OPERATION AND SERVICE OF HYDRAULIC CONTROLS ON MACHINE TOOLS

Section J—Typical Rockford Machine Tool Circuits
Unit 1—Rockford "Hy-Draulic" Shaper

GENERAL DESCRIPTION OF THE ROCKFORD SHAPER

The application of hydraulics to the operation of a shaper has been accomplished by the Rockford Machine Tool Company in the following manner. A Vickers vane type pump is used together with a Vickers control valve No. F-206 which incorporates the relief valve and the volume control in the one valve. Rockford has designed its own panel for the additional controls.

Function and Operation of the F-206 Vickers Volume Control Valve

The oil from the pump enters the valve at 2A, Fig. 1 and goes through the metering orifice and out at 4 to the three spool control panel. With the full pump volume (18 gallons per minute) coming into the valve at 1 and with the metering orifice set at half delivery, it will allow only 9 gallons per minute to go through the orifice. This causes a lower pressure at 7A, which is effective through the line from 7A to 8A so that there is a lower pressure on the one side of the hydrocone valve. The higher pressure on the one side causes the valve to open slightly to allow 9 gallons of the oil to be exhausted through port 5A and line 6A to the tank. By adjusting this orifice for various openings it results in a variable delivery being obtained out of line 4. It is this variable delivery that gives the variable ram speed, and the amount of the opening of the orifice is depended upon for marking the graduations on the plate on the front of the valve. The orifice is made in such a manner that its opening gives exactly the cutting speeds shown on the dial.

When line 4 is blocked, Fig. 5, as would be the case when the starting valve is in the rapid traverse position, the pressure rises through line 7A and 8A. This would tend to keep the hydrocone valve closed except that the pressure continues on to port 9A and opens the relief valve. As soon as the relief valve opens, the pressure drops behind the hydrocone valve and opens it so that it will discharge all of the oil through line 6A as long as this higher pressure is maintained in line 4. The small amount of oil going through the relief valve is discharged through the line 11A and 12A to the tank.

The Rockford Panel

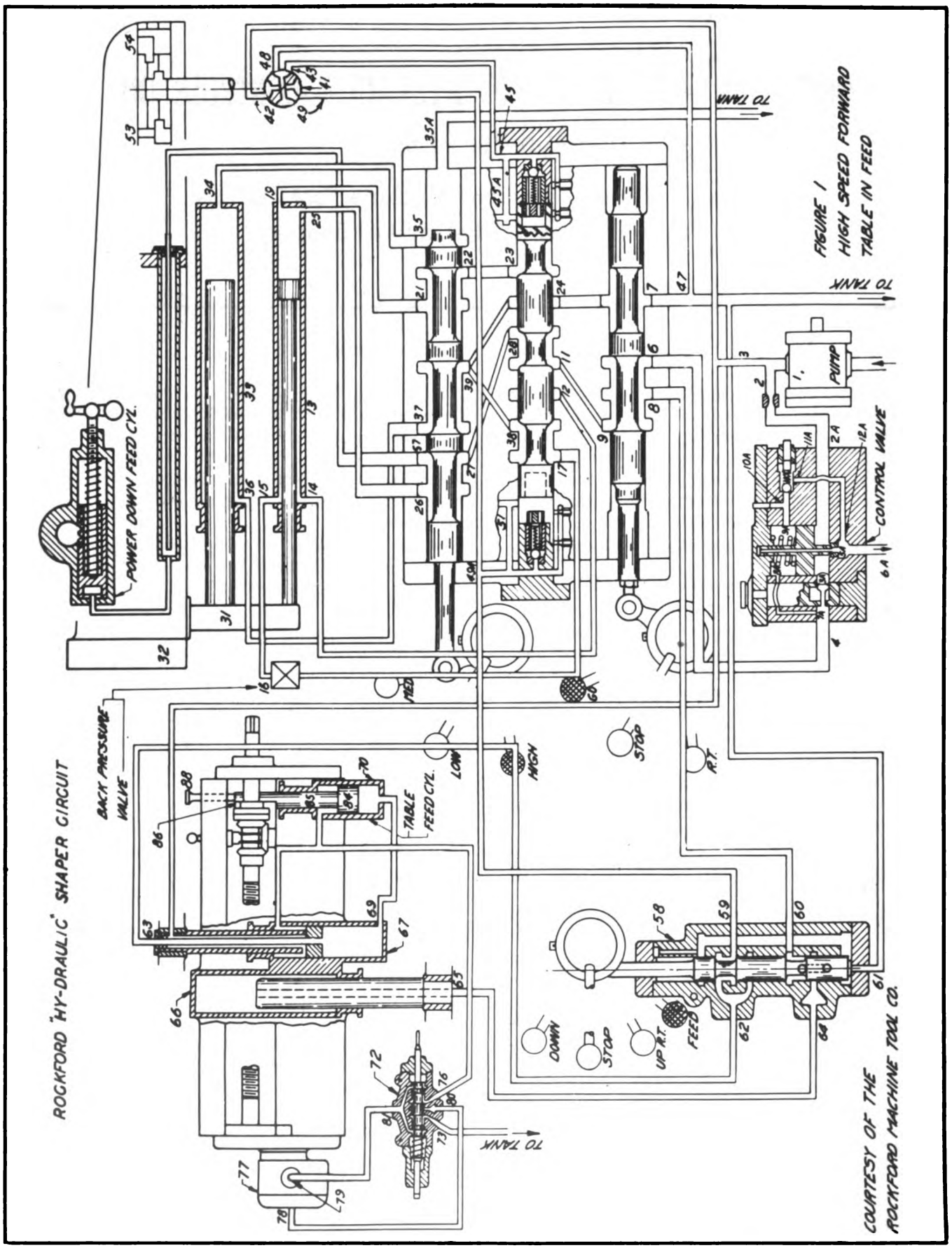
The control panel has three spool valves, the first controlling the Go, Stop, and Rapid Traverse on the table and elevating mechanism, the second being the reverse valve, and the third being the speed selector valve, the two latter being used to control the ram movements. The reverse valve is operated hydraulically through a pilot valve which is operated by the dogs on the shaper ram. The speed selector valve has three positions: low, medium, and high.

Ram Movements

The ram is actuated by two cylinders and pistons, one large single acting cylinder and a smaller double acting cylinder. The length and position of stroke are adjusted by moving the pilot valve operating dogs located on the ram to the desired location.

Ram speeds and directions are obtained as follows:

Forward	Reverse
Fast speed Pressure oil to head end of smaller cylinder.	Small cylinder less piston rod area



Forward (Continued)	Reverse (Continued)
Medium speed Pressure oil to large cylinder	Small cylinder less piston rod area
Slow speed Pressure oil to both large and small cylinder	Small cylinder less piston rod area

The valve positions are as follows:

First spool
1. Neutral or Stop
2. Go
3. Rapid traverse for vertical or transverse movement of table

Second spool
1. Forward
2. Reverse

Third spool
1. High speed forward and fast reverse
2. Medium speed forward and fast reverse
3. Slow speed forward and fast reverse

It will be noted from the positions indicated above, that spool two controls direction and that spool three controls speed. Thus when spool one is in the "Go" position, any of the six movements can be accomplished by spools two and three.

THE OPERATION OF THE SHAPER

Neutral or Stop

Place the first spool in "Stop" position and start the pump by throwing in the switch on the pump driving motor. The fluid will now pass from the pump through the control valve to port 6 on the first spool along the undercut section to port 7, and back to the tank. In this position it is an open center control valve.

High Speed Forward and Reverse

To start the ram in high speed, shift the third spool to "High" position. The second spool can be either in forward or reverse depending upon its position when the machine was stopped in the previous operation. However, for high speed forward we must assume that it stopped in the forward position.

Forward (Circuit Diagram, Fig. 1)

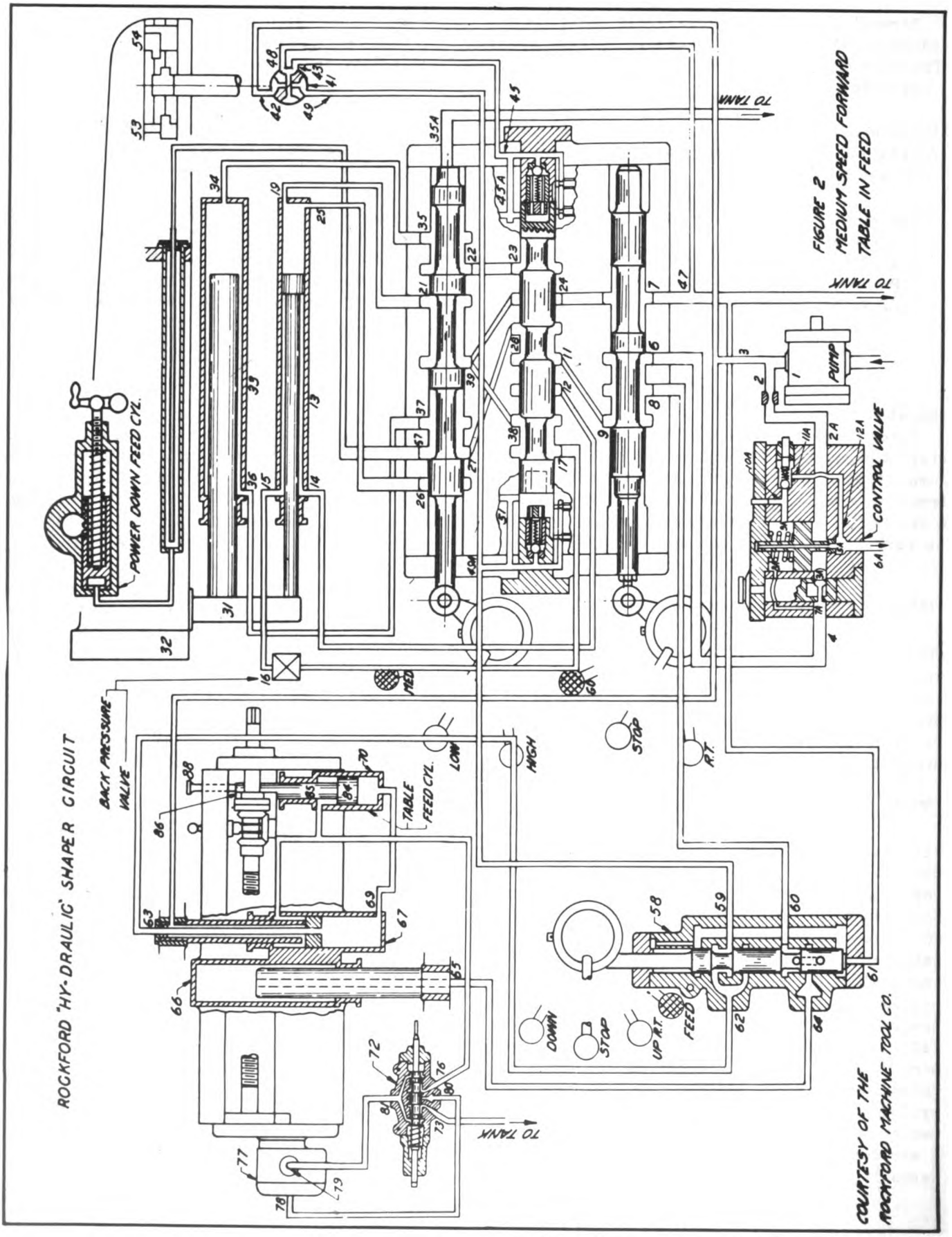
The first spool is shifted to "Go". This will route the fluid from the pump through the control valve to port 6 on the first spool, to port 9 on the same spool, then to port 11 on the second spool. From there it passes to port 28, then to port 27 and out of port 26 on the third spool to the drive end of the small cylinder through line 25. The exhausting fluid passes from the opposite end of the small cylinder through line 15 to the back pressure valve (16) into the second spool at port 17. From here it passes out at port 38 to port 39 on the third spool and out at port 37 into the large cylinder at port 36. The exhaust is also connected to the tank through ports 37, 39, and 7. A suction is created by the large cylinder which keeps it filled during this stroke.

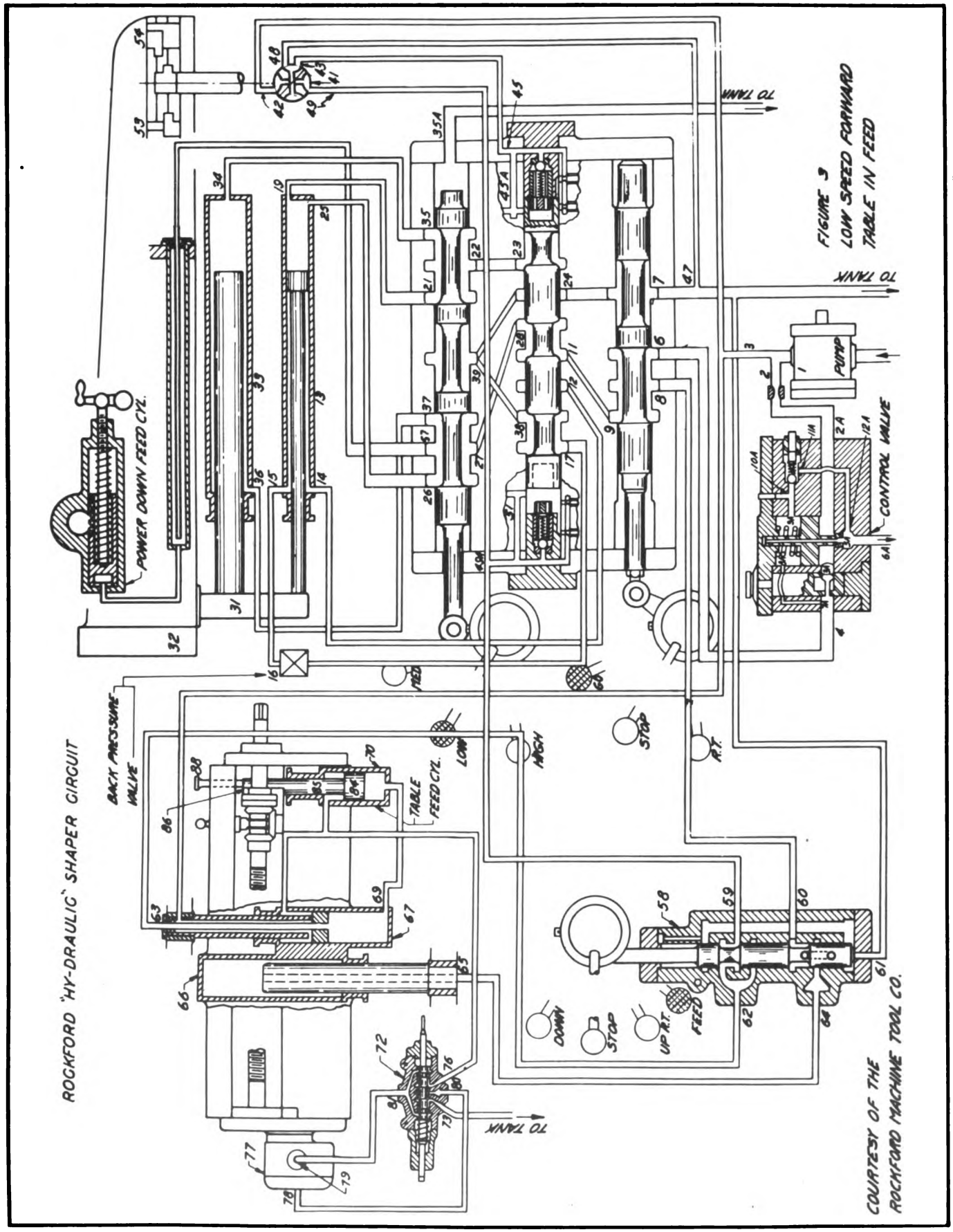
Reverse

To reverse the ram, the dog 54 on the ram shifts the pilot valve lever which in turn shifts the pilot valve. The pilot pressure is now routed through port 42 to port 43 on the pilot valve 41 and to the right end of the reversing valve at 45 and 45A. The exhausting fluid from the opposite end is now routed through port 49A and 49 to port 48 and back to the tank. This shifts the reversing valve in the opposite direction. As a result the fluid is routed from the pump through ports 6 and 9 on the first spool to port 11 on the second spool; out port 12 to port 14 on the end of the small cylinder which drives the piston in the reverse direction. The exhausting fluid from the small cylinder passes out port 19 to ports 21 and 22 on the third spool to ports 23 and 24 on the second spool, to port 7 on the first spool and to the tank. The fluid from the large cylinder passes out port 36 on the large cylinder to ports 37 and 39 on the third spool to port 24 on the second spool where it joins the fluid from the small cylinder on its way to the tank, and also out of port 34 through port 35 and out 35A to the tank.

Medium Speed Forward and Reverse (Fig. 2)

In medium speed the forward stroke uses the large cylinder. On the reverse stroke the small cylinder minus the rod area is used. (See Page 2.)





Forward

Shift the third spool to "Medium" position. The second spool, as in the discussion under high speed forward, is in the forward position. Shift the first spool to "Go". The fluid is now routed through ports 6 and 9 on the first spool to ports 11 and 28 on the second spool thence to ports 27 and 37 on the third spool and then into the large cylinder at port 36. The exhausting fluid from the small cylinder passes out through port 15 to the back pressure valve (16), to port 17 on the second spool, out of port 38 on the same spool to ports 39 and 21 on the third spool into the opposite end of the small cylinder to port 19.

Reverse

To reverse, the pilot valve is operated as explained in fast speed which shifts the second spool to the reverse position. The fluid is now routed through ports 6 and 9 on the first spool to ports 11 and 12 on the second spool to the small cylinder at port 14. The exhausting fluid from the small cylinder passes out at port 19 to ports 21 and 39 on the third spool to port 24 on the second spool. From here it passes to port 7 on the first spool and to the tank. The exhausting fluid from the larger cylinder passes out of port 34 on the large cylinder to ports 35 and 22 on the third spool, to port 23 on the second spool, where it joins exhaust from the small cylinder on its way to the tank.

Low Speed Forward and Reverse

In low speed both large and small cylinders are used on the forward stroke. The small cylinder, less rod area, is used on the reverse stroke. (See page 2.)

Forward (Fig. 3)

Shift the third spool to "Low" position. The second spool is now in the forward position. Shift the first spool to "Go" position. The fluid is now routed from the pump to ports 6 and 9 on the first spool, to ports 11 and 28 on the second spool, to ports 27, 26, and 37 on the third spool. The fluid passes into the small cylinder through port 25, and into the large cylinder through port 36. The exhausting fluid passes from the small cylinder through port 15 to the back pressure valve (16) to port 17 and 38 on the second spool to port 39 on the third spool to port 24 on the second spool and then to port 7 on the first spool to the tank.

Reverse (Fig. 4)

The pilot valve is shifted as explained previously, which shifts the second spool to the reverse position. The fluid is now routed from the pump to ports 6 and 9 on the first spool, to ports 11 and 12 on the second spool into the small cylinder at port 14 which moves the piston in the reverse direction. The exhausting fluid from the small cylinder passes out of port 19 on the end of the cylinder to port 21 on the third spool, out of port 22 and port 23 on the second spool, to port 24 and 7 on the first spool and then to the tank. The exhausting fluid from the large cylinder passes out of port 34 on the end of the cylinder to port 35 on the third spool where it joins the fluid from small cylinder on its way to the tank.

Rapid Traverse Elevation of the Table (Fig. 5)

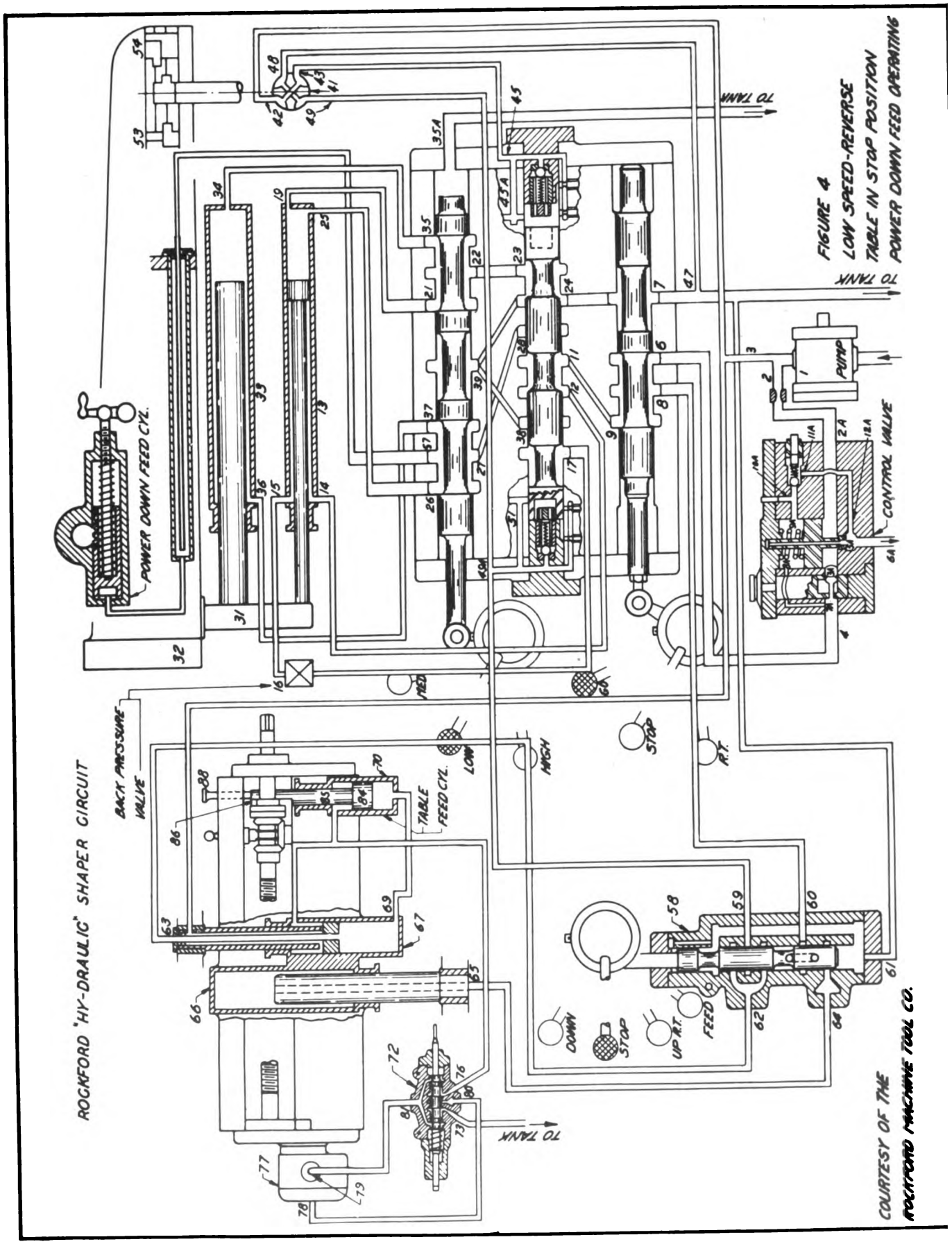
The rapid traverse elevation of the table is accomplished through the first spool and the table control valve (58). This table control valve has four positions -- 1. Table Down; 2. Stop; 3. Table Up Rapid Traverse; and 4. Feed.

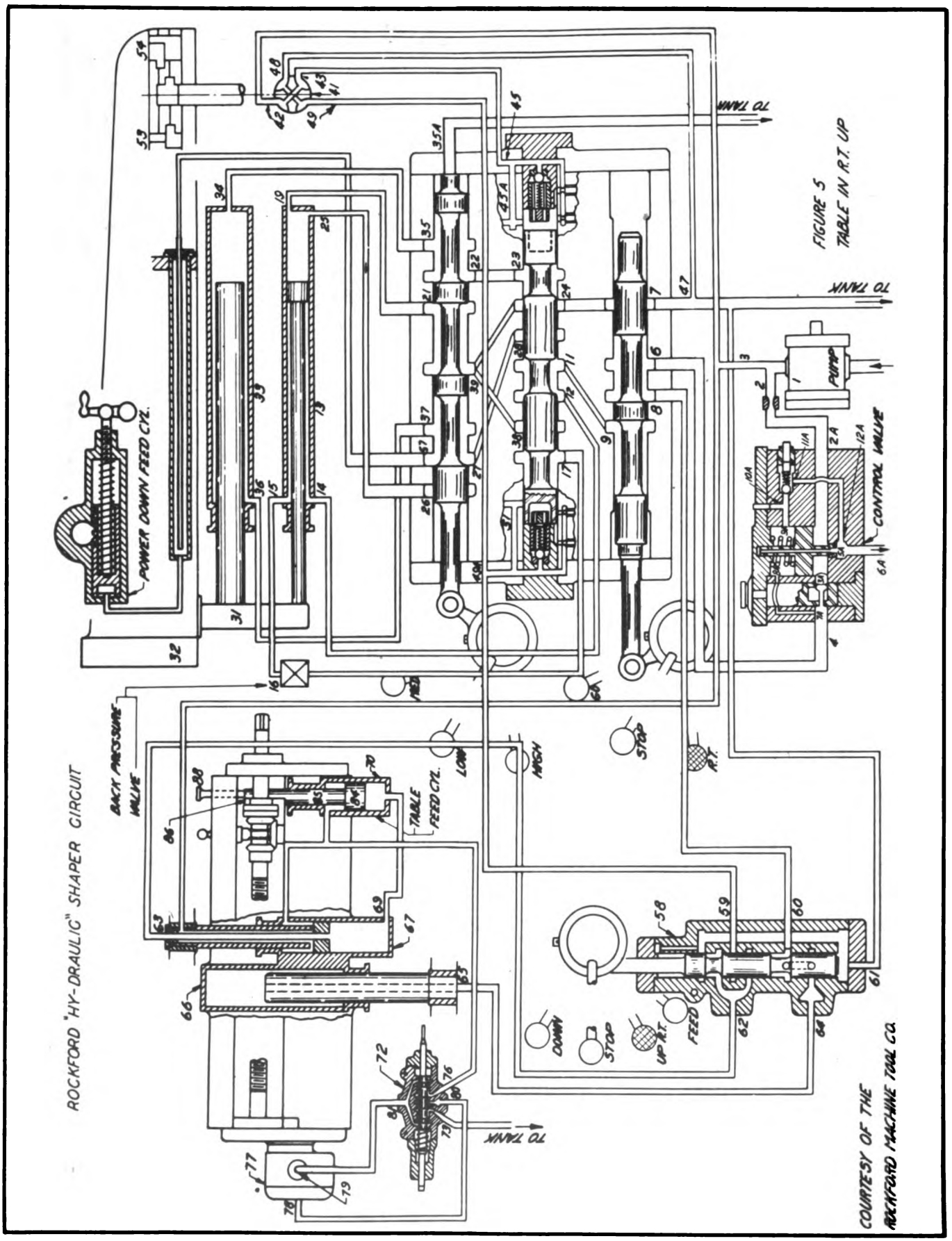
Table Up

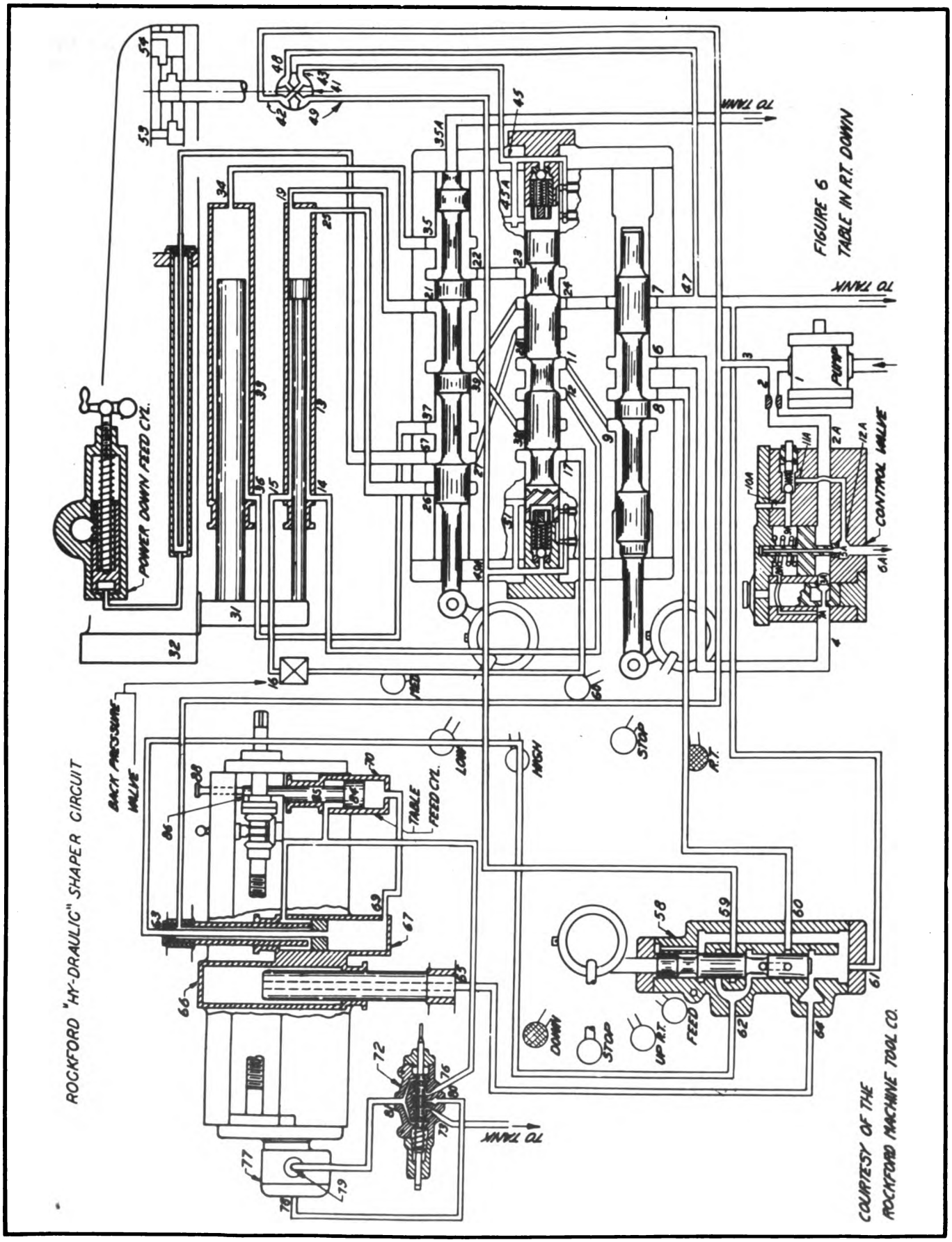
To rapid traverse the table up, place the table control valve in "Table Up Rapid Traverse" position. Shift the first spool into "Rapid Traverse" position. The fluid is now routed from the pump to ports 6 and 8 on the first spool, then to port 60 on the table control valve, through the drilled center of the table control valve spool to port 64, to the elevating cylinder 66, through port 65. This piston is anchored to the base of the machine, and the cylinder is anchored to the table. The cylinder moves upward, carrying the table with it.

Table Down (Fig. 6)

To rapid traverse the table down, place the table control valve in "Table Down" position. Shift the first spool in the control valve in "Rapid Traverse" position. The fluid is now routed from the pump to ports 6 and 8 on the first spool to the table control valve at port 60, then through the drilled center to the table control valve spool to port 62. From here it passes to port 63 on the end of the table lowering cylinder (67). This piston is anchored to the machine at the top. The cylinder moves downward, carrying the table with it. The exhausting fluid from the elevating







cylinder is exhausted through port 65 to port 64 on the table control valve, then out through port 61 to the tank. The pilot line pressure is always on the upper side of the lowering piston which creates a back pressure that prevents the table from dropping. The area is greater on the operating side than on the back pressure side.

Rapid Traverse Cross Feed to Table

The rapid traverse cross feed to the table is operated by a fluid motor (77) which is mounted on the end of the table and is connected to the cross feed screw by a gear train. This fluid motor will operate in either direction and is controlled by the four-way valve (72). The four-way valve is a spring-loaded, manual-controlled, open-center four-way valve, with three positions --- forward, reverse, and neutral. The spring holds the valve in the neutral position.

Rapid Traverse to Left

The pilot line pressure operates the rapid traverse cross-feed to the left. The fluid is tapped off the back pressure side of the table lowering cylinder and enters the four-way valve at port 76. The four-way valve spool is moved to the left, which allows the fluid to pass out at port 81 and into the fluid motor at port 79. The exhausting fluid passes out port 78 and back into the four-way valve at port 80 and out at port 73 to the tank.

Rapid Traverse Right

To rapid traverse the cross-feed to right, the four-way valve is shifted to the right. The fluid now passes into the four-way valve at port 76 and out at port 80 to port 78 and the fluid motor which causes rotation in the opposite direction. The exhausting fluid leaves the fluid motor at port 79, passes into the four-way valve at port 81, and out at port 73 to the tank.

Hydraulic Cross-Feed

The hydraulic cross-feed is operated through the table control valve and the feeding mechanism consisting of piston 84, piston rod 85, rack and pinion 86, and cylinder 70.

To operate the feed, shift the table control valve to "Feed" position. The fluid that operates the feed will now come from the reversing end of the reverse valve (second spool). This will give the feed at the beginning of the cutting stroke. When the pilot valve (41) is shifted to the forward position, the pilot line pressure is routed to left end of the second spool. A line which is tapped to this line routes the fluid to port 59 on the feed control valve. It then passes along the undercut portion of the spool to port 62, then into the table lowering piston at port 63, out at port 69 and into feed piston to force the piston upwards. The main pilot pressure is always on the upper side of the feed piston, but acts on a smaller area; therefore, the piston will move upward. The piston rod is connected to the feed screw by a pawl and ratchet, which in turn is attached to the screw by an over-running clutch. When the reversing valve shifts to reverse, the pilot line on the reverse end of this spool is open to drain. The pressure from main pilot line will force the piston 84 back to the lower position ready for the next feed impulse. The amount of feed is controlled by the adjustable stop 88. The reverse on the cross feed is accomplished by the conventional bevel gear reverse with a dog clutch.

OPERATION AND SERVICE OF HYDRAULIC CONTROLS ON MACHINE TOOLS

Section J—Typical Rockford Machine Tool Circuits
Unit 2—Rockford "Hy—Draulic" Planer

INTRODUCTION

The application of fluid power to large planers has been done by the Rockford Machine Tool Co.

An Oilgear Type "DR" pump is used with a three-way combination valve.

For a description of the Type "D" pump see Section B, Unit 1 and Section D, Unit 3.

A differential, or regenerative, type of oil circuit as used on the Rockford Planer is shown in Fig. 1.

The fluid power is applied to the piston rod end during the cutting stroke. This causes the table to be pulled toward the cutting tools.

As the fluid power is infinitely variable it enables the operator to change the rate of feed to meet varying conditions, such as, material, method of holding, or finish desired.

Fig. 2 shows the oil circuit of an Oilgear combination valve with a special three-way reversing plunger. By a careful study of this figure one can follow the flow of the oil as the trip dogs E and F (shown in Fig. 1) moves the pilot plunger, through linkage "G", to the right or left.

OPERATION OF THE VALVE

With the pilot plunger moved to the left (as shown in Fig. 2, position "B") gear pump oil enters port 1 and flows around the plunger.

This oil is directed through port 7 to the DR pump, shifting the slide block to the preset feed stroke. At the same time it passes through the end plate and around the deceleration valve, which allows the pressure to open the ball check and be applied on the left end of the reversing plunger.

The right end of the pilot plunger is connected to drain port 2 by means of a hole through the center. This allows oil from the right end of the main reversing plunger to exhaust, after it has gone through the two choke metering valves in the end plate.

High pressure oil from the "DR" piston pump enters the combination valve at port 5.

With the pilot plunger in position "B", high pressure is directed to port 4. Port 3 (connected to the left end of the table cylinder) is open to exhaust port 6.

With the pilot plunger in position "A", gear pump oil will be directed into port 8 and through the cored sections of the end plate on the right. If the metering chokes on the left are properly set they will restrict the movement of the main reversing plunger. This allows oil from port 8 to enter a line leading to the tool lifter and the crossfeed cylinder.

A needle valve is in this line to restrict the fluid. This causes pressure to rise, and actuate the tool lifter cylinder before the crossfeed cylinder and main reversing plunger can operate.

After the main reversing plunger is moved to

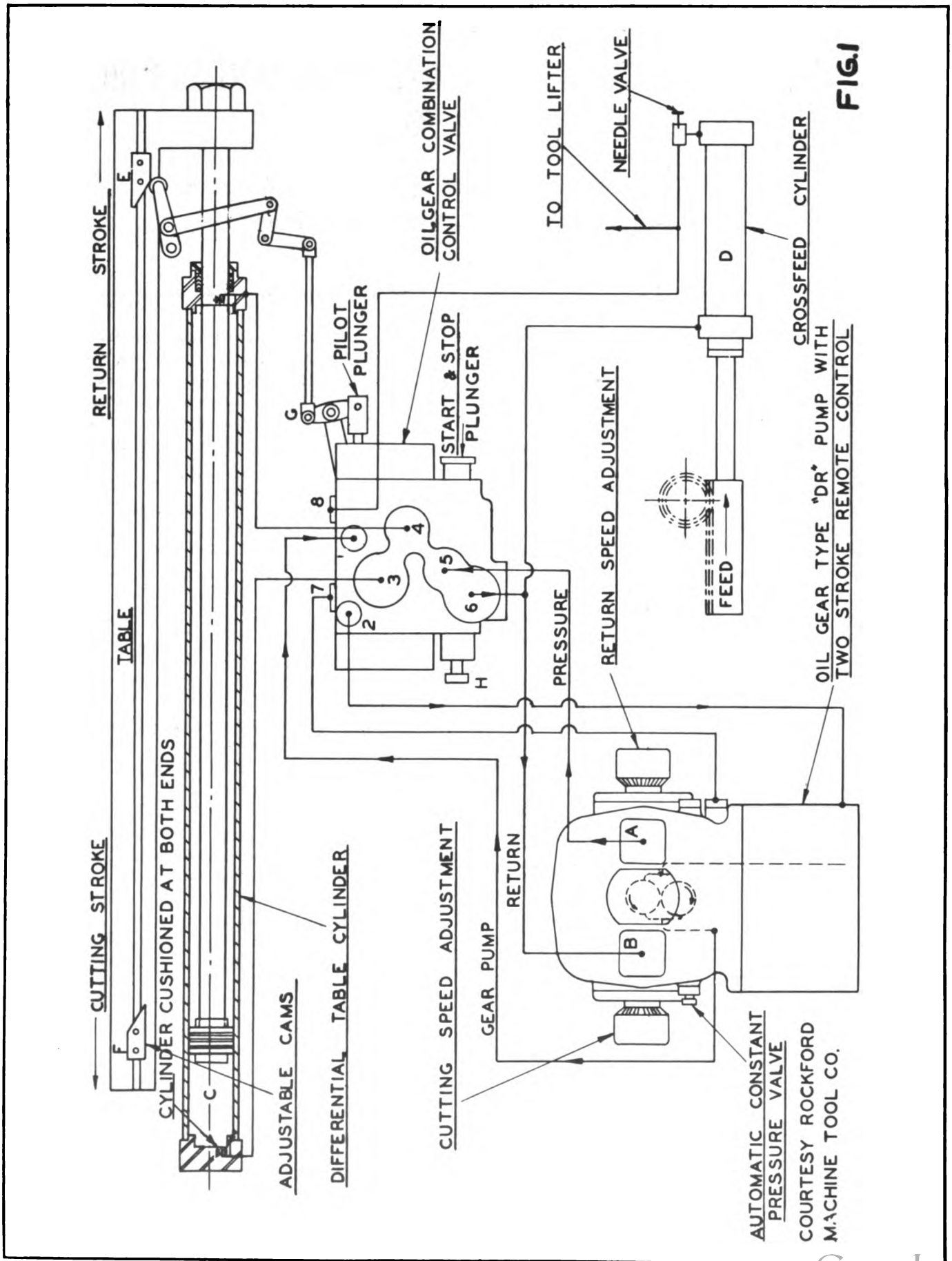


FIG.1

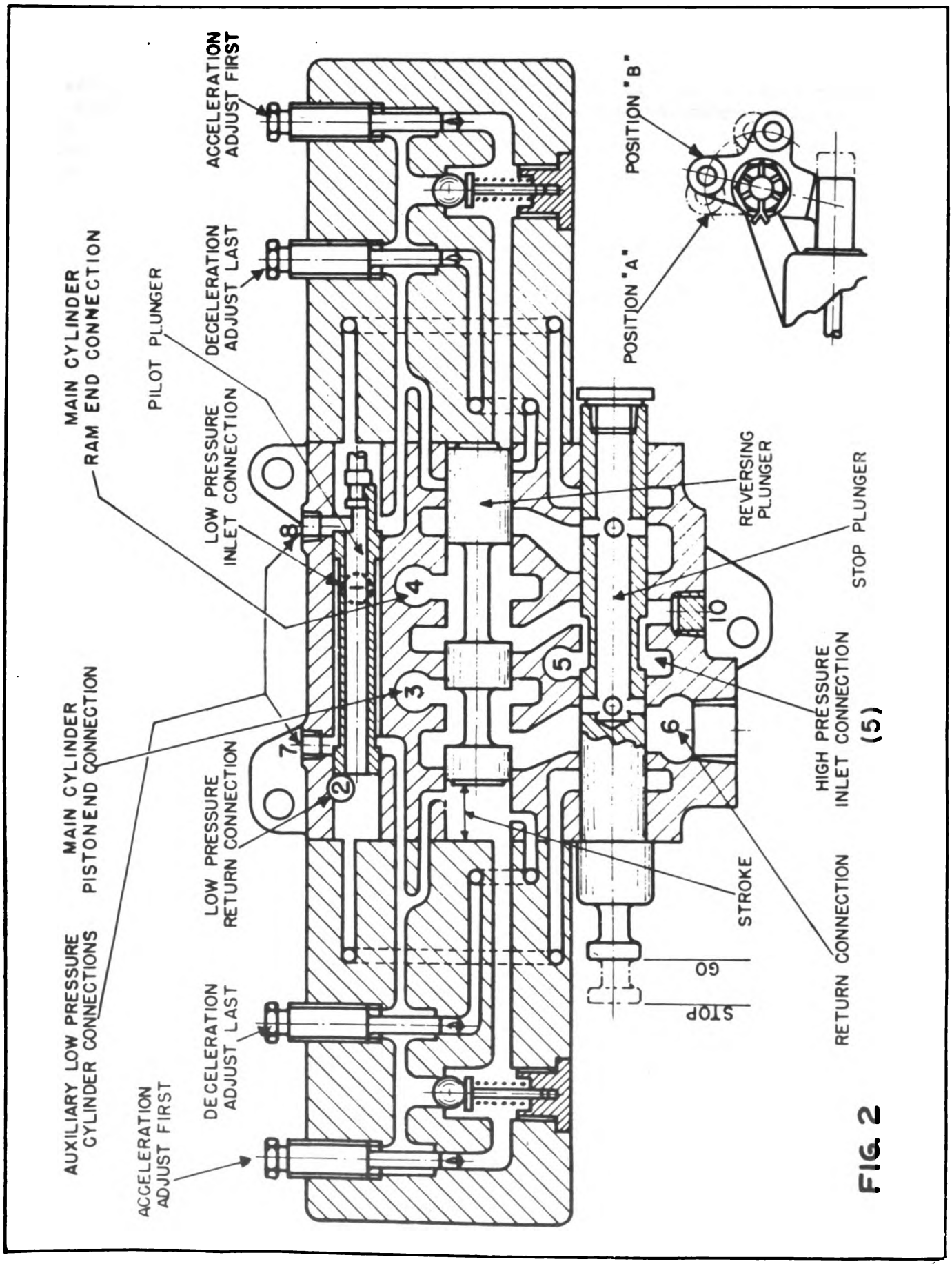


FIG. 2

the left it connects pressure port 5 with both ends of the table cylinder through ports 3 and 4.

Note: This plunger can only be used where a differential type of cylinder is used.

Port 3 connects to the end of the cylinder with the larger area. The pressure being equal causes the piston to move toward the right, because of the greater force being developed.

When the stop plunger is moved to the left, port 5 is connected to the return side of the "DR" pump through port 6. This allows the oil to circulate at no appreciable pressure, thus effecting a great saving in power consumption.

NOTES