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E. J. HIRVONEN
VALVE FOR CONTROL OF ADVANCE AND RETURN
OF A PISTON UNDER HYDRAULIC POWER

2,970,576

Original Filed Oct. 30, 1950

2 Sheets-Sheet 1

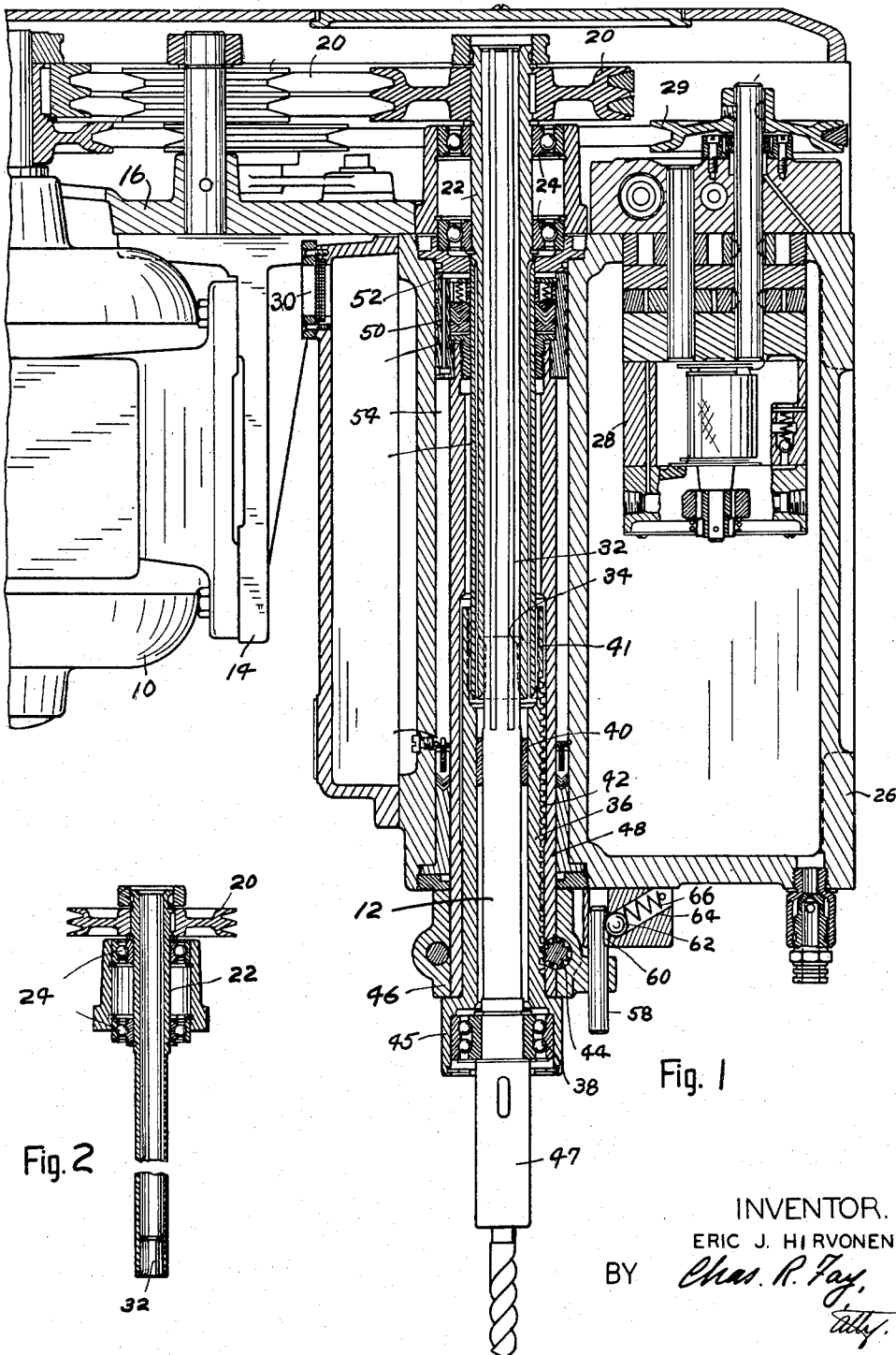


Fig. 1

Fig. 2

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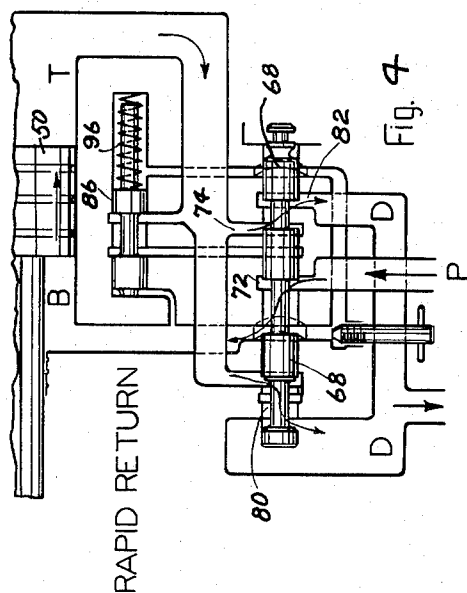
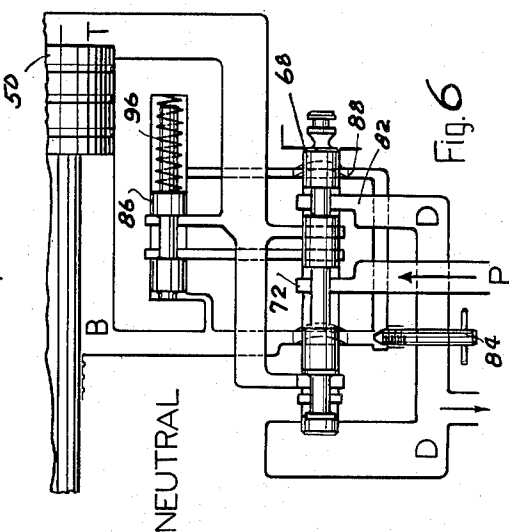
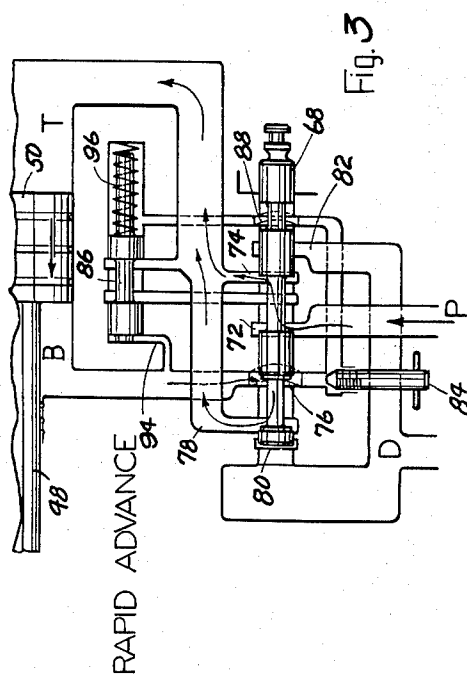
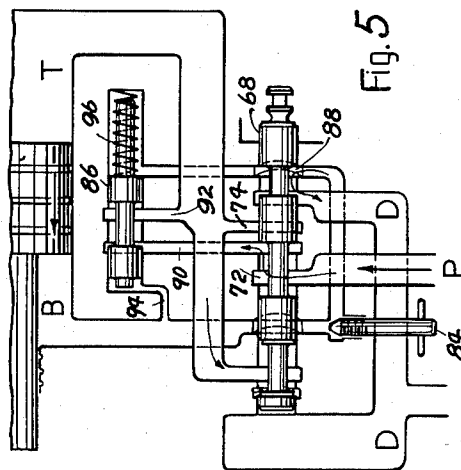
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VALVE FOR CONTROL OF ADVANCE AND RETURN OF A PISTON UNDER HYDRAULIC POWER

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Original application Oct. 30, 1950, Ser. No. 192,864, now Patent No. 2,748,629, dated June 5, 1956. Divided and this application Oct. 20, 1955, Ser. No. 541,590

1 Claim. (Cl. 121—45)

This application is a division of my prior application filed October 30, 1950, Serial No. 192,864, now Patent No. 2,748,629, issued June 5, 1956.

This invention relates in general to hydraulically actuated machine tool feeds wherein new and improved hydraulic means is provided for imparting four conditions of feed to a tool, i.e., stop or neutral condition, rapid advance until a point is reached where the tool contacts the work, slow feed while the tool is actually operating on the work, and rapid reverse at a point where the tool should be retracted for clearing of chips, application of coolant, etc.

The principal object of the invention resides in the provision of a valve for a hydraulic motor, said valve having a valve member which may be automatically or manually actuated to cause the hydraulic motor to operate in each of the four ways specified, said valve member being moved from one position to another through a cycle according to the needs of the hydraulic motor under consideration, and in one position of which wherein it is desired to move the cylinder of the motor rapidly, said valve member is provided with means providing for fluid under pressure to be applied to the pressure end of the cylinder and at the same time providing a passageway for the fluid at the opposite end of the cylinder to be directed to the pressure side instead of to the drain so as to apply a greater volume at the pressure side of the cylinder without the necessity of taking an extra amount of fluid from the pressure source.

A further object of the invention resides in the provision of a device as above described wherein the pressure side of the cylinder is greater in area than the other side and requires therefore a larger volume of fluid in order to operate as rapidly on advance as on retraction.

Other objects and advantages of the invention will appear hereinafter.

Reference is to be had to the accompanying drawings, in which

Fig. 1 is a vertical section through a drilling machine head showing an application of the present invention;

Fig. 2 is a view in vertical section on a reduced scale illustrating a detail of the drilling head;

Fig. 3 is a hydraulic diagram illustrating the main and regulating valves showing the cylinder in condition of rapid advance;

Fig. 4 is a diagram similar to that of Fig. 3 but showing the valve in the position of rapid return of the cylinder;

Fig. 5 is a view similar to Fig. 3 but showing the cylinder in slow feed condition; and

Fig. 6 is a similar diagram illustrating the condition of neutral.

Fig. 1 shows in general an application of the present invention which relates to hydraulic valve control of a hydraulic motor such as a piston and cylinder. In the illustration of Fig. 1, reference numeral 10 indicates an electric motor or other driver for the drill spindle 12, it being understood that all of the parts shown in Fig. 1

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are appropriately mounted on a conventional support, standard, or machine bed. It is also to be understood that the present invention is by no means limited to drills or to any other type of machine tool, but the invention finds one of its important applications in a machine of this nature.

Motor 10 may be supported on a plate 14 suspended from a bracket or the like 16, which in turn may be mounted on the machine bed or standard referred to above. The motor drives a sleeve 22 through appropriate gearing, pulleys and belts 20, the sleeve having bearings 24 maintaining the same in axially fixed but rotatable relation in a housing or the like 26. This housing may contain a fluid reservoir for a dual pump 28 according to the invention described in copending application Serial No. 741,139, filed April 12, 1947, now Patent No. 2,579,116 issued December 18, 1951. The details of this pump will be omitted but may be referred to in the application identified, but in any case the pump may be driven by motor 10 through a belt and pulley at 29. This pump may provide the hydraulic power to reciprocate spindle 12. The housing 26 may be provided with an air outlet 30 and various other pertinent parts which, however, are not important to the present invention.

The sleeve 22 extends downwardly and is provided at its lower end interiorly thereof with splines 32 keyed to the spindle 12 as at 34 for rotational driving of the spindle by the sleeve in axial adjustment of the former up and down in the sleeve. The spindle is journaled in a sleeve 36 as by bearings 38 and 40, the former bearing being made to cause the spindle 12 and sleeve 36 to move axially together. Sleeve 36 is held against rotation as by splines 41 and has a rack 42 operated by a gear 44 to manually adjust the spindle, bearing housing 45, and chuck 47. Gear 44 is located in the head 46 which reciprocates to feed and retract the tool spindle, the adjustment of the spindle being relative to this head.

A sleeve 48 reciprocates with head 46, the spindle, and sleeve 36, and at its upper end it carries a piston 50. Reference numeral 52 indicates the top or pressure side thereof indicated at T in Figs. 3 to 6 inclusive and this side has twice the area of the bottom side of the piston represented by the reference numeral 54 and by the letter "B" in the other figures. The relationship between the two areas, i.e., the top or pressure side being twice that of the bottom, is not a limiting relationship and naturally may be varied, but the top always is larger in area than the bottom. The fluid is of course pumped from the dual pump to the top of the cylinder and exhausted at 56 to the reservoir when the piston 50 travels downwardly.

In Fig. 1, the spindle and piston are at the extreme upper limit of travel and on the head 46 there is a post 58 having a notch 60 receiving a ball 62 in an inclined bore 64 backed by a spring 66. The angularity of the bore is such that the ball cannot be displaced upwardly to the right in Fig. 1 merely by the weight of the tool spindle but added pressure is required to release it. On the other hand, during upward travel, the post easily displaces the ball, which then snaps into the notch and locks the head 46 in its uppermost position.

Figs. 3 to 6 inclusive illustrate the main valve 68 which is notched and axially movable as by means of a head 70 in a bore which is provided with various passages and bores as will be described. The valve member 68 may be moved hydraulically or manually or by any mechanical means desired to keep the cycle of neutral, rapid advance to the work, feed while working, and rapid return after the stroke. Of course, in some cases, rapid advance succeeds rapid return immediately but also in some cases the neutral position will be included in the cycle.

Fig. 3 shows the condition of the main valve for rapid

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advance to the work while, however, no work is actually being done in the case of a drill and in this figure the piston 50 and the sleeve 48 are moving to the left. Fluid under pressure at P enters the valve at 72 and flows to the top of the cylinder T as through a port 74. Fluid under back pressure at B flows to the valve at 76 and thence to the top T of the cylinder through a port 78, thereby increasing the volume of fluid in the pressure side of the cylinder without the necessity of returning the fluid under back pressure at B to the sump to be repumped, thus greatly increasing the speed of the travel of the spindle. The one return to the sump indicated at 80 is closed and the same is true of the return port at 82 as will be clearly seen from the diagram. There may be a metering valve 84 which allows a small flow of fluid from B to flow to the self-regulating valve 86 at port 88 to keep this valve in balance.

When the tool spindle reaches the work or the end of the rapid advance is reached for any reason, the main valve part 68 is moved into the feed position (see Fig. 5) and in this case the port 74 to the top T is cut off, the fluid being directed through port 90 to the regulating valve 86, and thence to port 92 to the top of the cylinder T. The fluid from the bottom B does not now flow to the top T nor does it go to the drain except through the metering valve 84 which is easily manually adjusted as is clear to vary the speed of the feed by regulating the back pressure and flow from the point B. Fluid passing valve 84 and port 88 to the sump D clearly allows but slow progress of the piston 50. The back pressure at B may also act to move the valve 86 to the right through a passage 94 so as to tend to cut off pressure to the top at 90 when the back pressure exceeds that determined by the metering valve so that valve 86 is seen to be self-regulating.

The rapid return of the piston 50 is shown in Fig. 4 wherein valve member 68 is in an extreme position to the left to provide a direct drain from the top of the cylinder T at port 80 and also at port 82 while the pressure is directed to the bottom of the piston 50 to

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port 72. The valve 86 is again moved to the left being overbalanced by its spring 96.

In neutral position, the piston 50 does not have pressure applied at all because the source P is cut off and so also is the drain at B so that the piston must be at rest.

Having thus described my invention and the advantages thereof, I do not wish to be limited to the details herein disclosed, otherwise than as set forth in the claim, but what I claim is:

Apparatus of the class described comprising a cylinder and piston, a main valve for controlling hydraulic fluid to and from both sides of the piston to provide a rapid advance, slow feed, and rapid return cycle, a valve stem for said valve providing a direct passage for fluid from the drain side of the piston to the pressure side thereof to increase the fluid volume at the pressure side; a source of pressure, said valve stem providing a passage therefrom to the pressure side of the piston simultaneously with the opening of said direct passage, with the valve stem set at rapid advance, a regulating valve, the pressure source being controlled by the regulating valve only in feed position of the main valve stem to provide regulated pressure at the pressure side of the piston, the drain side thereof being connected to the drain, and means tending to urge the regulating valve to a position wherein the pressure source is not affected thereby at all other positions of the valve stem of the main valve.

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