Agriculture
Canada

Engineering Research Service

REPORT NUMBER:
6721-2

January 1974

Mechanical Details of a Belt Type Nursery Stock Lifter

G.B.Hergert H.H.DeVries

Contents

The use of brand names given for information only and does not imply endorsement. Equivalent brands may vary in dimension.

Contribution No. 419 from Engineering Research Service, Agriculture Canada, Ottawa, K1A 0C6.

MECHANICAL DETAILS OF A BELT TYPE NURSERY STOCK LIFTER

G. B. Hergert,
Engineering Research Service,
Research Branch,
Agriculture Canada,
Ottawa, Ontario, K1A 0C6.

and

H. H. DeVries,
G. Howard Ferguson Forest Station,
Ontario Ministry of Natural Resources,
Kemptville, Ontario, K0G 1J0.

1.0 Introduction:

Under a co-operative project between the Canadian Forest Service, Environment Canada, Ontario Ministry of Natural Resources and Engineering Research Service, Agriculture Canada, a belt type nursery stock lifter has been developed for harvesting tree seedlings for subsequent planting in reforestation projects.

1.1 The Crop:

The harvester was developed to lift conifer seedlings planted in beds 44 inches (1.11 m) wide with 6 rows spaced within the bed 8 inches (20.3 cm) apart. The seedlings could be from two to three years old and in some cases may be transplants. Heights vary from 6 to 16 inches (15 to 40 cm). Root structure, especially of seedlings, is very vigorous with roots as long as 20 inches (51 cm).

1.2 Background:

The requirement of many millions of seedlings for reforestation in Ontario has put a pressing labour problem on nurseries. A previous mechanical tree lifter was developed (1) and is now in commercial manufacture.[1]

---

[1]Grayco Harvesters Ltd., Heidelberg, Ontario.

However, the previous harvester presents the seedlings to the packing shed, disoriented in a bulk box. The harvester reduced field labour considerably but increased the amount of effort in the packing shed. The reasoning behind a belt type lifter is to present the nursery stock to the packing shed in an oriented way to reduce labour requirements in the packing shed. Other attempts have been made to produce a suitable belt type harvester (1-4) but none are in commercial production.

2.0 The Harvester:

The harvester consists of a main frame (A, Fig. 4) mounted on floatation wheels (B) and equipped with a steerable tongue (C), a control station (D), and belt frame (E) containing the lifting belts and drives and a cross conveyer mounting (F).

2.1 Main Frame:

The main frame of the harvester is made of 6 x 2 inch (15.25 x 5 cm) rectangular structural tubing welded oil tight to serve a second purpose as an oil resevoir. Floatation tires (B) are mounted under the frame on a straight axle. The tongue of the harvester (C) is attached to the main frame by a verticle pivot pin. A hydraulic cylinder (G) is used from the corner of the main frame to a point mid-way on the tongue to position the harvester on seedling rows by offsetting the tongue of the harvester. Provision is also included on the main frame to attach the belt frame (E), the side conveyer (F), the cutting blade (H), the shakers and drives (J) and a control station (D).

2.2 Belt Frame:

The belt frame is pivoted on the rear of the main frame and supported at the front by linkage from a hydraulic cylinder to permit lifting or lowering of the belt pick-up point in relation to the cutting blade which is attached to the main frame. Six pairs of belts are held within the belt frame using a similar mounting to the Virginia Nursery Tree Harvester (1). This design allows a large number of lifting belts to be positioned into a given width by locating the spring tensions and pulley supports above the product path. Double B section banded belts are used and are on 87 and 80 inch (221 and 203 cm) centres. Six matching idler pulleys in a staggered arrangement are used for each row to provide pressure for gripping the trees between the belts. Pressure is provided by a spring on the top of supports above a fulcrum point (see Fig. 2). Springs are also located in the nose pulley holders to keep a constant pressure on the belts lengthwise. All non-driven pulleys are mounted with bronze bearings and each pulley has groove scrapers to keep the grooves clean. Drive to the belts is via two hydraulic motors and chain threaded through drive sprockets to provide the correct rotation to each sprocket. Speed of the motors driving the belts is controlled by a flow regulator explained below.

2.3 Cutting Blade:

The cutting blade is mounted on the main frame with mounting alternatives to allow positioning of the blade horizontally. The cutting blade is six inches (15.25 cm) deep and is made of 5/16 inch (7.9 mm) thick abrasion resistant steel. The rear edge of the blade has extension bars on the row centres extending six inches (15.25 cm) which lets much of the soil fall through before subsequent root beating.

2.4 Soil Beaters:

The amount of soil to be removed from the roots of nursery stock after lifting is dependent on soil type and moisture content. Provision is made on this harvester for installation of up to three oscillating beater shafts which could have as many as five banks of beaters. The beaters have a ring made of .5 inch (12.7 mm) iron rod, six inches (15 cm) in diameter, welded to arms made of pipe 10 to 14 inches (25 to 35 cm) long depending on location. The beaters are mounted on 1-1/4 inch (31.8 mm) diameter shafts with a beater on each row centre. The beaters are operated by an eccentric shaft mounted over the frame at the front of the machine. Power to turn the eccentric shaft comes from the tractor power-take-off via a speed-up gearbox and a chain drive between the gearbox and eccentric shaft.

2.5 Side Conveyer:

A conveyer made of 3/8 inch (9.5 mm) diameter rod links is mounted at the rear of the harvester to convey the trees to a truck or wagon (Fig. 2). The conveyer is controlled by two hydraulic cylinders for height adjustment and folding for transport. The trees remain oriented crossways on the conveyer belt. The belt is powered by a hydraulic motor with speed controlled by a flow control valve.

2.6 Operator's Station:

A seat is provided near the front of the harvester. From there, the operator can control the row position of the belts for precise alignment, the height of the belts above the cutting blade, the speed of the belts and elevator position. All controls are hydraulic.

2.7 Hydraulic System:

Two hydraulic systems are incorporated in the prototype harvester. One system uses oil supplied by the tractor hydraulic system and is used for positioning functions from the operator's station. The prototye unit was equipped with an open centre valve bank which is operational for all tractors but not efficient for those equipped with "closed centre" or compensated flow systems. For applications where the only tractor to be used is equipped with closed centre hydraulics, a closed centre valve bank should be used (See #29, Fig. 2 and Appendix 1 Components List). Additional valve segments can be added to this system for other positioning functions such as vertical blade positioning and to eliminate the selector valve (#30, Fig. 2), for elevator positioning.

The second hydraulic system uses oil pressure supplied from a pump mounted on the power-take-off drive line to drive the three hydraulic motors on the harvester. Two motors are required to operate the belts to obtain sufficient torque from the available oil pressure. One motor is used to drive the loading conveyer. The motors are speed controlled by a combination of proportional and adjustable flow dividers to provide independent and adjustable rotation of motors (See Fig. 3).

The frame of the harvester is welded oil tight and acts as a resevoir for the motor hydraulic system. Hoses were used for the prototype for adaptability but should be replaced with steel tubing on any subsequent model for aesthetic reasons.

3.0 Construction Details:

A list of components used in the construction of the prototype harvester is given in Appendix I. Copies of shop sketches are available from Engineering Research Service, Agriculture Canada, Ottawa.

4.0 Discussion:

After one season's trials at two nurseries, the harvester was found suitable for harvesting nursery seedlings but some improvements can be made. It is very important that the rows of seedlings be equally spaced 8 inches (20.3 cm) apart in the 6-row seedbed configuration. Uniform spacing of seedlings within each row is desireable but not as critical as row spacing for successful removal of the seedlings by the 6 pairs of belts. The blade position was found critical for varying soil type and moisture content. The blade should, therefore, be hydraulic controlled in a horizontal plane frontand back. Shaker motion, especially in the upper beater positions, caused excessive vibrations even though the beaters were of balanced weight on each side of the beater shafts. The beaters must be secured with heavier attachments and larger precision bearings must be used in the linkage. The lifting belts worked well with very little problem with belts jumping from the pulleys. Some design improvement is warranted in preventing the entire belt system from tilting and to give more pressure on individual idler pulleys, but these problems are not critical. Suggestions have been made to incorporate a vibrating blade but experiments are required to prove the usefulness of such an attachment. Lighter chain can be used in the elevator attachment as the load of trees, with soil removed, is light. Presently, the harvester is adjusted for depth of penetration by the three point hitch of the tractor. This design is seldom used in agricultural machinery. A hydraulic operated tipping arrangement on the tongue would be better and would also give the harvester operator control of depth of cut. The hitch of the harvester would then be attached to the tractor draw bar giving better positioning control.

4.1 Further Development:

The second stage of the machine will be a gathering mechanism inserted between the belts and conveyer belt. Design is in initial stages to develop equipment that will gather trees from the belts in bunches, coils or a container for subsequent packaging or in some cases, direct shipment from the bed to planting site where bed quality and forest planting method allow.

5.0 References:

1. Heltzel, J.B. 1970. The Virginia forest tree seedling harvester. Tree Planters' Notes 21 (1): 27, 28.

2. Hergert, G.B. and W.E. Fagan. 1969. Notes on the modification of a potato digger to harvest nursery tree seedlings. Report 6721-1. Engineering Research Service, Agriculture Canada, Ottawa.

3. Hergert, G.B. and H.H. DeVries. 1968. Modification of a potato digger to harvest nursery tree seedlings. Forestry Chronicle 44 (5): 44 - 45.

4. Lott, J.R. 1971. Tree seedling harvester. Pres. A.S.A.E. Ann. Meeting, Pullman, Washington.

Appendix 1 (page 1)

Components List - Tree Digger - Project 6721

No.	Quantity	Item	Spec.	Source Code	Drawing No.
1	4	Hydraulic cylinder	Monarch 30 HC 08	1	3670 & 3676
2	2	Hydraulic motor	Grsen 10-16-1-4	1	3670 & 3676
3	6	Potato chain nose cones	Oscar Hill & Sons	2	3670
4	8	Potato chain idler pulley - nylon	Oscar Hill & Sons		3670
5	3	Chain type shaft coupler	See note #1		3670
6	1	Pillow block - 1-3/8 shaft	Sealmaster NP 22	6	3672
7	1	Universal joint 1½ to 1-3/8 round	Spicer 1200 series	3	3672
8	1	Gearbox	Durst A-17 1-3/4: 1 used as a speed-up	4	3672
9	1	Sprocket #60 - 23 tooth		1	3672
10	1	Pump adapter	G + G - SPA 1500		3672
11	1	Hydraulic pump	Gresen RJ-2000-100A	1	3672 & 3676
12	1	Sprocket #60 - 27 tooth		1	3672
13	3	Pillow blocks - 1½ shaft	Sealmaster NP 24	6	3672
14	1	P.T.O. Drive unit - shielded	Spicer 208950-1 - 1-3/8" quick connect to 1-1/2" round	3	3672
15	48	Pulleys 2-3/4" O.D. Double B Groove	1" bore	3	3674
16	120	Bushings 1" O.D., 3/4" I.D., 3/4" long - bronze		3	3674
17	12	Pulleys 3.2" O.D. Double B Groove	1" bore	3	3674
18	12	Pulleys 3.2" O.D. Double B Groove	1" bore - ¼ keyway	3	3674
19	40	Flange Bearings - 1" shaft	Sealmaster LFT-16C	6	3674
20	6	Belts - Powerband 2-B section	Gates 2B 195	5	3674
21	6	Belts - Powerband 2-B section	Gates 2B 180	5	3674
22	60	Snap rings - 1" shaft	Truarc 5100-75	3	3674
*23	65	Grease nipples - strait ¼ - 28 thread		3	3674
24	13	Sprockets #50 - 23 tooth		1	3675
25	1	Sprocket #50 - 17 tooth		1	3675
26	2	Idler sprockets #50 - 17 tooth	G + G CA-50	1	3675

Appendix 1 (page 2)

No.	Quantity	Item	Spec.	Source Code	Drawing No.
27	20 ft	Roller chain #50		1	3675
28	2	Quick connect hydraulic hose couplers	Pioneer 5010-5	1	3676
29	1	Manual control valve - triple spool - 4 way with built in relief	Gresen SP- 4-4	1	3676
30	1	Selector valve	Gresen SM-50	1	3676
31	1	Filter	Gresen FA-101	1	3676
		Replacement element after system cleaning	Gresen 1553-33 micron	1	
*32	1	Manual control valve - single spool - 3 way	Gresen W.P. 3	1	3676
33	1	Proportional flow divider 50-50	Gresen P.D. 75	1	3676
34	2	Adjustable flow control	Gresen CFD-A-50	1	3676
35	1	Proportional flow divider 50-50	Gresen P.D. 50	1	3676
36	1	Hydraulic motor	Charlynn Orbit Motor A.M.	1	3676
37	10 ft	Roller chain #60		1	3672
38	40 ft	Conveyer chain 1" pitch, 24" wide, 3/8" rod, rubber cover RCST 12 L/ft	Grayco	7	3670
39	2	Pillow blocks 1"	Sealmaster HP-16	6	3670
40	2	Flangette bearings 3/4"	Sealmaster SSFT-16	6	3670
*41	6	Flange bearings 1-3/8"	Sealmaster SF-22	6	3677
42	2	Flange bearings 1"	Sealmaster SSFT-16	6	3677
43	2	Hanger bearings 2-3/8"	Sealmaster SEHB-38	6	3677
44	24	Valve springs	G.M. 6 cyl. 1955-62	8	3674
45	1	Seat	Princess - 3315640	9	Not shown
46	2	Wheel assemblies 11.50 x 16	Princess - 1401072	9	3672
47	2	Hub assemblies 5 hole	Princess - 1602041	9	3672
48	1	Tank breather	Charlynn - 20166	1	3670
49	2	Belt sprockets - 14 tooth	1" bore 1" pitch	2	3670
50	12	Springs - 7/8" O.D.	Producte SW-7	10	3672

*May be specified different to product used on development machine.

Appendix 1 (page 3)

Note 1. Chain type shaft couplings are made of #40 chain sprockets with even number teeth wrapped with an appropriate length of #40 duplex chain.

Note 2. Sprockets - All sprockets used on the development machine, excepting those used for chain couplings, are G + G stock.

Source of Supply

1. James Wright & Company,
   Box 2520,
   London, Ontario.

2. Oscar Hill & Sons,
   Hornings Mills, Ont.

3. General Bearing Ltd.,
   418 Laurier Ave. W.,
   Ottawa, Ontario, K1R 5C4.

4. Durst Corporation,
   Thomas Jopling Co.,
   Toronto, Ontario.

5. Gates Rubber Co.,
   Brantford, Ontario.

6. Morse Chain Corp.,
   6342 Viscount Rd.,
   Mississauga, Ontario.

7. Grayco Harvesters,
   Heidelberg, Ontario.

8. Junk Yard

9. Princess Auto,
   Box 1005,
   Winnipeg, Man. R3C 2W7.

10. A.E. Mercer Ltd.,
    2374 Holly Lane,
    Ottawa, Ont., K1V 7P1.

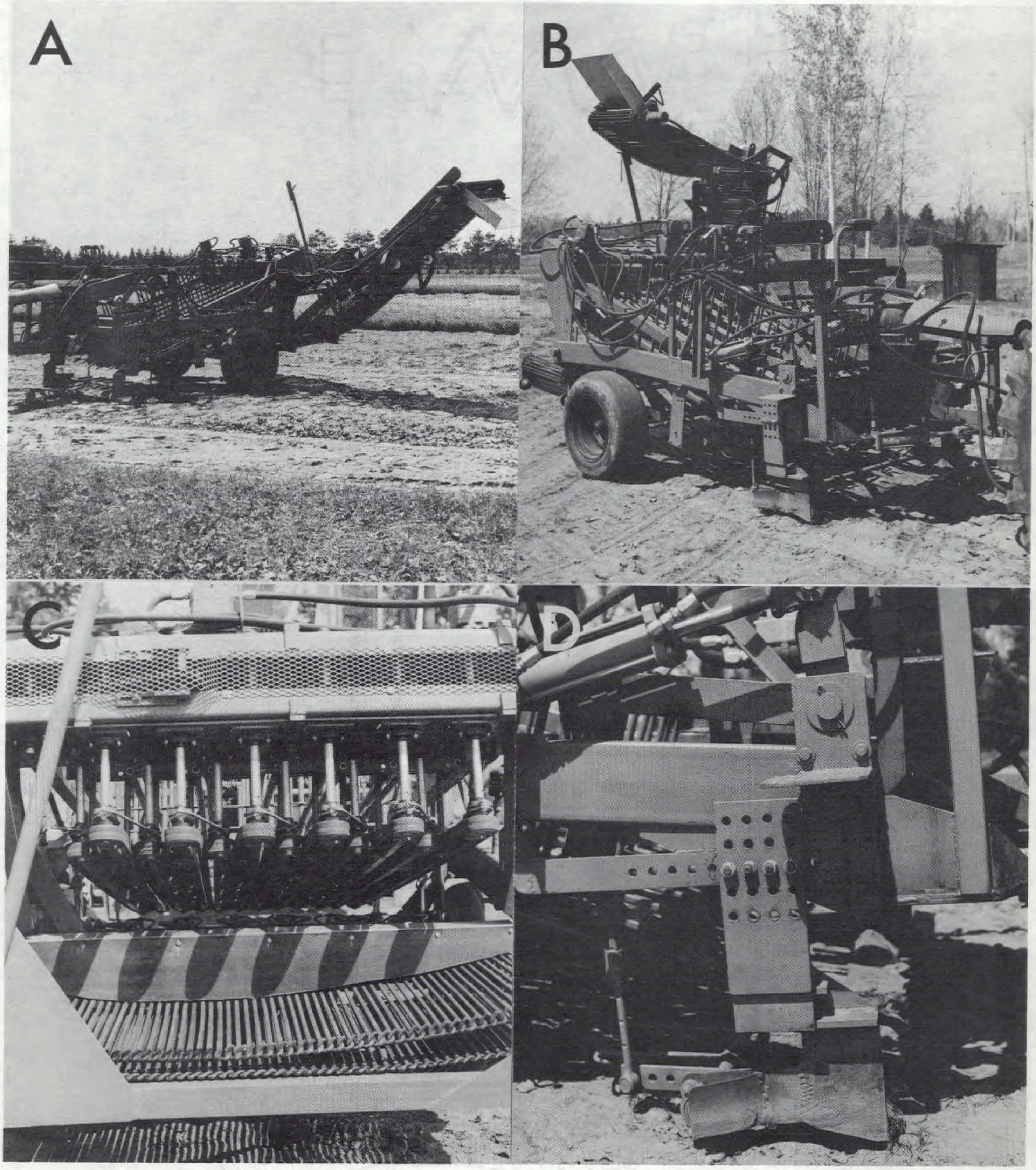

Figure 1. Photographs. A. Harvester - in operating mode; B. Harvester with side elevator folded for transport; C. Belt arrangement and discharge and D. blade attachment.

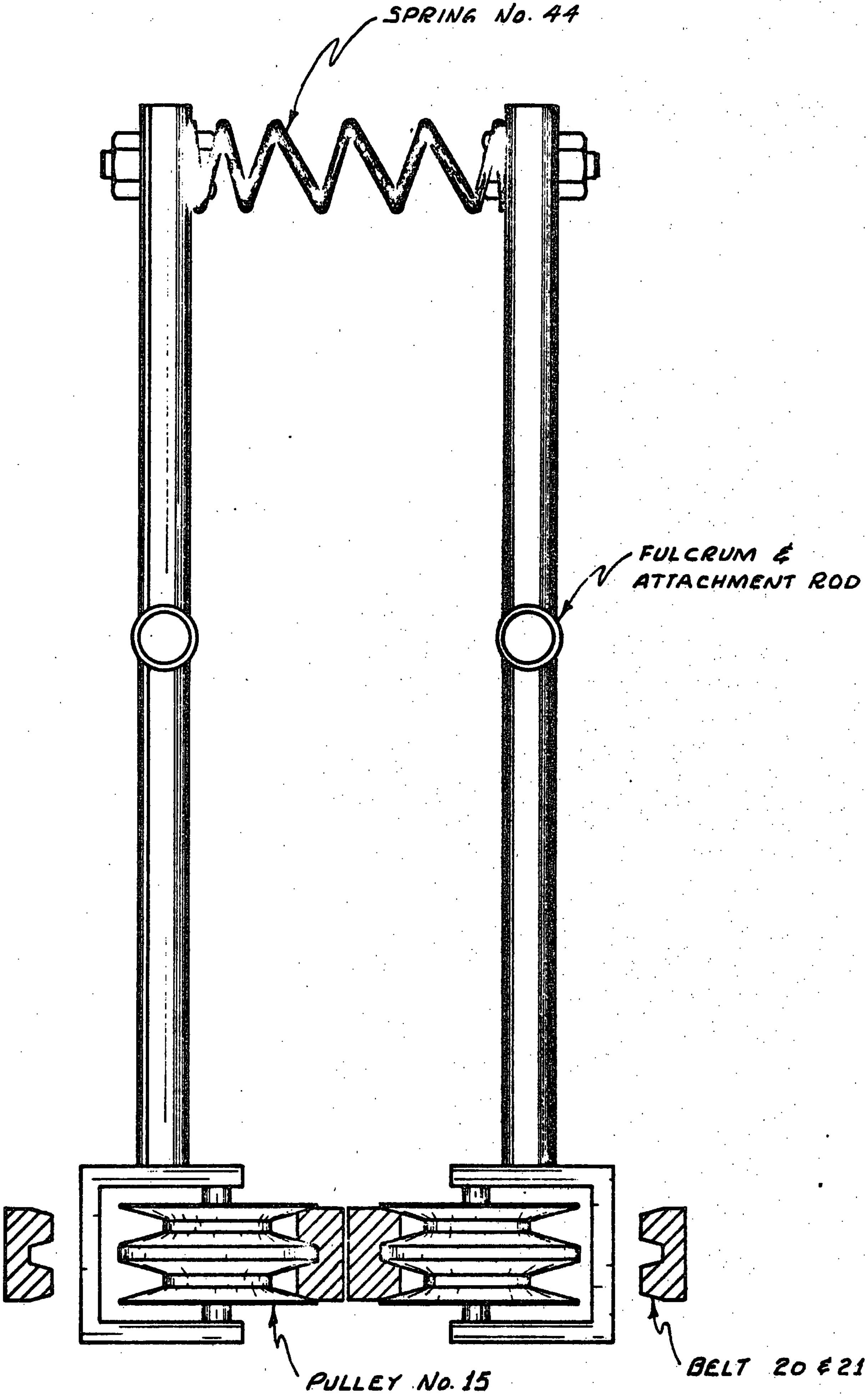

Figure 2. Pulley springing arrangement

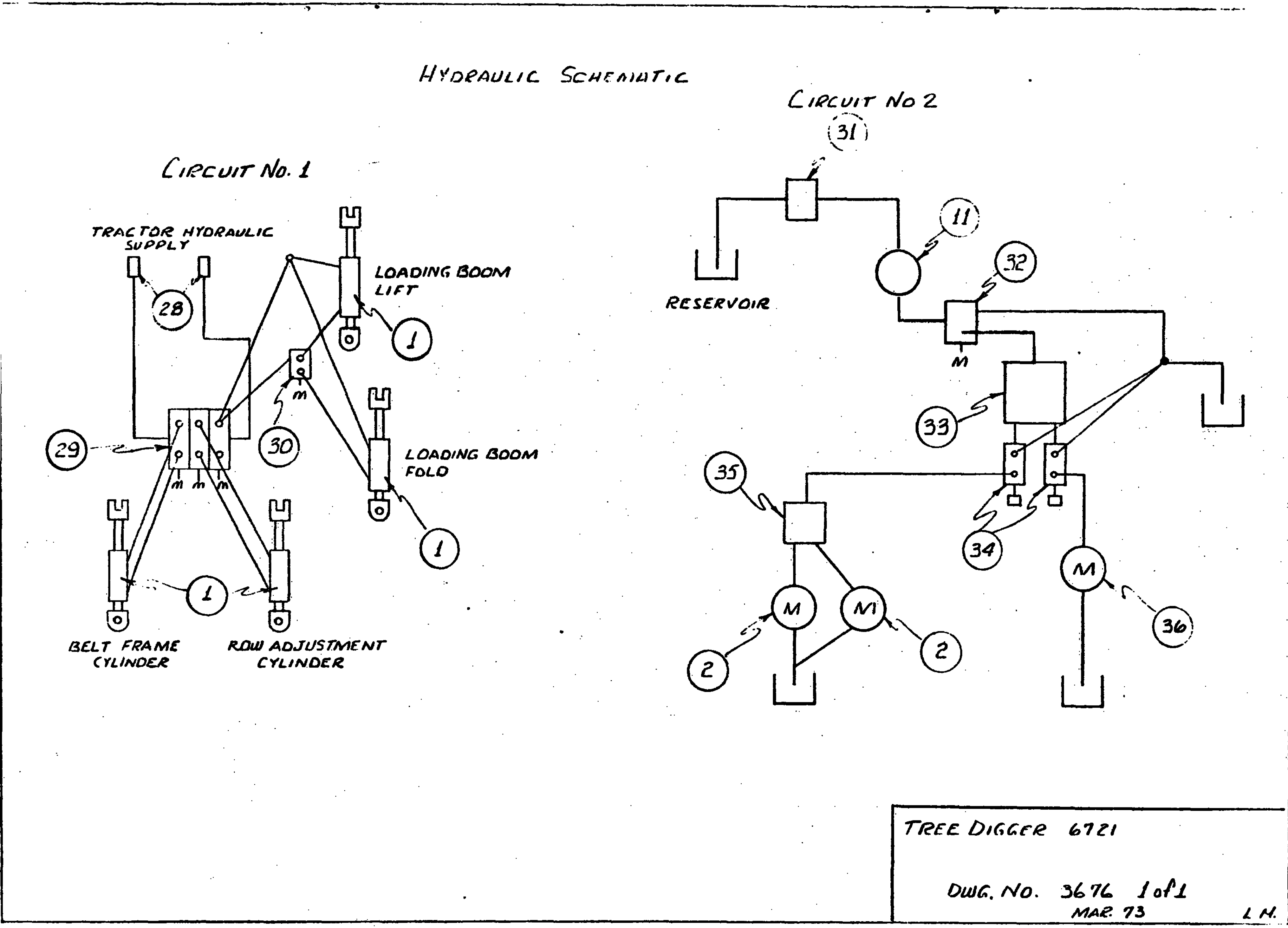

Figure 3. Hydraulic schematic

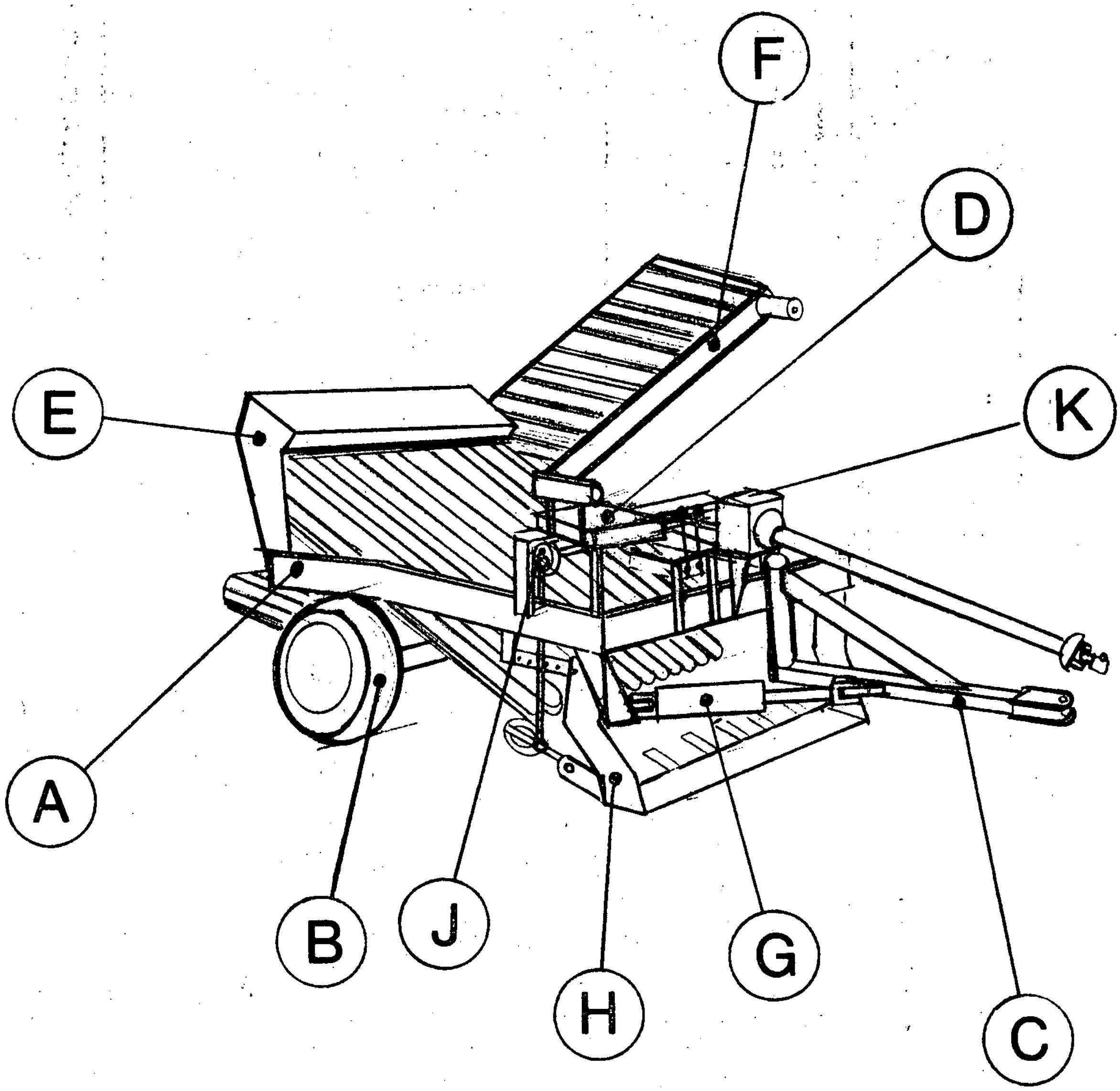

Fig. 4. Main components of the harvester. A. Main frame; B. floatation tires; C. steerable tongue; D. operators station; E. belt frame; F. rear elevator frame; G. hydraulic cylinder for tongue steerage; H. under-cutting blade; J. shaker drive; K. gearbox and universal joint drive.