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HYDRAULIC MACHINERY

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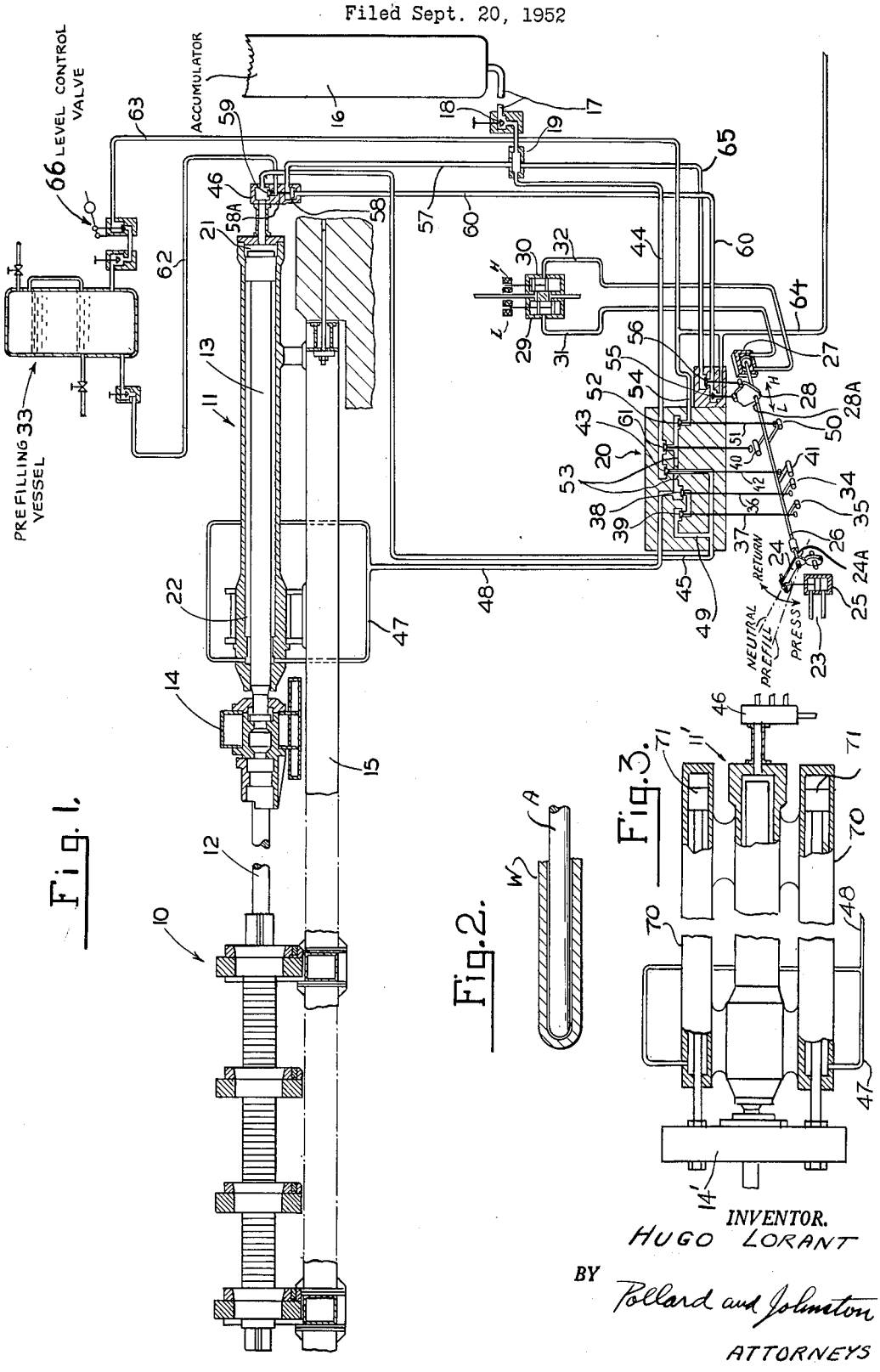


Fig. 1.

Fig. 2.

Fig. 3.

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HYDRAULIC MACHINERY

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This invention relates to hydraulic draw benches or presses for producing hollow shapes or the like, and particularly to the hydraulically operated means for controlling and supplying operating fluid thereto.

When accumulators are used for furnishing fluid under pressure to a hydraulic motor, such as for a hydraulically operated draw bench, the flow of fluid from the accumulator to the motor at high velocity through relatively long pipe lines may result in high friction losses reducing the speed and impairing operation of the machine.

One of the objects of the present invention is to provide an improved means and method for operating a hydraulic draw bench or the like.

In one aspect, the hydraulic cylinder of the draw bench is arranged to be furnished fluid under pressure from a remotely located accumulator. The cylinder or motor can have a pressure side and a return side or there may be separate return cylinders. A control valve is connected in the fluid circuit for the pressure and return sides so that when pressure is supplied to the pressure side of the hydraulic motor, the return fluid from the return side may be fed to the pressure side of the hydraulic motor. By such an arrangement, the volume of liquid being furnished from the accumulator is reduced markedly. Thus, the friction losses because of a large volume of fluid passing through long pipes at high velocity are substantially lowered and the speed of the machine is increased. This will not only increase the production but will also materially reduce heat losses when dealing with hot workpieces on draw benches having a long stroke.

The control valve can be arranged so that the fluid from the return side or motor can be fed selectively to the pressure side of the hydraulic cylinder or can be returned to the accumulator.

These and other objects, advantages, and features of the invention will become apparent from the following description and drawing.

In the drawing:

Figure 1 is a schematic fragmentary view of one form of the invention.

Figure 2 is a fragmentary enlarged view of a tool and work piece.

Figure 3 is a fragmentary broken view of a modified form of the invention.

The invention will be described in conjunction with a draw bench but can be used for other similar purposes. A draw bench is illustrated generally at **10**, said bench having a hydraulic motor **11** for operating a mandrel or tool A such as seen schematically in Fig. 2, the work W being placed on said tool as is known in the art. Ram or piston **13** is connected to crosshead **14** in a conventional manner and the mechanism is supported on a machine frame indicated by **15**. Ram **13** serves to reciprocate crosshead **14** and tool means associated therewith. An accumulator or liquid pressure vessel **16** is connected by means of pipe **17** with stop valve **18** and distributor or manifold **19**, pipe **17** being shown broken inasmuch as the accumulator may be located at a remote point from the draw bench involving relatively long feed piping. A main cylinder control valve **20** is selectively connectable, as will be described hereafter, with the pressure end **21** and return end **22** of hydraulic motor **11**. The various valves are illustrated in the position which they take when main control valve **20** is in neutral position. The control valve shaft operating arm **24** can be moved by servo-motor **25**, which in turn can be controlled by control means located

conveniently relative to the machine operator. Operating arm **24** rotates shaft **26** which can be supported as desired. Besides the rotative movement, shaft **26** can be moved longitudinally by control valve shifting means **27**, there being a spline connection **24A** between shaft operating arm **24** and shaft **26** to permit shaft **26** to slide relative thereto. Cam **28** also is rotatable by shaft **26** and is connected thereto by a spline **28A** so that the shaft can move longitudinally relative to the cam. Arm **24** and cam **28** are secured against axial movement by suitable means. Shaft **26** is shown in its neutral, right hand position (Fig. 1) arranged so that it is set for full force operation of the hydraulic motor when a relatively slow travel of the mandrel or tool is required. When in the opposite position, reduced force and higher speeds of hydraulic motor **11** will be involved. The shaft **26** is moved longitudinally, or between high to low force positions, by means of the solenoid controlled valves **29** and **30**, these valves admitting fluid pressure appropriately through lines **31** and **32** to the desired side of the piston in hydraulic motor **27**.

Assuming that reduced force operation is desired and that the mandrel is to be moved at a relatively high speed, valve **29** can be operated so as to move the shaft **26** to the left from the position shown in Fig. 1. When this occurs, valve operating arms or lugs **34**, **35** will become aligned with valve rods **36** and **37** controlling valves **38** and **39**, respectively. When it is desired to have a pressing movement of the ram **13** toward the left under reduced force, shaft operating arm **24** is moved downward or counter-clockwise so as to rotate shaft **26**. Apart from the prefilling step which is described hereafter, rotation of the shaft will cause valve operating arm **41** to lift valve rod **42** and thereby open valve **43** so as to admit fluid from accumulator **16** through pipe **44**, valve **43**, pipe **45** to valve **46** and into the pressure side **21** of motor **11**. Valves **38** and **39** also will be lifted because valve operating arms **34** and **35** are in alignment therewith due to prior movement of shaft **26** to the left. Opening of valves **38** and **39** will open a connection from the return end **22** of the hydraulic motor **11** through pipes **47**, **48**, valve **38**, valve **39**, passage **49** to pipe **45** and into the pressure side of the hydraulic motor. Thus, as accumulator pressure is exerted on ram **13** and the ram moves to the left, liquid will be transferred from the return side of the hydraulic motor **11** to the pressure side so that a relatively small volume is required to be supplied through long pipes **17** and **44** from the accumulator to ram **13**. The velocity in pipes **17** and **44** will be relatively high so that serious friction loss would occur if all of the liquid required for pressure side **21** was supplied from the accumulator. It will be clear that the reduction in force, as compared with full force operation, exerted by ram or piston **13** when the reduced force operation is used is due to the fact that the pressures in the connected cylinder ends **21** and **22** are equal and thus only the differential piston area is effective.

When it is desired to use a higher force and the movement of ram **13** is to be relatively slow, fluid from the return side of the piston may be returned directly to the exhaust leading to the pumping means (not shown) for accumulator **16**. This is accomplished by permitting shaft **26** to remain in the longitudinal position shown in Fig. 1. When the shaft operating arm **24** is moved to pressing position with shaft **26** moved to the right, valve operating arms **34** and **35** will not be contacted so that valves **38** and **39** will remain closed. Valve operating arm **50** will be aligned with the valve rod **51** so that valve **52** will be opened, such not being the case when shaft **26** is moved to the left as previously described. Fluid exhausted from the return end of hydraulic motor **11** will flow through pipes **47**, **48**, passage **53**, open valve

52, pipe 54, and pipe 64 to exhaust or to the pump for accumulator 16. After prefilling which is described further hereafter, pressure fluid will be supplied to the pressure end 21 of motor 11 through open valve 43, valve operating arm 41 having an elongated lug to contact valve stem 42 so as to operate the same regardless of the longitudinal position of shaft 26.

Cam 28 is concerned with operation of the prefilling valve 59 as now will be described, said cam 28, when shaft 26 is in neutral position, holding valve 55 open and valve 56 closed. Pressure from the accumulator entering through pipe 57 will act on the upper side of piston 58 so as to allow valve 59 to remain in closed position. The under side of piston 58 is connected through pipe 60, open valve 55, and pipe 64 to the exhaust. When shaft 26 is turned towards pressing position, valves 55 and 56 will stay in the position shown in Fig. 1.

The piston rod 58A of piston 58 is adapted to contact and lift valve 59 and hold it in open position but when piston 58 is lowered, valve 59 may move independently of piston 58 and will operate in the manner of a check valve. A low pressure prefilling vessel 33 is connected through pipe 62 to valve 59. In the neutral position shown in Fig. 1, the return end 22 of the hydraulic motor 11 is closed so that ram 13 cannot move to the left and no liquid will flow from vessel 33 through valve 59 into the hydraulic motor.

When shaft 26 is shifted, from the position shown in Fig. 1, to the left and turned to prefill position, liquid can escape from the return side 22 through open valves 38 and 39 into the pressure side 21, and liquid under low pressure will then flow from vessel 33 through pipe 62 so as to lift valve 59, enter into pressure side 21 and move ram 13 to the left. This allows a carrying out of the approach stroke at low pressure and will reduce the consumption of high pressure fluid. Thereafter, when the workpiece engages the die, shaft 26 will be turned to pressing position so as to open valve 43 and admit high pressure fluid from the accumulator through pipe 44, valve 43, pipe 45 to valve housing 46 and into the pressure side 21 of the hydraulic motor. Check valve 59 will be closed due to the action of the high pressure fluid. At the same time, liquid is transferred from the return side to the pressure side to allow operation at increased speed and reduced force as set forth hereinbefore.

If shaft 26 is in its right-hand longitudinal position (Fig. 1) and then turned to prefill position, fluid can escape from the return side 22 through open valve 52 to exhaust, the fluid under low pressure will then flow from vessel 33 into the pressure side 21 to advance ram 13 under said low pressure. Thereafter, when shaft 26 is turned to pressing position, valve 43 will be opened to admit high pressure fluid from the accumulator 16 to the pressure side 21. Valve 59 will again be closed due to the action of the high pressure fluid, and the full force will be applied to the ram 13.

It should be noted that valve rods 36, 37 and 51 are longer than rod 42, which permits the prefill position to be reached before the pressure inlet valve 43 is opened.

When shaft operating arm 24 in any of its longitudinal positions is moved clockwise to return position, valve 61 will open and connect the accumulator through pipe 44, open valve 61, passage 53, pipe 48, and pipe 47 with the return side of hydraulic motor 11. When the shaft is moved in said clockwise direction to return position, cam 28 will move to permit valve 55 to close and valve 56 to open. Pressure from the accumulator then will be fed from pipe 65, through open valve 56, and pipe 60 to the under side of piston 58. Because of the piston rod of piston 58, the difference in area on each side thereof will cause valve 59 to open and connect pressure side 21 of motor 11 with the prefilling vessel 33. Vessel 33 may have a level control valve 66 which will permit fluid to flow from the vessel 33 through pipe 63 to exhaust pipe 64 when the fluid level reaches a predetermined level in vessel 33.

A further form of the invention is illustrated in Fig. 3, wherein crosshead 14' is connected to the main hydraulic motor 11'. The return action of the crosshead is accomplished by means of separate return cylinders 70, having pistons 71 therein. Pipes 47, 48 and control valve 46 correspond to those in Fig. 1. Fluid is fed to the return cylinders 70 through lines 47 and 48 in the same manner as Fig. 1 and valve 46 of Fig. 3 can be made to operate in the same manner as that described for Fig. 1.

It should be apparent that details of construction can be changed, such as using more than one valve in place of the main control valve, or using a plurality of pressure reservoirs or bottles instead of the one illustrated, without departing from the spirit of the invention except as defined by the appended claims.

What is claimed is:

1. A control apparatus for fluid pressure motor means having a pressure side and a return side and piston means in said sides acting oppositely to each other, the combination comprising prefilling means including a closed pressure tank for furnishing fluid under low pressure to the pressure side of said motor means and for receiving fluid therefrom, remotely located fluid accumulator means for furnishing fluid under high pressure to said motor means, a control means having a plurality of valve means, pipe connections between said control means and said prefilling means, said accumulator means, said pressure side, said return side and to an exhaust, and means varying the positions of said valves to selectively connect said prefilling means, pressure side and return side together, to connect said accumulator, pressure side and return side together, to connect said prefilling means to said pressure side and the return side to said exhaust, to connect said accumulator to said pressure side and the return side to said exhaust, or to connect said return side to said accumulator and to connect said pressure side to said prefilling means.

2. In control apparatus for fluid pressure motor means having a pressure side and a return side and piston means in said sides acting oppositely to each other, the combination including remotely located fluid accumulator means for furnishing fluid pressure to said piston means, a control device including a valve body having fluid connections with said accumulator means, said pressure side, said return side and an exhaust, a plurality of movable valve members in said valve body operable selectively to connect said accumulator to said pressure side and return side simultaneously, to connect said accumulator to said pressure side and the return side to the exhaust, or to connect said return side to said accumulator, a control shaft movable longitudinally between high and low operating pressure positions and rotatable from a neutral position to press and return positions, a plurality of valve actuators carried by said control shaft, some of said actuators being operable upon rotation of the shaft to press position when the shaft is in low pressure operating position to open valve members for connecting said accumulators to said pressure and return side together, some of said valve actuators being operable upon rotation of the shaft to press position when the shaft is in its high pressure operating position to open valve members for connecting the accumulator to the pressure side and the return side to the exhaust, and one of said valve actuators being operable upon rotation of the shaft to return position to open a valve member connecting the accumulator to the return side.

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