automatic electro-magnetic hoist was used at one furnace to move the billets from the tote box to a hopper.

In most of the plants the tote boxes were unloaded by hand by the heater. At Daimler-Benz, where an automatic loading and unloading mechanism for a rotary furnace was used, the positioning of the billet was performed by placing the billet in an eight station vertical rack. As the top billet was taken away the remaining billets in a station would raise a notch. When the last billet in the station was used, the turret would automatically index to the next station. This mechanism had a capacity of about 40 ft. of 5 in. long billets.

A vibratory descrambler was under development at R.I.V. in Italy to carry the billets up

an inclined central circular ramp to feed an induction furnace but the Mission did not see it in operation. Most descramblers were of the turntable type with collection on the outer edge. One installation had a simple recycle mechanism for those billets which were in the wrong way. In this installation they had relieved a section of the track so that a long dimension on the width would overbalance and fall back into the descrambler.

In most plants equipped with the pusher-type furnaces or induction heating units, the furnaces were raised to allow the next operation to be fed by gravity. At English Steel, one gravity conveyor feeding billets from an induction furnace to a press had an automatic device rejecting the billet to a tote box if the previous billet had not yet been cleared. One pusher type furnace had a bottom discharge and was fed to the next operation by a powered conveyor. This had the advantage of reducing the radiant heat from the furnace to the press operator. One of the most common types of conveyor from the furnace was a narrow chain link drive. These were normally operated at a fairly high speed achieving partial descaling of the part by rubbing against the side of the conveyor. Further descaling was accomplished by dropping the part up to 18 in, when it discharged from the conveyor.

R.I.V.—S.K.F. in Italy had two novel material handling methods to and from a press or hammer: in transferring a billet to the hammer, they operated an inclined screw conveyor arrangement with long flights which was driven on the periphery of the conveyor. This conveyor of fairly large diameter (approx. 16 in.) ensured a good tumbling and descaling action and, because of no moving parts, could be considered virtually maintenance-free. (Photo 14.)



Circular billet seen at discharge end of an inclined internal spiral conveyor. Note a pan filled with scale removed as the billet rotates in the spiral conveyor.

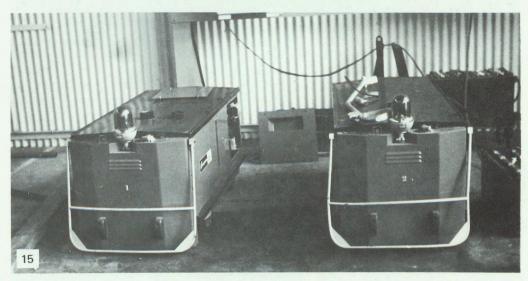
Daimler-Benz in Stuttgart had a fully automated axle line which consisted of a furnace, three reducer rolls, a reheat furnace, and an upsetter.

10.3 HANDLING AFTER FORGING

Renault had perhaps the best arrangement for handling the forgings after hot trimming. The forgings were fed down through the floor to a powered conveyor which took them outside the forging shop, where they emptied into tote boxes. Besides reducing the activity around the press, this method reduced the heat at the press.

A number of plants had pin ejectors at trimming stations and an air blast blowing the part on to a conveyor. At Forgevis in France crankshafts were placed after hot trimming on a slow-moving conveyor which travelled along the ceiling to give a uniform air cool. Most installations placed the forged part in tote boxes after forging, and there was not much mechanization of handling after this point.

Garringtons had automatic robot train units which pulled waggons of forged parts to a storage area and automatically parked then in an empty storage space. (Photo 15.)



Conveyance robot tug units used to pull storage bins at the Hatebur Forging Machine at Garrington's Bromsgrove plant. The robot units are guided by a wire set into the concrete floor.

10.4 MISCELLANEOUS

At Bar-Lorforge in France the die storage racks, made of steel pipe, served as the structural support for the walls and roof of the building.

Daimler-Benz operated a travelling vertical crane with pallet racks up to about 25 ft. for the storage of dies.

At Walter Gott in Germany trim presses were installed along one wall of a building and the flashing was dropped by a gravity conveyor through the wall to the ground one level below.

C.A. Schlemper had a below floor conveyor taking the flashing from the trim presses to outside storage.



Railway gondola car at the Carlo Raimondi plant in Italy, after being transported to the weigh scale by a highway tractor trailer.

11.0 HEAT TREATMENT AND SECONDARY OPERATIONS

11.1 HEAT TREATMENT

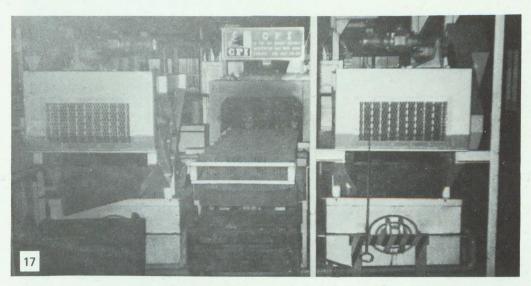
In addition to conventional conveyor furnaces, there were two predominant types of heat treating furnaces in the European forging plants without machining facilities. Both types were quite different from those commonly used in North America, and operated usually without any form of atmosphere to prevent decarburization.

For conveying the forgings through the furnace, one type utilized flat rectangular cast stainless steel trays, with trunions extending left and right from the sides at the rear of the tray.

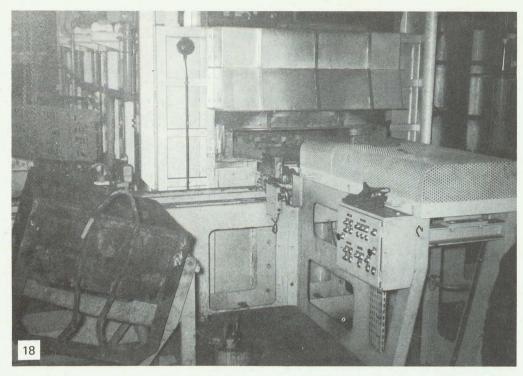
Forgings were hand loaded on the trays, which were then advanced through the furnaces by either pneumatic or mechanical pushers, or by chains with lugs engaging the trunions. At the exit end of the furnace, the trays would tip by gravity allowing the forgings to drop into a quench tank or into tote boxes. The trays then had to be lifted by hoist and returned to the front end of the furnace, usually by travelling on a monorail.

In most cases, the furnaces had both oil and water quench tanks which were shifted left or right by mechanical means. However, a new unit just installed at one of the Bar-Lorforge plants in France, was equipped with separate tray tipover stations to drop the forgings into separate chutes for water or oil quench. In all cases parts were raised out of the tanks by conveyors.

This type of furnace would appear to have the disadvantage that at least 30 percent of the material being heated would be the tray itself. The need for manual loading and manual return of the trays to the loading end would also increase the heat treating costs. (Photos 17 and 18, Bar-Lorforge plant)



Discharge end of a furnace. Trays seen hanging vertically in centre have dumped the heated forgings into a chute on the left for oil quench, or a chute on the right for water quench, or directly in front for normalizing. Parts are lifted from the quench tanks by conveyors.



Charging end of a new tray pusher type heat treat furnace at Bar Lorforge in France. A tray being returned on a monorail from discharge end, can be seen at left.

The second type was the conventional style box furnace equipped with various types of electrical or pneumatic charging units.

Parts for heat treating were stacked by hand on flat stainless steel sheets and charged and discharged from the furnaces by travelling loaders. It was not possible to remove parts from the stainless steel trays until they had cooled sufficiently for manual handling.

The need to hand load and unload would considerably increase the labour content in such heat treating operations in relation to units utilizing hopper feeds and conveyor belts.

In those plants where subsequent machining operations on rough forgings were performed, conventional batch, shaker hearth and/or conveyor type furnaces were employed. However, the Mission saw only two furnaces equipped with controlled atmosphere to prevent decarburization.

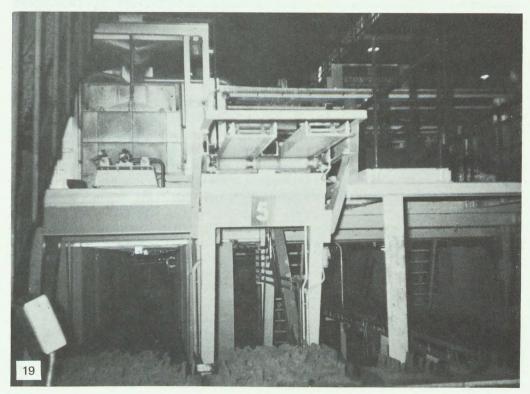
To achieve a more accurate control of their heat treating, Firth-Derihon Stampings Ltd. housed all the controls and recording equipment for their heat treating furnaces in an airconditioned room maintained by a permanent laboratory staff.

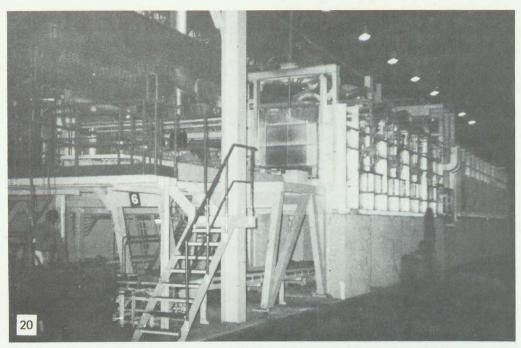
One of the most unique heat treating units, seen at the Italsider plant in Italy, was used for the heat treating of railway car axles and wheels at the rate of approximately 15 metric tons per hour. One operator controlled this heat treat complex from a console, using closed-circuit television to observe each operation. Both the heating unit and the tempering unit were of the walking beam type.

When heated the parts would be walked from the rear end of the heating unit onto four forks supported by an overhead centre post-type elevator shaft and lowered into the quench tank. The extended fork arm would raise the part out of the quench tank, rotate horizontally 180° and place it on the second walking beam for entry into the tempering furnace. The part would be traversed through the tempering furnace with the walking beam transfer and out the back end, ready for finish machining.

At the Forgevis plant in France heat treating equipment was modern and efficient. One operator, acting as a loader only, operated their automatic furnaces for hardening and tempering of automotive crankshafts. Crankshafts were transported from the trim press to the furnace by monorail conveyor of sufficient length to permit cooling for handling. The operator placed the forgings on a walking beam for travel through the oil fired furnace (no atmosphere). Heated parts dropped into the quench (either water or oil tanks with a mechanical shifter), were retrieved by a 45° elevator conveyor and dropped onto a vibratory tray. The vibratory tray gently deposited the crankshaft onto a slot type conveyor belt for travel through the tempering furnace, with gravity discharge into tote boxes.

The pusher type twin annealing and normalizing furnaces were elevated with a cooling tunnel under each one. Forgings were loaded on trays on the upper furnace level and, after completing the travel through the heat treating cycle, the tray and a roller section of the furnace hearth were lowered from the furnace by an air cylinder. The tray then advanced along the cooling tunnel to the unloading point and the air cylinder elevated the furnace hearth back into place. (Photos 19 and 20.)





Elevated twin annealing and normalizing pusher furnaces with cooling tunnel underneath for conserving space, at the Forgevis plant in France.

11.2 SHOTBLASTING

Shotblast equipment was generally of the conventional type found in North America. The Mission observed two automatic units. One was at Walter Gott Co. in Germany, utilizing a conventional type tumble-blast unit with automatic timing and automatic feeding devices. A lift truck dumped a full tote box load of parts down a chute into an elevator bucket. The bucket raised automatically and dumped the forgings down another chute directly into the shotblast machine. After shotblasting, the parts tumbled out of the equipment onto a vibratory tray and then dropped into a tote box. The others were drum type units at the Daimler-Benz plant in Germany and the Forgevis plant in France.

The Fried. Krupp Huttenwerke in Germany had a Wheelabrator manufactured unit, utilizing a powered monorail conveyor on which the forgings were hung and passed through a shotblast tunnel. The support hooks were rotated as the forgings passed through the shot pattern fo expose all sides. This unit was capable of handling very large forgings. Smaller forgings were hung in multiples from the same hook.

11.3 SECONDARY MACHINING

Generally speaking, the machine tools found in the German forging plants were more modern than those found in England and this could probably be attributed to the fact that their original equipment was either destroyed during the war or expropriated afterwards.

One of the English hand tool manufacturers, Elliott-Lucas, had just recently put into operation a new "tunnel type" broaching machine for simultaneous machining of both sides of linesman's pliers. The operator loaded the plier forging in one of the eleven vertical fixtures anchored to a continuous moving chain. As it entered the tunnel, two tapered wedges centred the forging and activated hold-down clamps on the fixture. The forging then travelled between the two broaches completing the machining. At the exit end, two more wedges unclamped the forging and, as the fixture rotated downwards for return underneath the broaches, the broached part dropped into a tote box. This machine would broach one forging every six seconds.

The same manufacturer had overcome one of the usual problems of trying to maintain uniform tightness on spin-rivetted joints by the use of a "BODMER KUSHNACHT" Swiss made spin-rivetter. This unit had an automatic pressure control which was selectively fully variable.

Another hand tool manufacturer in England, manufacturing wood planes, utilized a twinhead vertical milling machine (made by Fritz Hursthal of Germany) for machining the bottom of the plane casting. Fixtures for holding the casting were mounted on a continuously moving turntable for travel under the roughing and finishing milling heads. Clamping and unclamping of each fixture holding four castings was automatic and the operator had only to remove four machined castings and load four new ones.

The Italian companies visited by the Mission appeared quite cognizant of the need for exporting and were making large capital expenditures for machine tools to modernize their machining operations and to reduce their manufacturing costs.

The Mission did not observe any actual machining in France and it is not possible to comment on this phase of their industry.

Spanish industry is not, as yet, faced with the high wages that are being paid in other European countries, such as Germany, and, as a result, have not made any great strides in modernizing the manufacturing methods in their hand tool manufacturing plants.

12.0 OPEN-DIE FORGING

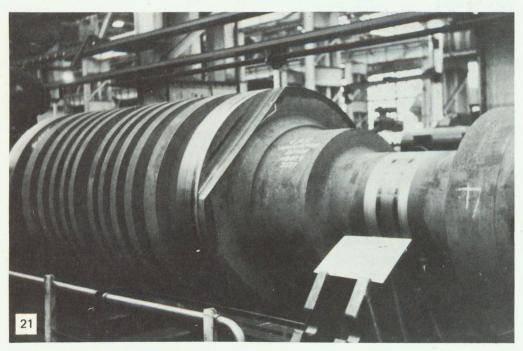
In total, six open-die forge operations were visited. These were: English Steel Corporation, Forge Department and Firth Brown Ltd., Forge Department, both in Sheffield, England; Heuer Hammer, GmbH, in Germany; Carlo Raimondi & Co. and Italsider in Italy and the Custine plant of Bar-Lorforge in France.

12.1 UNITED KINGDOM

English Steel and Firth Brown, as mentioned in an earlier section of this report, are fully integrated steel mills, melting and rolling their own steel requirements.

Press sizes in English Steel are one 9600 ton hydraulic with a 1600 ton per month output, two 2400 ton hydraulic and one 1230 ton. Fifteen acres of rough and finish machining equipment enable them to produce a variety of forged and machined components, the largest of which used a 210 ton steel ingot. (Photo 21.)

At Firth Brown, the presses used are one 6000 ton, one 4000 ton, one 1750 ton, two 800 ton and one 600 ton. All are hydraulic, backed by large machine shops for roughing and finishing.



Typical size of open-die forged products at English Steel Corp.

12.2 GERMANY

The one open-die plant visited in Germany uses four drop hammers, varying in ram weight from 500 to 2000 kilograms. Specialty mining and lifting equipment is designed and built at this plant.

12.3 ITALY

Carlo Raimondi & Co. in Italy is a family owned, small, integrated facility providing mainly valves and fittings for the petroleum industry. A small open-die hammer forge is operated to produce mandrel-forged rings for their own use in producing valves and flanges.

The Lovere plant of Italsider is an integrated steel facility, and its Forge Department is a highly automated facility producing mainly railway axles and forged wheels. In addition to the axle/wheel facilities, two open-die hydraulic presses are operated intermittently, one a 2000 metric ton and the other a 3600 metric ton press, backed up by a complete roughing and finishing machine shop. Products range from finished marine rudder stock, propeller and power shafting, to rolling mill rolls, discs, etc. Maximum weight of their rough machined forging is 30 tons.

12.4 FRANCE

The Custine plant of Bar-Lorforge in France combines both an open-die and drop-forging facility. The open-die facility specializes in rings and discs to a diameter of 6.5 feet and a thickness of 360 mm (15 in.). One 1000 metric ton press is used along with two hammers, one with a 2000 Kg. ram and the other a 4500 Kg. ram. Most steel is purchased from its parent company, next door, Societe des Acieres de Pompey, an integrated steel producer. Open-die product output averages 900 tons per month.

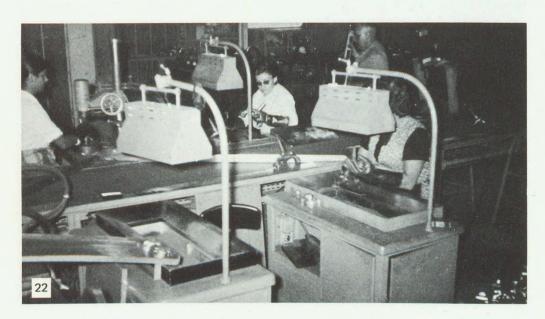
13.0 INSPECTION AND QUALITY CONTROL

Generally, product quality in the European forging plants was high, and appeared to reflect the fiercely competitive nature of the business and the demands from customers for sound, clean forgings.

Quality control procedures of the unintegrated forgers in most cases called for chemical and physical checking of incoming raw materials. In some cases elaborate laboratories were maintained for this purpose. Ultrasonic and/or magnaflux inspection was not uncommon. All plants associated with or owned by the integrated steel producers, such as English Steel Corporation, Firth Brown Limited, Bochumer Works of the Fried. Krupp Huttenwerke and the Societe Bar-Lorforge plants, relied on the test certificates provided by their own central control laboratories.

The level of sophistication and the actual method of quality control on forged production depended on the company and markets served. It was common to find forging and line inspection personnel to be on an incentive pay system. In some cases a wage bonus was dependent on the degree the established minimum quality level was surpassed. In other cases, where the main responsibility for quality was put directly on the forgers, any scrap produced would be charged against the operators incentive wages. One plant in Britain reported average scrap reject rate of 0.8 percent.

Where warranted by reasons of production quantity or by end-use specifications, automated 100 percent inspection of finished parts was performed. (Photos 22 & 23) A typical inspection station utilizing the magnaflux principle was centered around a moving rubber belt



Dry particle magnetic crack inspection of front wheel spindles at Forgevis. Operator at left magnetizes forging and inspectors check with black light after immersing in phosphorized iron particles.



Demagnetizer conveyor delivers parts to tote boxes after crack inspection. Note automatic shifter for tote boxes after filling.

conveyor. The first operator inspected the part visually, the second magnetized it by contact, the third dipped it into dry phosphorized iron powder and the last one checked under ultraviolet light before placing it back on the conveyor. Frequently, the parts passed on a conveyor between two photo-electric cells for counting before being dropped into shipping skids.

Other non-destructive testing involved cathode Ray oscilloscopes or similar equipment. A typical station is illustrated in Photo 24.

Routine ultrasonic testing equipment was prevalent in the open die shops along with die penetrant crack detection equipment. One shop, Firth — Derihon in England, had two submersible ultrasonic inspection facilities for routine examination of aircraft quality superalloy, titanium and aluminum forgings; this being standard equipment for work to aircraft specifications.



Magnetic testing of flanged rings with readout on oscilloscope.

14.0 LABOUR, WAGES & INCENTIVES

14.1 UNITED KINGDOM

All forging plants visited have incentive programmes in operation and the average remuneration for a 40-hour week ranges from \$62 in the Sheffield area to \$82 in the Birmingham area.

In no case were tool shop employees on incentive. Labour in all plants is represented by unions. The cost of fringe benefits in general averages 40% of wages paid and includes such items as social benefits, vacations, in-plant meals, etc.

14.2 GERMANY

All plants work on an incentive system, with the exception of the Krupp Plant at Bochum, where the system was dropped in April of 1968. No reason was given. The forge shop operators earn from \$65 to \$87 per 40-hour week, although one shop, Belzer Werke in Cronenburg, reported figures of \$87 to \$108 per week, with incentives. Average fringe benefit cost to the employers is approximately 50% of wages. All workers are in some sort of labour union but in some cases, the union concerned has no contract with the employer.

14.3 ITALY

All three plants visited work on an incentive system in the forge departments, with the average forge operator wage being \$40 per week, including incentives. Fringe benefits, on the other hand average 105% of weekly pay, and apparently include income taxes, amongst other usual benefits. No information on unions was obtained.

14.4 FRANCE

Forge shop operators earn, with their incentive payments, an average of \$55 per 40-hour week. The tool makers apparently earn 10% less for the same time. Fringe benefits vary from 60% to 80%, with the national average for all metal working plants being 65%. No union information was obtained.

14.5 SPAIN

The average wage at the Patricio Echeveria plant in Spain was reported to be equivalent to approximately Can. \$1,600. per year based on a 48-hour working week. Fringe benefits amount to additional 50 percent of the wage rate.

15.0 NEW DEVELOPMENTS

It must be remembered that, when discussing new developments, what is new to one company may not be new to another. With this in mind, we will discuss some of the newer methods and equipment observed.

15.1 FURNACE LOADER

A unique type of furnace loader was in operation at the Daimler Benz plant in Germany. This consisted of a rotary magazine which was preloaded with columns of slugs. The slugs were picked up from a given column by a reciprocating arm which deposited the cold slug in the furnace and removed a hot slug for forging. When a column was emptied, the table indexed and the next column was brought into line with the arm.

15.2 HATEBUR 1201 AUTOMATIC FORGE MACHINE

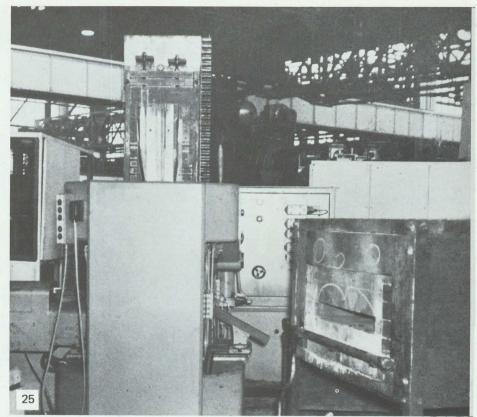
At Garringtons, in England, a new automatic Hatebur forging machine was installed. This unit was not fully operational but the planned output was approximately 4,500 pcs. per hour. The equipment consisted of an unscrambler and bar feeder, a resistance heater capable of heating a 20 ft. bar of steel, an electric holding furnace, and the basic forging machine where the stock was sheared, forged and trimmed. This machine is described in more detail in Appendix I.

15.3 TRANSVERSE ROLLING

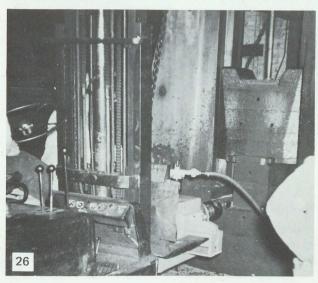
A "transverse" rolling machine was also in operation at Garringtons on an experimental basis. This machine employed flat, formed dies and the rolled parts seen were rolled to a good clean form. The machine was purchased from East Germany. (Photo 25.)

15.4 LASCO ELECTRO HYDRAULIC PRESS

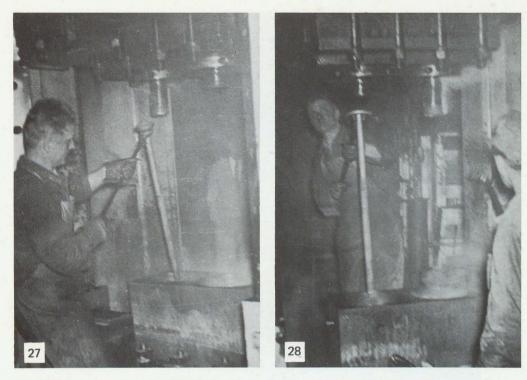
This machine, basically a combination press and hammer, was seen in operation at C.A. Schlemper in Germany. The hammer side had a rating of 18 metric tons and the hydraulic press portion a rating of 630 tons. During the visit, a Daimler-Benz rear axle was being forged on this machine in 4 blows. The sequence of operations was one horizontal rounding blow, one vertical flattening blow, extrusion of the long shaft in the hydraulic press side of the machine followed by finish forging of the flange in the hammer side. In this particular case, the shaft was being returned to the furnace between the extruding and hammer operation for reheating. The need for this reheating would be dependent upon the particular part being forged. There was approximately a 25 second delay in the extrusion cycle to allow the shaft to strengthen sufficiently to be removed from the dies. (Photos 26 to 28.)



Vertical Transverse Roll Machine recently installed at Garringtons in England, Diameter reductions of up to 60% in one pass are possible.



Round cornered square billet in preparation for extruding and forging of flanged axle in a Lasco combination press-hammer at C.A. Schlempez in Germany.



Extruded and upset axle being removed from die following press cycle on a Lasco combination press-hammer. Upset end is reheated prior to hammer cycle.

Flanged axle being removed from die following hammer cycle on a Lasco combination press-hammer.

15.5 U.S.E.M. MACHINE FOR CUTTING GRAPHITE ELECTRODES

This machine had only been installed a few weeks before, but was running during the visit. The principle of the machine is to take a steel master, with a rough surface and vibrate it into the graphite. The blocks of graphite were glued to a steel backing plate which was bolted to the machine. The amplitude of vibrations can be varied but was set at 4.4 millimetres for this particular job. The advance rate or cutting rate was 1.1 millimetres per minute. This is a horizontal machine which has a general appearance of an ordinary lathe. Vickers Hydraulics were used on the machine. (Photo 8.)

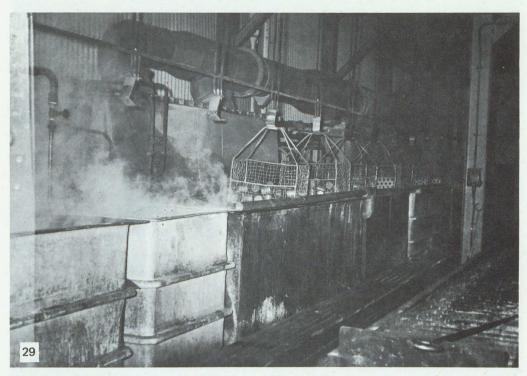
15.6 EUMUCO WEDGE PRESS

One of these machines was operating at the Daimler-Benz plant. The principle of operation is to insert a wedge in a horizontal direction to actuate the ram. The advantage claimed for the machine is to have a larger load carrying surface than is possible with the conventional machines.

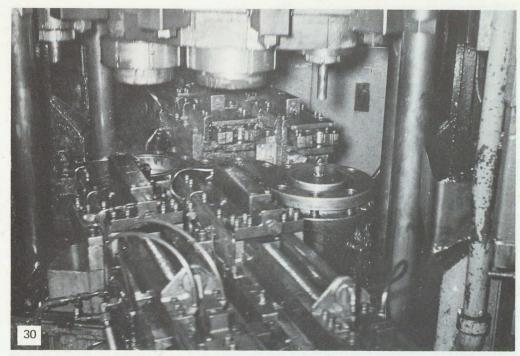
15.7 COLD FORGING

Cold forging operations were being performed on a variety of presses both mechanical and hydraulic. (Photos 29 to 35.)

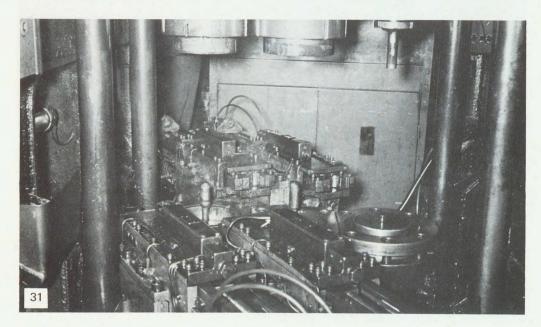
Invariably, the slugs were treated with a phosphate coating. Generally, parts were plain stepped shaft type or small circular parts. However, at one plant, a relatively complex part, which appeared to be part of a universal joint, was being cold forged in one blow on a 2500 ton hydraulic press. Slugs were sawn from a bar of triangular shaped rounded stock and bonderlubed. Punches for this operation were made of high speed steel and were produced by an E.C.M. process. The E.C.M. machine was manufactured by "Anocut". The accuracy was quoted as .0008" but this would seem a little too much to expect from the E.C.M. process on a part of this shape.



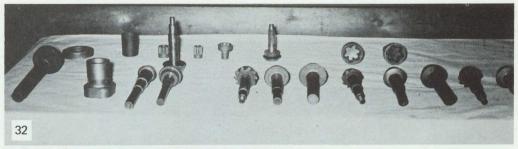
Automated cleaning and phosphating line for slugs to be cold-forged into gear blanks at English Steel Corp.



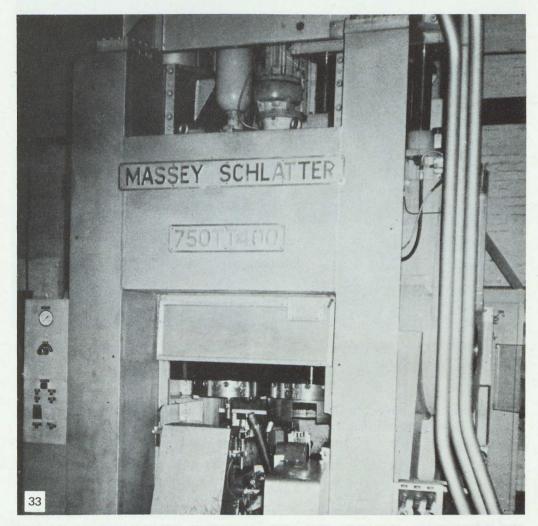
Cold forging operation with parts ready for transfer automatically between the four dies by the mechanism seen in front and rear of the press.



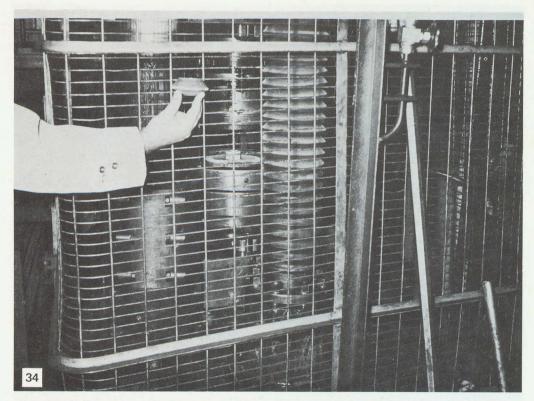
Press operation, as seen in #30, just prior to parts being raised by bottom ejector pins.



Range of products being cold forged on the Massey Schlatter presses.



Massey Schlatter two station press cold forging a bevel gear shaft at the B & S Massey manufacturing plant in England.



Gear blank being held, is cold forged in one stroke in a press at English Steel Corp. Photo was taken at the rear of press and shows the die open with ejector raised in the bottom die.

15.8 DIE WELDING

Welding of dies was not too generally used except as a means of repairing trimmers and forge dies. However, at one shop this process was very extensively used and the toolroom had six welding booths. "Argon Arc" equipment was used with Hastalloy and Stellite rods.

15.9 CAST DIES

Cast dies, manufactured by the Shaw process, were used in production at one plant and were in experimental use at several other plants. The one plant using them stated that they had realized an increase of almost 100% in die life on a particularly severe application.



Cold forged part, seen on front press guard, is made in one stroke on a cold forging press at English Steel.

PART 2

SUMMARY OF INFORMATION ON FORGES VISITED

FIRM:

Garrington Ltd., Newton Works, Division of Guest, Keen & Nettlefold.

ADDRESS:

Bromsgrove.

PRODUCTION: 14,000 tons of steel in storage at all times. Newton Works - over 100,000 tons of forgings per year; Albert Works - over 30,000 tons of forgings per year. All automotive forging requirements for Rootes, Standard and Massey Ferguson, large percentage for BMC, Vauxhall and British Leyland.

Exports - 10% of total production, including \$1,000,000 of forgings per year

to U.S.A.

PRINCIPAL PRODUCTS:

Automotive and heavy vehicles parts, such as conrods, crankshafts, axle shafts, ring gears, steering parts, etc. 90% of total production to automotive accounts.

EMPLOYEES:

Total employment: over 2,500.

Press operator's wages \$63 to \$77 per 40 hr. week. Direct labour 11% of the total manufacturing cost.

Plant unionized: Association of Engineering and Foundry Workers. Incentive pay based on minimum of 6 hrs. production output.

PLANT EQUIPMENT:

About 25 forging presses 500 to 4500 ton capacity. About 25 drop hammers up to 20,000 lbs. capacity.

Predominantly induction heating, using Birwelco equipment manufactured by a GKN subsidiary. Automatic spray lubrication systems, using colloidal graphite, manufactured by Jaco and Graphoidal Developments.

DIE SHOP:

Well equipped, with major pieces of equipment being 4-spindle Cincinnati Hydrotel, 2-spindle Rigid Metals, EDM machines by Agietron, Wickman and GKN. Experimenting with cast dies and tape controlled die sinking.

SECONDARY OPERATIONS & HEAT-TREATMENT:

Pangborn sandblast equipment with vibratory feed conveyor and powered rubber belt exit conveyor.

QUALITY CONTROL AND INSPECTION:

100% Magnaflux inspection used on critical parts. Rejection rate less than 2%. Good quality on all products made.

COMMENTS:

High equipment productivity rates achieved by increasing manpower on each press complex and rotating individual operators on the different jobs.

Excellent housekeeping throughout the plant. Fixed chutes were used in preference to conveyors between stations. Overhead powered conveyors, suspended forks and small overhead cranes were other material handling methods employed.

Automatic Hatebur 1201 forging machine is described in detail in Appendix II.B.

FIRM:

Smethwick Drop Forgings Ltd., Division of Guest, Keen & Nettlefold.

ADDRESS:

Stourport Road, Kidderminster.

PRODUCTION: 20,000 tons of forgings per year.

3,000 tons of steel in storage at all times.

80% of total production to automotive accounts.

Exports negligible.

5% annual growth rate of plant output.

EMPLOYEES:

Kidderminster:

Total hourly rated employment: over 615, including 95 in die shop, 240 in forge shop, 100 in finishing, balance in maintenance, inspection, storage, shipping. Ratio of salaried to hourly-paid employees 1 to 4. Two 40 hrs.

shifts (8½ hrs. per day, 5 days 4 nights).

Rolle St. plant: Total hourly rated employment: 425

staff: 50

PLANT EQUIPMENT:

Eight Massey forging presses of 1000, 1600, 1800 and 2500 ton capacity.

Predominantly induction heating with presses up to 1800 tons equipped with

400 K.W. induction units and a 2500 ton press with 600 K.W. unit.

DIE SHOP:

EDM Sparcatron equipment used for die sinking (Sparcatron Mfg. Ltd.,

Tuffley Cresc., Gloucester, England.).

SECONDARY OPERATIONS & HEAT-TREATMENT:

18 normalizing furnaces, two Birlec belt-type heat-treating furnaces with vibratory feed tables and a chain belt feed to the electrical tempering furnace. Five shot blasting machines.

QUALITY CONTROL AND INSPECTION:

Good quality of all products made. Fettling of the forging flash more frequently done than is common in North America.

COMMENTS:

Fixed chutes or slot type conveyors predominantly used for material handling

between stations.

FIRM:

Bescot Drop Forgings Ltd.

ADDRESS:

St. Paul's Road, Wednesbury, Staffs.

PRODUCTION: 7200 tons of forgings per year.

PRINCIPAL PRODUCTS:

14% — heavy automotive components.

1% - passenger car parts.

15% - mining.

30% - agricultural and offroad equipment parts.

Balance - general engineering components.

EMPLOYEES:

Total employment: 316, including 130 in forge shop, 40 in die shop.

Transport Workers Union represents hourly rated employees.

Skilled hammer men wages \$91 per week.

Skilled die sinkers \$66 per week.

Total wage bill 22 - 24% of the sales value.

PLANT EQUIPMENT:

About 30 Massey forging hammers from 700 lbs. to 10,000 lbs. capacity. Slot type furnaces for heating forging stock.

SECONDARY OPERATIONS & HEAT-TREATMENT:

Heat-treating costs \$3.25 per ton for pusher type furnaces; \$11.70 per ton for batch type furnaces. Batch and pusher-type furnaces for heat-treating. Three controlled atmosphere furnaces with oil and water quench. Oil or coal gas heating.

COMMENTS:

Material costs in forgings about 40% of the total cost. Scrap generated about

21 – 25% of steel used. Quoted profit figures – return on capital 15%.

- profit on sales 8.9% before

taxes.

Mostly manual handling of work in process.

FIRM:

Clydesdale Stampings Ltd.

ADDRESS:

Atlas Works, Netherton, Dudley.

PRODUCTION: Steel consumption 10,000 tons per year.

Output of forgings 7,500 tons per year.

Scrap 25% average.

PRINCIPAL PRODUCTS:

80% of total output for automotive industry.

12% for heavy engineering including off-highway equipment.

8% for mining industry.

EMPLOYEES:

Total employment: 180 including 50-60 in forge shop, 25 in die shop, 25

inspection, heat-treat; balance in shipping, maintenance.

Incentive scheme for all hourly-rated employees.

PLANT EQUIPMENT:

Head Wrightson converted billet shear.

1200 ton Hasenclever Screw press.

Wilkins-Mitchell trim presses.

Eumuco reducer rolls.

Two 3" and one 4" National Upsetters.

Automatic die lubrication on presses using spray system made by Graphoidal

Developments Ltd.

DIE SHOP:

Conventional die shop with Degnsmith and Grace Tracer Lathes and 2-spindle

Rigid Mill Duplicator.

SECONDARY OPERATIONS & HEAT-TREATMENT:

Pangborn sandblast equipment with skip loader.

QUALITY CONTROL AND INSPECTION:

Conventional testing and inspection procedures.

COMMENTS:

Little mechanized material handling.

Non-returnable plastic bags used for shipping forgings. Experimenting with warm forging (500-1000°F).

FIRM:

Staffordshire Edge Tool Co.

ADDRESS:

Newlon Rd., Cradley Heath, Staffordshire.

PRINCIPAL PRODUCTS:

Forgings purchased from Wm. Whitehouse, hammers heat-treated, finished and assembled in the plant.

EMPLOYEES:

40 employees.

PLANT EQUIPMENT:

Equipment for normalizing, annealing, grinding, finishing and assembling of various sizes and types of hammers.

HEAT-TREATMENT:

Gas heated lead pots for heat-treating.

QUALITY CONTROL:

A combination of magnaflux and current flow testing for ball pein hammers.

FIRM:

Elliott-Lucas Ltd. and Abbey Drop Forgings Ltd.

ADDRESS:

Churchbridge Works, Cannock.

PRODUCTION: Weight of steel consumed 1200 long tons per year. 50% of output exported to 80 different countries.

PRINCIPAL PRODUCTS:

Hand tools, pliers, wrenches, etc. Forge shop produces about 450,000 pcs. of forgings per month, of which 200,000 pcs. are processed into various types of pliers by Elliott Lucas Ltd. The balance, mostly wrench forgings, is supplied to Britools Ltd. and L. Victor Hand Tools Ltd. (plumber's and joiner's tools).

EMPLOYEES:

Total employment: 240 including 100 in Abbey Drop Forge, which is the

drop forging division.

Average wages: die sinkers \$62.50 per week; hammer operators \$65.00 per

week.

Bonus incentive system on plant basis.

PLANT EQUIPMENT:

About 25 strap drop hammers of their own manufacture.

One 250 ton press made by David Etchells of Darlaston, Staffordshire.

Modern machine shop for processing of hand tools.

DIE SHOP:

Warm hobbing of dies at 1000°C. was commonly employed.

SECONDARY OPERATIONS & HEAT-TREATMENT:

Wild-Barfield heat-treating furnaces.

Barrel-tumbling of rough forgings using Aloxite Stone in preference to shot

blasting.

COMMENTS:

Product cost: Material - 45%. Labour - 25-30%.

Variable & fixed overhead - balance.

Conventional material handling.

Export sales handled through T.E. Elliott Overseas Ltd. Warehousing facilities in various countries, including Canada.

FIRM:

English Steel Forge & Engineering Corp.

ADDRESS:

Brightside Lane, Sheffield.

PRODUCTION: Material used: 3000 tons per month.

PRINCIPAL PRODUCTS:

Drop forgings 5 lbs. to 3000 lbs.

Solid and hollow open die forgings up to 175 tons. 78% of total output in automotive components, including parts for heavy trucks, balance aircraft parts (landing gears, discs, turbine blades, etc.) and precision forgings for Atomic Energy Commission.

EMPLOYEES:

Total employment: 12,500 including 800 in forge shop, inspection and heattreat and 185 in die shop. Fringe benefits amount to 10% of direct wages.

DROP-FORGE PLANT EQUIPMENT:

Friction, drop and counterblow hammers from 25 to 1300 tons; "Covmac" 1¾", 2¾", 3½" and 6" upsetters manufactured by Coventry Machine Tool Co. Ltd.; Forge presses 1,000 to 2,000 tons; Wilkins and Mitchell trip presses; Induction heating equipment; Wilkins & Mitchell 2,000 tons mechanical and 1000 tons Lowey hydraulic cold forging presses.

OPEN-DIE PLANT EQUIPMENT:

Presses from 2400 to 9600 tons. 300 ton ingots used.

MACHINE SHOP:

Well equipped, large machine shop capable of finish machining of large ship's shafts and rudder shafts and rings up to 30 ft. diameter.

SECONDARY OPERATIONS & HEAT-TREATMENT:

Batch-type heat-treating furnaces.

Rotary sand-blast units.

Continuous belt-type hardening and tempering furnace.

QUALITY CONTROL AND INSPECTION:

Most advanced testing and inspection methods employed.

COMMENTS:

An automated "bonderlubing" installation consisting of 9 tanks and serviced by an overhead chain hoist prepared blanks for the cold forging presses. Bevelled gear blanks were cold forged in one blow on the cold forging press.

FIRM:

Stanley Works (G.B.) Ltd.

ADDRESS:

Sheffield (2 plants).

PRODUCTION: Reported to be 180 claw hammers and 250 ball pein hammers per hour.

PRINCIPAL PRODUCTS:

Hammers, chisels, screwdrivers, wood planes, and other hand tools.

EMPLOYEES:

Approx. 200 employees, including 8 forgers and six helpers.

Average wage: women \$33.50 per week.

forgers 63.75 per week

die sinkers 56.50 per week

Bonus incentive system.

PLANT EQUIPMENT:

Four strap hammers 1,200 lbs. capacity, "C - frame" trim presses.

Conventional heating furnaces.

Stevens Bullivant Rotary swaging machine for production of screwdriver bits.

DIE SHOP:

Own die shop with 9 employees.

100 percent own tooling.

Unique twin-head vertical milling machine made by Fritz Hursthal of

Germany.

SECONDARY OPERATIONS & HEAT-TREATMENT:

Electrically heated lead pots for heating and quenching of hammer heads.

Pit-type annealing furnaces with propane atmosphere.

Shaker hearth heat-treating furnaces with endothermic atmosphere.

COMMENTS:

Several Dennison hydraulic presses for the assembly of handles with the

hammer heads.

Changing oil fired furnaces in the forging shop to induction heating.

Very modern and clean plant.

FIRM:

Firth-Derihon Stampings Ltd.

ADDRESS:

Dale Road North, Darley Dale, Matlock, Derbyshire.

PRINCIPAL PRODUCTS:

45% — automobile components

25% - heavy automotive parts

10% - aircraft forgings, including titanium parts

Balance - general engineering

EMPLOYEES:

Total employment: 350 hourly rated employees including 100 in die shop.

Press operator's average wage \$58. to \$63.75 per week. All employees on an

incentive scheme. Die sinker's wage — \$56. per week. Indirect workers \$41.00 to \$43.50 per week.

PLANT EQUIPMENT:

5 mechanical forging presses: one -500 tons, two -1000 tons, one -1600 tons, one -2500 tons. Lamberton and Covmac upsetters up to 4 in. capacity. Wilkins and Mitchell trim presses. Rotary or pusher-type gas heated furnaces for heating forging stock. Wilkins and Mitchell billet shears and Russell automatic saw. Jaco die spray units on some presses.

DIE SHOP:

Conventional die making equipment.

SECONDARY OPERATIONS & HEAT-TREATMENT:

9 batch heat-treating furnaces.1 continuous heat-treating furnace.

QUALITY CONTROL AND INSPECTION:

Sophisticated inspection procedures on aircraft parts, including ultrasonic testing.

COMMENTS:

All automated material handling utilizing gravity feed or vibrating conveyors.

FIRM:

Firth Brown Ltd.

Atlas Works.

ADDRESS:

Sheffield (Associate Company of Firth-Derihon Stampings Ltd.)

PRINCIPAL PRODUCTS:

Ingots up to 75 long tons.

Finished hollow forgings up to 13' 6" forged outside diameter. Products include steam turbine, alternator and gas turbine rotors, marine forgings, pressure vessels, forged steel rolls up to 36" in diameter.

PLANT EQUIPMENT:

Electric arc melting furnaces up to 30 long tons capacity.

Hydraulic forging presses of 6,000, 4,000, 1,750, 800 and 600 tons capacity with rail or mobile-type manipulators.

Gas or oil heating furnaces up to 35' long, 18' wide and 13' high.

Light forging hammers up to 1 long ton capacity.

Reheating and annealing furnaces.

Electroslag remelting, vacuum remelting and vacuum degassing facilities.

DIE SHOP:

Exclusive die and machine shops with lathes accepting products up to 100' long and planing machines taking parts 15' 6" wide and up to 30' long.

SECONDARY OPERATIONS & HEAT-TREATMENT:

Elaborate heat-treating equipment capable of accommodating ingots up to 200 tons.

QUALITY CONTROL AND INSPECTION:

Every known type of inspection equipment available.

COMMENTS:

Two-stand 28" reversing billet and bar mill, bar mills 8" to 14" capable of rolling rounds, squares, flats and special section bars.

Ring and tyre mill.

FIRM:

B. & S. Massey Ltd.

ADDRESS:

Openslaw, Manchester.

PRINCIPAL PRODUCTS:

Forging equipment such as hammers, presses, reducer rolls, rolling stock tie rolls, etc. Also an open-die forging plant for internal requirements.

EMPLOYEES:

Total employment approximately 1,500, including 500 in the fabrication of their line of forging hammers and about 300 in the steel fabricating division. 90 percent of employees on incentive. Average wage with incentive bonus \$59 to \$62 per week.

PLANT EQUIPMENT:

Extensive fabricating and machining facilities as required by a large equipment manufacturer.

QUALITY CONTROL:

Conventional quality control facilities and equipment.

COMMENTS:

To develop competency in designing and building cold forging equipment,

Massey are presently producing cold forged parts for sale.

Also operate a cast iron foundry and a structural steel fabricating plant.

FIRM:

Heuer-Hammer.

ADDRESS:

Letmathe-Untergruene near Iserlohn.

PRINCIPAL PRODUCTS:

Heavy open-die and drop-forgings, mainly hooks, lift truck forks, etc. from 5 to 250 metric tons. Also fabrication of wire-rope lifting devices and cold-

heading machines.

EMPLOYEES:

Total employment: 180, including 35 open-die forgers, 5 heat-treating employees, 15 machine operators, 40 general shop workers, 50 clerical staff.

PLANT EQUIPMENT:

3 C-frame hammers.

1 large double-column hammer.

2 large mechanical manipulators for open-die forging billets.

DIE SHOP:

Well equipped machine shop for finishing work.

SECONDARY OPERATIONS & HEAT-TREATMENT:

2 oil-fired heat-treating furnaces.

QUALITY CONTROL AND INSPECTION:

Ultrasonic and Magnaflux testing.

COMMENTS:

Siemens production control system recording machine running time for

management control purposes (cost 50,000 DM - \$13,500).

FIRM:

Stahlwerke Bruninghaus.

ADDRESS:

Werdohl, Im Ohl 3.

PRODUCTION: 2,000 tons of forgings per month.

PRINCIPAL PRODUCTS:

Wheel hubs for trucks, ring gears, crankshafts, cold forgings.

EMPLOYEES: Total employment: 450.

PLANT EQUIPMENT:

Six Eumuco presses 400 to 1000 ton capacity. Kieserling cold forge automatic transfer press. AEG Elotherm, 3000 cycle induction heaters.

12 hammers, including 4 counterblow, 1½ to 25 metric tons.

Reducer rolls. Cold forging.

DIE SHOP:

Conventional tool and die making facilities. EDM equipment on order.

SECONDARY OPERATIONS & HEAT-TREATMENT:

3 pusher-type quench and temper furnaces with oil and water quench.

3 shotblasting systems. Normalizing furnaces.

QUALITY CONTROL AND INSPECTION:

Hot and cold inspection methods.

Magnaflux inspection.

COMMENTS:

Latest mechanized material handling techniques.

High degree of machine utilization and of labour productivity.

Experimenting with cast dies for presses and hammers.

FIRM:

Fried, Krupp Huttenwerke AG, Bochum Works.

ADDRESS:

Bochum, Alleestrasse 165.

PRODUCTION: 3,200 metric tons per month — largest in Germany.

8% exported directly, more indirectly.

PRINCIPAL PRODUCTS:

Forgings for automotive, marine and rolling stock applications.

45 various steel analyses used, including stainless steel.

EMPLOYEES:

580 employees in forge shop.

Average wage \$1.62 per hour, die shop \$1.57 per hour.

Incentive system for plant employees cancelled at union's request.

PLANT EQUIPMENT:

Maxipresses, Ajax, Wagner - Dortmund presses 1600-6000 tons.

Nasal type or counterblow hammers 4-35 metric tons.

Upsetters 900-2000 tons. Eumuco rolls and trim presses.

SECONDARY OPERATIONS & HEAT-TREATMENT:

Continuous water and oil quench and temper furnaces. Shotblasting of large parts on an overhead monorail. Town-gas heating being converted to natural

QUALITY CONTROL AND INSPECTION:

All conceivable modern testing and inspection methods, including magnatest, ultrasonic, magnetic particle inspection, etc. Portable ultrasonic testing for large marine valves.

COMMENTS:

Automatic die spray methods and hand lubrication commonly used. Overhead counterbalanced hoists were commonly used for handling heavy material.

FIRM:

C.A. Schlemper.

ADDRESS:

Bruhlerstrasse 74, Solingen

PRODUCTION: About 700 metric tons of forgings monthly.

PRINCIPAL PRODUCTS:

Heavy automotive and general purpose forgings from carbon, alloy and stain-

less steel.

EMPLOYEES:

Approximately 350 employees, including 68 in die shop.

Average wage \$1.90 to \$2.16 per hour. Toolmaker's wage up to \$2.60 per hour.

All employees on incentive.

PLANT EQUIPMENT:

3 Lasco hammers.

8 belt-type hammers up to 4 tons.

2 - 13 tons counter blow hammers.

2 - 600 tons upsetters. Eumuco forging rolls.

Lasco electro-hydraulic press. (Hammer unit 18 metric tons, hydraulic press

630 tons.)

Gas fired furnaces. Roll forming machines.

DIE SHOP:

All dies and tools made in own die shop.

Separate facilities for heat-treatment of dies.

SECONDARY OPERATIONS & HEAT-TREATMENT:

Tray-type continuous water and oil quenching and tempering furnaces made

by G. Schmid of Solingen.

Also normalizing and annealing furnaces.

QUALITY CONTROL & INSPECTION:

Contact type Magnaflux units on conveyorized inspection stations.

COMMENTS:

All products marketed through agents.

FIRM:

Walter Gott Gesenkschmiede GmbH.

ADDRESS:

Solingen - Foche.

PRINCIPAL PRODUCTS:

Hand tools, automotive and agricultural forgings.

EMPLOYEES:

575 employees, including 96 in the forge shop and 60 in the die shop.

Average wage \$1.22 - \$1.62 per hour. Hammer operators \$1.90 - \$2.18 per hour.

PLANT EQUIPMENT:

About 50 forging hammers of various types.

Berrenburg friction screw press.

Eumuco reducer rolls. Peddinghous shear presses.

DIE SHOP:

90 percent of tools and dies made in own die shop. Milling, hobbing and

E.D.M. facilities. Sach & Kiessalbach hydraulic press.

SECONDARY OPERATIONS & HEAT-TREATMENT:

Gas fired pit-type heat-treating furnaces.

QUALITY CONTROL AND INSPECTION:

Elaborate Magnaflux inspection facilities.

COMMENTS:

Very efficient forging plant with high output and machine utilization rate.

Hand tools are sold through agents, including in export markets.

FIRM:

Belzer - Werke.

ADDRESS:

Hastenerstrasse 4-8.

Wupperstal-Cronenberg.

PRODUCTION: Most forgings purchased from small independent firms.

PRINCIPAL PRODUCTS:

Special tools for aircraft, railway, machine-building and other industries. About 30,000 various items, of which some 7,000 are produced con-

tinuously.

EMPLOYEES:

Approximately 700, including 450 production, 60 technical and 190 office

employees.

Average wage \$1.78 per hour.

Fringe benefits additional 60% of wages.

PLANT EQUIPMENT:

1 Lasco drop hammer and four strap hammers.

4 upsetters and several friction screw presses for coining.

SECONDARY OPERATIONS & HEAT-TREATMENT:

Extensive secondary operations for finishing, heat-treating and assembling of hand tools. Box, pit and continuous type heat-treating furnaces, including salt pots.

COMMENTS:

Subsidiary plants in Belfast, Ireland and Sao Paulo, Brazil. Computerized

order tracing and invoicing and payroll calculation system.

FIRM:

Carlo Raimondi & Co. S.A.S.

ADDRESS:

Rescaldina, near Milan.

PRINCIPAL PRODUCTS:

Forged and cast valves, flanges and fittings for the petroleum, water and gas

industries.

Forged valves up to 2 in. diameter in carbon, alloy and stainless steel.

EMPLOYEES:

700 people, including 40 in the forge shop.

Average wage 350 Lira per hour, plus incentive pay 250 Lira, equal to about

\$1.00 per hour.

PLANT EQUIPMENT:

7 Nasal type hammers.

5 Air drop hammers.

Oil fired furnaces.

COMMENTS:

All dies and tools purchased from outside sources. New machine shop, built

one year ago equipped with conventional but modern machinery. The com-

pany also produces castings in bronze, iron and stainless steels.

FIRM:

Italsider.

ADDRESS:

Lovere, near Bergamo.

PRODUCTION: 100,000 tons per year of vacuum cast steel.

12,000 tons per year of steel castings. 25,000 tons per year of railway axles.

18,000 tons per year of miscellaneous forgings.

PRINCIPAL PRODUCTS:

Open die forgings: - railway wheels, rims and axles, piston rods, turbine shafts, rotors, rolls and pinions for rolling mills.

EMPLOYEES:

Total employment - 2,200.

PLANT EQUIPMENT:

5 electric arc furnaces of 35 ton capacity.

Vacuum casting equipment.

Oil fired heating furnaces with revolving hearth of 14 ton/hour capacity.

6,000 ton forging press with electronic controls.

Two 2,000 ton, two 800 ton presses.

MACHINE SHOP:

Approximately 300 pieces of machinery for boring, planing, milling, shaping, drilling, etc.

SECONDARY OPERATIONS & HEAT-TREATMENT:

26 gas and oil-fired furnaces.

6 electric furnaces.

Facilities for differential quenching and flame hardening.

Modern oil-fired continuous furnace approximately 250 ft. long.

QUALITY CONTROL AND INSPECTION:

Most advanced quality control and testing equipment, including the biggest Gamma-ray industrial installation in Europe.

FIRM:

SKF - R.I.V. Officine di Villar Perosa.

(Subsidiary of Aktiebolaget Svenska Kullanerfabriken, Sweden).

ADDRESS:

Villar Perosa, near Torino.

PRODUCTION: Villar Perosa plant: 85,000 bearings per day, consuming 30 - 32 metric tons

of steel forgings per day. Nine SKF plants in Italy: 400,000 bearings per day.

PRINCIPAL PRODUCTS:

Ring-type forgings from 80 mm. to 1.5 m. (3.15 to 59 in.) in diameter.

EMPLOYEES:

Total employment in Villar Perosa: 2,900 including 110 in forge shop.

Average wage: 500 Lira per hour (\$0.85) for unskilled workers. 600 - 650

Lira per hour (\$1.00) for skilled workers. Fringe benefits over 100% of direct wages.

PLANT EQUIPMENT:

2,500 ton Lamberton, 2,500 ton Maxipress, Eumuco press, ring rollers.

Induction heating using equipment made by ASEA of Sweden.

Kreuser-Wagner hammer.

SECONDARY OPERATIONS & HEAT-TREATMENT:

Lindberg batch case hardening furnaces.

COMMENTS:

Spiral conveyor for vertical material transfer to feed induction heaters.

Gravity conveyors and chutes commonly used.

Hot shearing of billets with automatic weighing of slugs.

New forging plant under construction to be equipped with the most modern equipment and capable of producing three times the present production.

FIRM:

Renault.

ADDRESS:

Billancourt (near Paris).

PRODUCTION: Approximately 2500 m. tons of forgings per month.

PRINCIPAL PRODUCTS:

All automotive forgings for Renault and Peugot cars.

EMPLOYEES:

1300 employees in forge plant.

300 in die shop.

PLANT EQUIPMENT:

15 hammers 680 to 6000 Kg. capacity.

6 mechanical presses 1200 to 3000 m. tons.

4 horizontal upsetters.

11 screw presses 120 to 600 m. tons.

8 billet shears 120 to 1000 m, tons.

10 circular and 4 alternating billet saws.

Oil fired furnaces and induction heaters, reducer rolls, 1600 and 2500 m. tons hydraulic cold forging presses.

DIE SHOP:

Four ECM and several EDM machines.

Large well equipped machine shop with lathes, milling and copying machines.

SECONDARY OPERATIONS & HEAT-TREATMENT:

3 continuous quench and temper furnaces.

2 continuous isothermal annealing furnaces.

Various batch-type furnaces.

Shot-blasting, pickling and grinding equipment.

QUALITY CONTROL AND INSPECTION:

Modern quality control and non-destructive testing procedures employed.

COMMENTS:

A second forging plant at Hagondange, Lorraine, contains 4 hammers up to 1800 Kg., 6 presses up to 3000 m. tons, 4 upsetters, heat-treating, finishing and die making facilities. Hammer-forging operations progressively being phased out in favour of presses.

FIRM:

Forgevis, subsidiary of Simca-Chrysler Corp.

ADDRESS:

Sully sur Loire.

PRODUCTION: 30,000 tons of forgings per year, mostly automotive, for Simca, Massey-Ferguson, Fiat, Volvo, Renault, etc. Supply 40% of Simca forging requirements. 70% of plant's output shipped to Simca, balance exported throughout Europe to Massey-Ferguson, Fiat, etc.

PRINCIPAL PRODUCTS:

Forgings from a few ounces to 60 lbs., including crankshafts, conrods, axle shafts, etc.

EMPLOYEES:

Total employment: 850.

Average wage 6.0 francs per hour (\$1.20) plus 62% fringe benefits. Actual working days 220 per year. Four weeks annual holiday.

Year-end bonus equal to a full month's wages.

PLANT EQUIPMENT:

17 forge presses 300 to 4500 tons.

4 upsetters 1" to 4".

4 hammers.

6 friction screw presses 330 lbs. to 2200 lbs.

3 reducer rolls.

Equipment manufacturers: Hasenclever, Keiserling, Eumuco, Bliss, Ajax.

5 billet shears, including Lamberton and Hill-Acme.

DIE SHOP:

Well equipped tool and die shop including: Droop and Rein copy milling machines, Cincinnati Hydrotel etc. EDM equipment by USEM S.A. and a new

USEM S.A. horizontal machine for making graphite electrodes.

SECONDARY OPERATIONS & HEAT-TREATMENT:

Continuous quench and temper furnace with alternate oil and water quench tanks. Four tumble-type Pangborne shot blasting units.

QUALITY CONTROL AND INSPECTION:

Dry Magnaflux inspection system.

COMMENTS:

Automatic unscrambler on one billet shear.

FIRM:

Société Bar Lorforge, subsidiary of Société des Acieres de Pompey.

ADDRESS:

Bar sur Aube.

PRODUCTION: 700 to 800 different parts per month.

30% automotive components, balance for farming equipment, aircraft indus-

try, motor bikes, railways and defence.

Monthly output: 3,000 tons.

PRINCIPAL PRODUCTS:

30,000 conrods and 40-45,000 crankshafts per month. Other products in quantities as low as 20 to 450 pieces.

Steel, aluminum and other non-ferrous forgings from a few ounces to 100

lbs., average 21/2 lbs. weight.

EMPLOYEES:

Total employment: 400 including 65 in the die shop.

Hourly wages: 3.5 francs (\$0.70) - labourers.

5.0 francs (\$1.00) - forge operators

5.0 - 6.0 francs (\$1.00 - \$1.20) - die sinkers

7.0 - 8.0 francs (\$1.40 - \$1.60) - press operators

Fringe benefits 80% of direct wage costs.

PLANT EQUIPMENT:

20 presses and board drop hammers.

Slot type and circular rotary type furnaces.

Weingarten friction screw presses. Wilkins and Mitchell trim presses.

DIE SHOP:

Extensive facilities producing up to 300 die sets per month. Large and orderly

die storage department.

SECONDARY OPERATIONS & HEAT-TREATMENT:

Continuous quench and temper furnace, 9 tons per day capacity.

COMMENTS:

Experimenting with cast forging dies.

FIRM:

Société Bar Lorforge.

ADDRESS:

Custines.

PRODUCTION:

900 tons of open-die forgings per month.

1400 tons of drop forgings per month.

PRINCIPAL PRODUCTS:

Large ring gears, wheel spindles, flanges, C-clamps, rings, etc.

EMPLOYEES:

500-600 employees including 200 in drop forge plant, 140 in open die shop,

70 in die making.

Hourly wages: 5.0 francs - \$1.00 - die sinkers. 6.0 - 6.5 francs (\$1.20 -

1.30) - average for forge shop employees.

44 hours - 5½ day working week.

4 to 5 weeks annual holidays.

PLANT EQUIPMENT:

Capacity of hammers in kilogram-meter: 16,000 - 15,000 - 10,000 - 6,300

-3,200 - 800 - 200.

Presses in tons: 2500 - 2000 - 1300 - 650.

Upsetters: one 5", two 3", one 2".

3 billet shears and 3 saws.

SECONDARY OPERATIONS & HEAT-TREATMENT:

Conventional batch heat-treat furnaces.

Continuous quench and temper furnace.

One controlled atmosphere box furnace for die work.

COMMENTS:

Material handling by powered conveyors, chutes and hand operations.

FIRM:

Patricio Echeveria S.A.

ADDRESS:

Legazpia, Spain.

PRINCIPAL PRODUCTS:

Forgings for automotive, machinery, armament, aircraft, mining and other industries. Hand tools, garden and agricultural tools, files and rasps. Also carbon and alloy steels, including stainless in various shapes.

EMPLOYEES:

3200 employees, of which 280 are in the forge plant.

Average annual wage equivalent to U.S. \$1,500. 48 hrs. working week.

Fringe benefits about 50% of the hourly wage rate.

PLANT EQUIPMENT:

Oil-fired slot-type heating furnaces and induction heating units. Five Erie air-operated drop hammers and five Erie board drop hammers; roll forming machines; hot trimming presses; 2500 ton Maxipress for production of large gear blanks. Soleco billet shear, which twisted the bar resulting in a more square cut.

DIE SHOP:

Modern die making facilities with four twin-head Rigid die sinking machines.

Four Agietron EDM machines using forged copper electrodes.

SECONDARY OPERATIONS & HEAT-TREATMENT:

Three large in-line pusher type furnaces using trunnion trays.

COMMENTS:

Medium size specialty steel producer with two arc melting and two induction

melting furnaces and a conventional rolling mill.

FIRM:

Irimo S.A.

ADDRESS:

Legazpia, Spain.

PRINCIPAL PRODUCTS:

Open-end, combination and box wrenches, pliers, pipe wrenches, centre pun-

ches and other tools.

EMPLOYEES:

300 employees.

50 hours working week.

Forge shop operators 30-40 pesetas (Can. \$0.50) per hour.

Tool room employees 20-30 pesetas (Can. \$0.40 - 0.45) per hour.

PLANT EQUIPMENT:

Conventional oil-fired heating furnaces. Two Lasco drop hammers, one strap

drop hammer, two chain drop hammers. Horizontal upsetters.

DIE SHOP:

Conventional die sinking equipment.

Two EDM machines by U.S.E.M., one by O.N.A.

SECONDARY OPERATIONS & HEAT-TREATMENT:

Electrically heated controlled atmosphere water or oil quench and temper

furnace.

QUALITY CONTROL AND INSPECTION:

Conventional quality control procedures.

PART 3

APPENDICES

APPENDIX IA MEMBERS OF CANADIAN FORGING MISSION

Name	Title	Firm
Jack C. Haun	General Manager (also President of the Canadian Forgings Association)	Haun Drop Forge Co. Ltd. Division of Gray Forgings and Stampings Ltd. Welland, Ontario
Ken H. Jones	Engineering Manager (also Vice-President of the Canadian Forgings Association)	Thompson Products, Ltd. St. Catherines, Ontario
Dr. Walter Morris	Director of Commercial Development	Crucible Steel of Canada Ltd. Montreal, Quebec
Wallace H. Nutt	General Manager	ETF Tools Ltd. St. Catherines, Ontario
Art T. Davies	Plant Manager	Canadian Warren Pink Division, Dominion Chain Company Ltd. St. Catherines, Ontario
T.P. Misener	General Manager	Welland Forge Ltd. Welland, Ontario
Nickolas M. Switucha	Mission Secretary	Department of Industry Trade and Commerce Ottawa, Ontario

APPENDIX IB COMMERCIAL FIRMS AND INDUSTRIAL ASSOCIATIONS VISITED BY THE CANADIAN FORGING INDUSTRY MISSION

FIRM AND ADDRESS UNITED KINGDOM

National Association of Drop Forgers and Stampers, Grove Hill House, Handsworth, Birmingham

Garringtons Ltd., Newton Works, Bromsgrove

Smethwick Drop Forgings Ltd., Stourport Road, Kidderminster

Bescot Drop Forgings Ltd., St. Paul's Road, Wednesbury, Staffs

Clydesdale Stampings Ltd., Atlas Works, Netherton, Dudley

The Staffordshire Edge Tool Co. Ltd., Cradley Heath, Staffs.

Abbey Dropforgings Ltd., Churchbridge Works

Elliott-Lucas Ltd., Cannock

English Steel Corp. Ltd., Brightside Lane, Sheffield.

Stanley Works (G.B.) Ltd., Sheffield

CONTACTS

Mr. J.L. Hewitt, President Mr. A.L. Stuart Todd, Director Mr. Ken Abbott, Technical Officer

Mr. G. Onions, Director & General Manager Mr. R.K. Johnson, Chairman Mr. Irvin Betford, Works Manager

Mr. A.W. Penning, Chairman Mr. A.G. Bradbury, Director Mr. J. Birthwhistle, Technical Director

Mr. T.N. Biggings, Director & General Manager

Mr. C.A. Roper, Chairman
Mr. N. Harlow, Managing Director
Mr. L.A. Cartwright, Commercial Director

Mr. P.T. Silvers, Managing Director

Mr. N.L. Elliott, T.D., Managing Director

Mr. Reekes, Development Engineer

Mr. R. Dunn, Manager - Forged Products

Mr. Brian Grasson

Mr. T. Mills, Managing Director Mr. A.B. Chambers, Manager

Drop Forging Research Association, Sheffield

Dr. P.H.R. Lane, Director of Research Mr. Norman McGowan, Information Officer Mr. A. Thomas, Senior Scientific Officer Mr. J.M. Haywood, Liaison Officer

The Firth-Derihon Stampings Ltd., Dale Road North, Darley Dale, Matlock, Derbyshire

Mr. H.G. Brown, Chairman Mr. B.W. Battersby, Sales Director Mr. G.E. Leyborne, Director & General Works Manager

Firth Brown Ltd., Atlas Works. Sheffield

Mr. J.A. Croft, Export Manager Mr. K.C. Barraclough, Manager - Vacuum Melting Department

B. & S. Massev Ltd., Openshaw, Manchester Mr. Tom Watson, Plant Superintendent

Mr. J.S. Byam-Grounds, Managing Director Mr. Christopher N. Massey, Assistant Export Sales Manager

Mr. John Callagham

Mr. W.J. Moriarty, Export Sales Director

GERMANY

German Forging Association, Stahlverformung House, Hagen-Emst, Goldene Pforte 1. Mr. Herbert Schmidt-Cotta, Executive Director

Heuer-Hammer, Letmathe-Untergruene near Iserlohn

Mr. H. Th. Heuer, Owner

Stahlwerke Bruninghaus GmbH., Werdohl, Im Ohl 3.

Mr. Horst Korte, Director

Fried. Krupp Huttenwerke AG, Bochum Works,

Mr. Reinh. Lenzner, Director

Bochum, Alleestrasse 165.

Mr. Hans Hermann Oehler, Managing Director Dipl.Ing. Kurt Grunberg, Works Director

Dipl-Ing. Adolf Sickbert Mr. Werner Samtleben, Engineer

C.A. Schlemper, Solingen, Bruhlerstrasse 74 Mr. Carl-Albert Schlemper, Partner Mr. Claus Schlemper, Partner

Walter Gott Gesenkschmiede und Machinenfabrik GmbH., Solingen-Foche, Fochestrasse Mr. Jurgen Gott, Managing Director

Belzer-Werke, Wuppertal-Cronenberg, Hastenerstrasse 4 - 8 Mr. Gunter Dorken, Partner

Forging Department of Daimler-Benz A.G.,

Mr. Otto Raible, Manager — Forging Department

Mr. Stoehr, Works Manager Mr. Dietrich Suck, Engineer

Stuttgard - Unterturkheim

ITALY

Officine Fonderie, Carlo Raimondi & Co., S.a.s.,

Rescaldina, near Milan.

Italsider,

Lovere, near Bergamo

SKF-RIV Officine di Villar Perosa,

Torino

FRANCE

Syndicat National de L'Estampage et de la Forge, 10, Avenue Hoche,

75 Paris 8^e

Renault (Centra les Forges) 10, Avenue Emile Zola, Boulogne-Billancourt Mr. Donato Raimondi, Owner

Mr. Mario Pasquinelli

Miss Minotto, Export Promotion

Dr. Alvaro Fontana, Engineering Manager

Mr. Rag. Grandi

Dr. Agostino De Negri, Works Manager

Mr. Eridano Parodi, Director

Dr. Federico Balmas, Secretary General

Mr. Colla, Plant Manager

Mr. Anders Carlen, Assistant Plant Manager

Mr. Carine, Engineer

Mr. A. Macchia, Director General Mr. A. Chamouard, Engineer

Mr. Maurice Bardin, General Secretary

Mr. C. Martinet, Directeur des Methodes,

Centre des Forges

Mr. De Longcamp, Directeur de L'UFMB, Usine

Fabrication Mecanique de

Billancourt

Mr. Faure, Engineer

Forgevis, S.M.A.

(Societe de Metallurgie

'Automobile'),

Sully sur Loire

Mr. Christ. Cardoux, Director

Mr. Francis Gerardin, Director General

Mr. Gaston Provost, Manager - Forging Division

Mr. Pierre Thevenet, Assistant Manager -

Forging Division

Mr. Roland de Chaudenay, Controller

Societe Bar Lorforge,

Bar sur Aube

Mr. Foret, Director

Mr. Simonard, Manager

Societe Bar Lorforge,

Custines

Mr. Caffiot, Director

Mr. Arnould, Chief of Laboratories

Mr. Lampietti, Chief of Production Planning

Mr. Bourgeois, Sales Manager Mr. Vannier, Engineering Manager Mr. Littmann, Personnel Manager

SPAIN

Patricio Echeveria S.A.

Legazpia, Spain

Irimo S.A.

Legazpia, Spain

Mr. Roman Echeveria, Plant Manager

Mr. Jose Luis Aguirre, Manufacturing Manager

APPENDIX IIA LIST OF GERMAN MANUFACTURERS OF COLD FORGING EQUIPMENT

MECHANICAL PRESSES

Firma

565 Solingen

Kieserling & Albrecht

Birkenweiher 66

Werkzeugmaschinen-

fabrik

Tel. 2831

Tx: 8514813

Eumuco AG.

für Maschinenbau

509 Leverkusen Tel. 71141

Tx: 8510821

L. Schuler, GmbH.

Maschinenfabrik

732 Göppingen

Bahnhofstr. 41

Tel. 661

HYDRAULIC PRESSES

Eitel KG.

75 Karlsruhe

Werkzeugmaschinen-

Wikingerstr,13

fabrik

Tel. 52955 Tx: 7825611

Fritz Müller

73 Esslingen

Pressenfabrik

Tel. 356941

Tx: 722283

AUTOMATIC FORGING PRESSES

J.G. Kayser GmbH.

85 Nürnberg

Regensburger Str. 420

Tel. 405071

Tx: 622150

Malmedie & Co. GmbH.4000 Düsseldorf

Maschinenfabrik

Königsberger Str. 87

Tel. 785231

Tx: 8582651

Pelzer & Ehlers

415 Krefeld

Maschinenfabrik

Diebner Bruch 130

Tel. 50161

APPENDIX IIB HATEBUR 1201 AUTOMATIC FORGING MACHINE* AT GARRINGTONS, LTD.

Garrington's Ltd., one of the G.K.N. group of companies, installed a new addition to their Bromsgrove plant, a large £750,000 automatic forging machine designed by the Swiss firm of Hatebur.

This unit can produce circular forgings at rates up to 4200 pcs. per hour with tolerances within 0.012 in., thus being far superior in terms of productivity and dimensional accuracy than any most advanced conventional forging press.

The Hatebur 1201 hot-forging machine is an automatic transfer press of the horizontal type designed for multi-stage operations. The total weight of the machine is 165 tons and the combined forging tonnage is 1,200 tons. The maximum forging diameter is 4.75 in., maximum height 3.15 in. and maximum weight 6.75 lb. The stroke of the press ram is 12.6 in., of the shearing slide 10.25 in., of the die ejector 5.12 in. maximum, and of the punch ejector 2 in. maximum: maximum feed length is 5.5 in. The cycle of movements of various assemblies is controlled by camshafts driven through a series of spur and bevel gears.

In spite of the vastly increased rate of production, as compared with standard press forging practice, the life of tools in the 1201 is claimed to be longer because of less wear through improved tooling design, incorporating interchangeable wearing surfaces. Added to this is the advantage of special water cooling, which prevents overheating of punches and dies and reduces scaling of forgings to a minimal degree.

The steel bars from which the forgings are to be made range in length from 14 ft. to 19 ft. and in diameter from 1-9/16 in. to 2-3/8 in., the speed of production depending on the size of the finished forging. They are delivered in bundles by an overhead crane to a conveyor and loaded into a magazine from which they are automatically fed into the Birwelco resistance-type heater. This operates from a single-phase heating transformer which has an input voltage of 6,000 and an output voltage ranging from 70 to 120 in seven steps with a low-voltage current of 33,350 amps. A full length bar is heated to forging temperature in less than a minute.

From the heater, the bar is transferred on rollers to the holding furnace, which is of the radiant tube type fitted with eighteen silicon carbide elements and rated at 90 KW. The furnace is located on two rails which allow it to be swivelled away to permit access to the forging machine.

Leaving the holding furnace the bar, retained at the forging temperature, is guided into the forging machine. The bar is sheared and a sequence of up to four forming operations is simultaneously performed. In this way a finish forged component is produced at every stroke, without flash. The third and fourth stations may be used for forming or piercing. All tooling is water cooled. With a view to preventing any mishap to the machine, there are twenty-seven built-in devices which halt the operations should any fault occur.

The forged components are delivered from the machine by an inclined conveyor, past a random inspection point, to a delivery and sorting station outside the forge building. Here the forgings are deposited into trucks for delivery to stock or for further treatment. The trucks into which the forgings are deposited are drawn by conveyancer robot tug units guided by a wire set into the concrete runway.

* F.B. Hatebur, Basel/Schweiz, Spiegelgasse 4, Postfach Basel 1.

The machine is designed to be operated by a crew of three men: one operator, one inspector and one helper to load bars on to the transport mechanism feeding the resistance bar heater.

The range of forgings which the machine can produce in high volume is suited to the requirements of those industries employing circular components such as gear blanks, flanges, bearings, etc. Bearings can sometimes be forged to form both inner and outer races simultaneously from the same piece.

APPENDIX IIIA

COMPARISON OF SOCIAL SECURITY CONTRIBUTIONS IN GERMAN, FRENCH AND BRITISH FORGING INDUSTRY AS OF MARCH 1967

(expressed as % direct wage cost)

1. Legally Prescribed Payments by the Employee

A. GERMANY

Contributions:

Health insurance	5.50%
Old age pension	7.00%
Unemployment insurance	0.65%
	13.15%

B. FRANCE

Contributions:

Social insurance	6.00%
Old age pension (supplement)	1.25 - 2.00%
Unemployment insurance	0.05%
	7 30 - 8 05%

C. GREAT BRITAIN

Contributions:

National insurance	3.35%
Accident insurance	0.26%
Health insurance	0.74%
Old age pension	1.50 – 2.50%
	5.85 - 6.85%

2. Legally Prescribed Payments by the Employer

A. GERMANY

Contributions:

Health insurance	5.50%
Old age pension	7.00%
Unemployment insurance	0.65%
Payment of wages in the event of illness	
(up to 6 weeks) approx.	1.00%
Accident insurance	3.50%
	17.65%

B. FRANCE

Contributions:

Obligatory contributions with fixed rate:

Social insurance	13.50%
Family benefits	14.25%
Wage tax borne by company	5.00%
Housing contribution	1.00%
Apprentice tax	0.40%
Unemployment insurance	0.20%
Accident insurance	5.00 - 10.00%
Travelling expenses (Paris only)	
16.00 francs per month	
Costs with variable rate:	
Old age pension (supplement)	1.25 - 2.00%
Health service (annual examination)	
Compensation for employees who are not able to	
take their meals with their families at	
the normal times because of thier	
working hours.	

40.60 - 46.35%

C. GREAT BRITAIN

Contributions:

National insurance	3.80%
Accident insurance	0.25%
Health insurance	0.17%
Old age pension	2.50 - 5.00%
Welfare	0.23%
Training	2.50%
Paid Holidays	2.25%
	$\overline{11.70 - 14.20\%}$

APPENDIX IIIB TYPICAL LABOUR RATES IN THE BRITISH FORGING PLANT

RATE PER HOUR

			RATE PER HOUR
TRADES	British	Funds	Canadian Funds
	S	d	\$
Stampers	11	1½	1.43
Stampers Helpers	9	4¾	1.10
Mech. Press OP's	10	6¼	1.35
Maxi Press OP's	9	31/2	1.19
Torsion Plant	8	7	1.09
Fettlers	11	41⁄4	1.45
Straighteners	10	9¾	1.38
Straight's Labs	9	3	1.18
Sawyers	11	-1/4	1.40
Crack Detectors	9	5¾	1.21
Test Marker	6	-1/2	.78
Inspectors	10	31/4	1.31
Pickler	10	7½	1.36
Wheelabrator OP's	10	6½	1.35
Brinell Men	8	11%	1.14
Treatment Assistants	. 8	5¾	1.08
Despatch Men	7	4¾	.95
Smiths	10	3½	1.32
Rough Smiths	9	11/4	1.16
Strikers	8	8%	1.11
Hammer Drivers	8	5¼	1.07
Cropper Men	10	-3/4	1.29
Heller Sawyers	10	2	1.30
Grinders	11	4¾	1.45
Charge Hand Inspectors	8	71/4	1.09
Inspectors	8	3¾	1.06
Visual Examiners	7	-1/2	.91
Markers	7	-1/2	.91
Exam Labrs	6	3	.80
Final Visual Examiners	7	41/2	.95
Gangers	6	10%	.88
Gas Attendants	7	21/2	.93
Pyro Men	6	5	.82
Staca Drivers	6	8	.85
Crane Drivers — Gas	6	10½	.88
Truck Drivers	6	5	.82
Slingers — Gas	6	7½	.85
Accty Burner	6	-3/4	.78

Labourers	5	10½	.75
Slingers	6	5½	.83
Crane Drivers	6	10%	.87
Steel Examiner	7	3½	.94



QUEEN'S PRINTER FOR CANADA OTTAWA, 1970