Oct. 25, 1932. E. CANNON 1,885,077

SYSTEM OF CONTROL

Filed Oct. 15, 1924

Fig. 2.

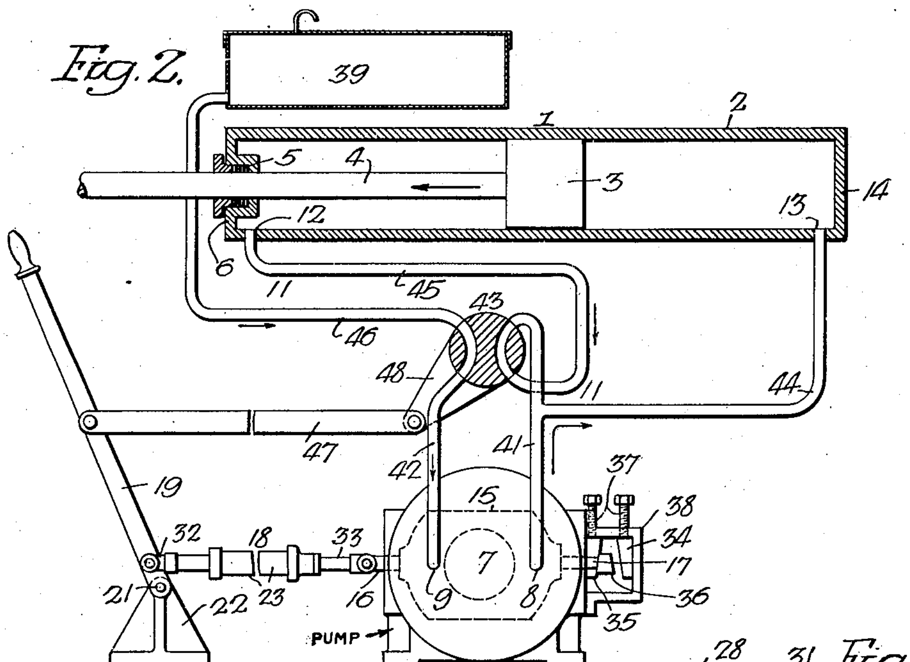


Fig. 3.

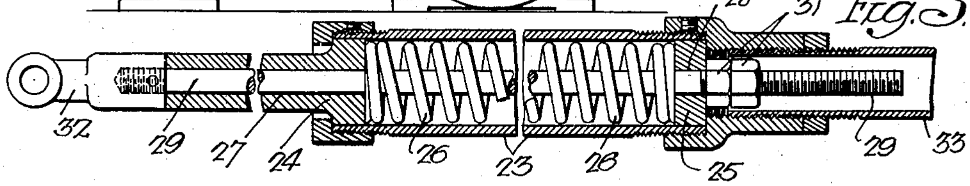
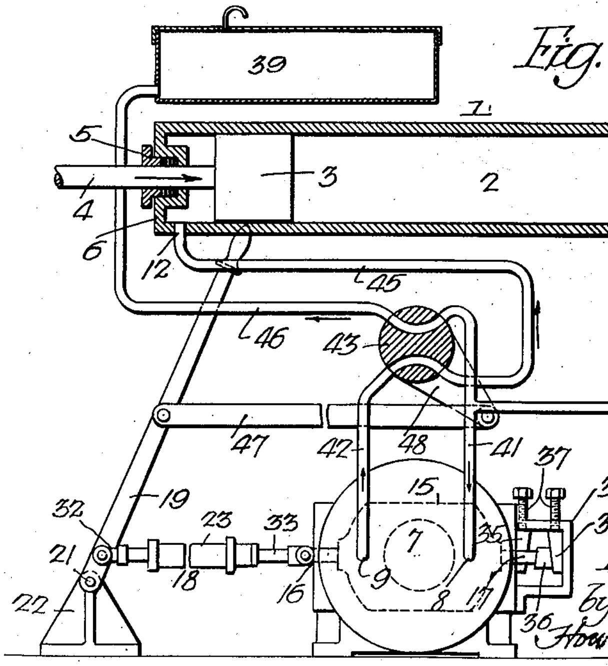


Fig. 1.



Inventor:
Earl Cannon,
by his Attorneys:
Howson & Howson

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UNITED STATES PATENT OFFICE

EARL CANNON, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO AMERICAN FLUID MOTORS COMPANY, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA

SYSTEM OF CONTROL

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My invention relates to power apparatus, and it has particular relation to apparatus of the hydraulic type.

One object of my invention is to provide a fluid motor and means whereby the direction of operation and the rate of movement of the motor may be controlled.

Another object of my invention is to augment the variable speed feature of a reversible, variable-stroke pump by differentially associating therewith apparatus having a fixed speed ratio.

A further object of my invention is to provide a novel power system which includes a hydraulic motor having equal piston speeds in opposite directions,—such desired result being obtained without the use of a double acting ram and two single acting cylinders or by an auxiliary cylinder with a displacement equal to the volume of the piston rod.

A still further object of my invention is to provide a valve and pump arrangement in connection with a hydraulic motor which permits equal pressures per square inch on opposite sides of the piston during the operation of said motor in at least one direction.

A still further object of my invention is to provide a hydraulic motor having a differential, quick-return stroke adapted to actuate a machine tool, say, for instance, a broaching tool, together with a reversible variable-stroke pump for operating said motor.

With these and other objects and applications in mind, my invention further consists in the details of construction and operation, hereinafter described and claimed and illustrated in the accompanying drawing, wherein

Fig. 1 is a view partially diagrammatic and partially structural of one form of embodiment of my invention;

Fig. 2 is a view similar to Fig. 1, but showing the apparatus in the reverse operating position; and

Fig. 3 is a detail sectional view of the device connecting the operating lever and the stroke-controlling element of the pump.

In the illustrated form of embodiment of my invention shown in the drawing, a hydraulic motor 1 comprises an elongated cylinder 2 having a piston 3 mounted therein, the latter being provided with a piston-rod 4 which extends through a stuffing box 5 at one end 6 of the cylinder 2. In one application of my invention, the piston-rod 4 is connected to the tool of a broaching machine (not shown), though of course my invention is not specifically limited to such use.

The connection of the piston-rod 4 to the broaching machine may be such that the working stroke occurs as the piston-rod 4 moves either into or out of the cylinder 2. For purposes of illustration, the former has been shown in the drawing.

As hereinbefore noted, one object of my invention is to provide means for determining the direction as well as the rate of movement of the piston 3. To this end, I provide a reversible, variable-stroke pump 7 having ports 8 and 9 which are respectively connected by piping 11 to ports 12 and 13 disposed in opposite ends 6 and 14 of the cylinder 2.

The variable capacity pump 7 is provided with a reversing, stroke-controlling element 15 of usual form and it has end portions 16 and 17 extending from opposite sides of the pump 7. The end portion 16 of the reversing element 15 is operatively associated through a lost-motion connection 18 (Fig. 3) with a main control lever 19 having a pivotal mounting at 21 on a supporting member 22.

The spring telescoping connection 18, which is designed to permit a continued movement of the operating lever 19 beyond the limit of the movement of the reversing element 15 may comprise a tubular member 23 having the ends thereof closed by abutments 24 and 25 which are movable inwardly against the force of a coil spring 26 extending therebetween. The abutments 24 and 25 are provided with axially aligned perforations 27 and 28 adapted to receive the ends of a rod 29. One end of the rod 29 extends beyond the adjacent abutment 25 and is provided with locking nuts 31. A head 32 serves to connect the end of the rod 29 adjacent to the abutment 24 to the main operating lever 19, while a tubular extension 33 connects the tubular supporting member 23 with the end portion 16 of the reversing element 15.

When a force is applied to the operating lever 19, a corresponding force is imparted to the reversing, stroke-controlling element 15 through the telescoping connection 18. When the element 15 has moved a desired amount, it engages one of a pair of abutments 34 and 35 to be described more fully hereinafter, thereby interrupting the further movement of the reversing element 15. The continued movement of the operating lever 19, which may be necessary for reasons to be set forth hereinafter, causes an inward movement of one of the abutments 24—25 against the force of the spring 26, all as will be understood by those skilled in the art. The stroke of the operating lever 19 may thus be made equal to or greater than the desired stroke of the reversing element 15.

The extent of movement of the reversing element 15 and hence the stroke of the pump 7 may be varied in either direction by the adjustable abutments or stop wedges 34, 35 disposed on opposite sides of a block 36 carried on the end 17 of the reversing element 15. The stop wedges 34, 35 may be adjustably mounted on rods 37 having a threaded connection with a supporting frame 38 extending from the frame of the pump 7. The stroke of the pump 7 on either side of the neutral position may thus be varied from zero to the maximum of the pump by vertically adjusting the stop wedges 34, 35.

The piping 11, which is operatively associated with the pump 7, the hydraulic motor 1 and a storage or so-called compensation chamber 39, comprises a pair of pipes 41 and 42 which extend respectively from the ports 8 and 9 to a four-way reversing valve 43, the pipe 41 being also connected by means of a branch pipe 44 to the port 13 in the end 14 of the cylinder 2. The other end 6 of the cylinder 2 as well as the storage chamber 39 are connected respectively by pipes 45 and 46 to the four-way control valve 43,—the disposition of the several pipes at said valve being such that when the parts are in the position shown in Fig. 1, the port 9 of the pump 7 is connected through pipes 42 and 45 to the end 6 of the cylinder 2. At the same time, the port 8 of the pump 7 is connected to the storage chamber 39 through the pipes 41 and 46 and to the end 14 of the cylinder 2 through the pipes 41 and 44.

When the connecting valve 43, however, is moved into the position shown in Fig. 2, the port 9 of the pump 7 is connected to the storage chamber 39 through the pipes 42 and 46 and the port 8 of said pump is simultaneously connected to both ends of the cylinder 1 through the pipes 41, 44 and 45. The four-way valve 43 may be actuated by the main operating lever 19 from the position shown in Fig. 1 to that shown in Fig. 2 through an interconnecting link 47 and arm 48.

Assuming the reversing stroke-controlling element 15 to be so disposed that with the connection-reversing valve 43 in the position shown in Fig. 1, the pump 7 discharges through the pipes 42 and 45 into the end 6 of the cylinder 2, the force exerted on piston 3, which is proportional to the difference in cross sectional area between the piston rod 4 and the piston 3, causes said piston 3 to move toward the end 14 of the cylinder 2. As hereinbefore noted, this movement of the piston 3 may be termed the working stroke. The movement of the piston 3 causes the fluid contained in the end 14 of the cylinder 2 to be discharged therefrom through the pipe 44 into the pipes 41 and 46, the pump 7 drawing in a certain quantity of the fluid and the storage chamber 39 receiving the excess. The rate of movement of the piston 3 on the present stroke may be controlled by vertically adjusting the stop wedge 34 inasmuch as the latter determines the quantity of liquid propelled per revolution from the pump 7 through the pipe 42.

When the operating lever 19 is moved to the left, the control valve 43 and the reversing element 15 are corerspondingly moved from the positions shown in Fig. 1 to those shown in Fig. 2. The movement of the element 15 into its reversing position therefore causes the pump 7 to discharge fluid through the pipe 41 rather than the pipe 42 as in the preceding position. Since the pipe 41 is now connected by pipes 44 and 45 to the opposite ends 14 and 6 of the cylinder 2, a force is exerted on the piston 3 which is proportional to the cross sectional area of the piston rod 4. As a result, the piston 3 moves to the left and traverses what has been termed for purposes of illustration the return stroke. With the pump 7 discharging into the pipe 41, fluid is drawn into port 9 from the storage chamber 39 through the pipes 42 and 46. The rate of movement of the piston 3 during the present return stroke may be controlled by the stop wedge 35 independently of the stop wedge 34.

Inasmuch as the extent of movement of the four-way valve 43 may be materially greater than that of the reversing element 15, it is seen that the telescoping connection 18 between said reversing element 15 and the main operating lever 19 permits the continued movement of the latter after the end member 36 of the reversing element 15 has engaged one of the stop wedges 34—35.

In view of the foregoing, it may readily be seen that the rate of operation of the piston 3 in either direction can be directly controlled by the stop wedges 34 and 35 so that various speed combinations can be obtained. For example, if the stop wedges 34 and 35 are adjusted to cause the pump 7 to have a short working stroke and a long return stroke, then the working speed of the motor 1 is exceedingly slow compared with the return speed.

Furthermore, the use of a motor with differential pressure characteristics permits of increases in the ratio of the working speed and the return speed independent of the other apparatus embodied in my invention. As noted above, the motor 1 operates at an increased return speed even though the pump 7 is working at full discharge on both strokes.

In some installations, it is desirable to have the working speed and the return speed equal, when using the same pump discharge in either direction, and the apparatus embodying my invention makes this possible without the use of the usual double-acting ram and two single-acting cylinders. In order to effect such desired result, the area represented by the difference between the cross sectional area of the piston 3 and the piston-rod 4, must be equal to the cross sectional area of the piston-rod 4. The reason for this is apparent in view of Figs. 1 and 2, since in the former a propelling fluid is admitted only to the end 6 of the cylinder 2, whereas in the other figure, the propelling fluid is admitted to both ends of the cylinder 2. If the area of the piston-rod 4 is still further increased, the net effective area on the working stroke becomes less than that on the return stroke so that the ratio of the piston speeds on said strokes for constant pump discharge is reversed, causing the greater speed on the working stroke.

Another desirable result characteristic of my apparatus is the absence of leakage or slip past the piston 3 at least during one of its strokes, inasmuch as the insertion of a propelling fluid into both ends of the cylinder 2 results in equal pressures per square inch being exerted on the opposite piston faces. This is of greater advantage when the piston-rod 4 is large relative to the cylinder 2, as then higher pressures may be used during the differential stroke.

While I have shown only one form of embodiment of my invention, for the purpose of describing the same and illustrating its principles of construction and operation, it is apparent that various changes and modifications may be made therein without departing from the spirit of my invention, and I desire, therefore, that only such limitations shall be imposed thereon as are indicated in the appended claims or as are demanded by the prior art.

I claim:

1. In a hydraulic power system, the combination with a fluid motor provided with a piston having different effective areas on the opposite sides thereof, of a reversible, variable-stroke positive displacement pump, an element for reversing said pump and for controlling the stroke thereof, a pair of pipes extending from said pump, means for operatively connecting one of said pipes to both sides of said piston and subsequently the other of said pipes to the side of said piston having the smaller pressure area, said means including a control valve, and common means for actuating the latter and said element, said last-mentioned means including a lost-motion device permitting a differential operation of said means in actuation of the control valve and said element.

2. Hydraulic apparatus comprising a pump having a stroke-controlling element, adjustable means for varying the movement of the stroke controlling element, a fluid motor, means including a control valve for operatively associating said pump and said motor, and means for actuating said valve and said element.

3. Apparatus of the class described including a pump having a variably movable flow-controlling element, means for adjusting the extent of movement of said element, a fluid motor, a connecting valve operatively associated with said pump and said motor, and means for actuating said valve and said element, said means having a lost-motion connection with said element whereby to permit variations of the movement thereof while maintaining a uniform movement of the valve.

4. A pump having a variably movable stroke controlling element, means for adjusting the extent of movement of said element, a fluid motor, a four-way valve operatively associated with said pump and said fluid motor, and a common operating lever for said valve and said element, said lever having a lost-motion connection to said element whereby to permit a uniform movement of said valve accompanied by variable movements of the element.

EARL CANNON.