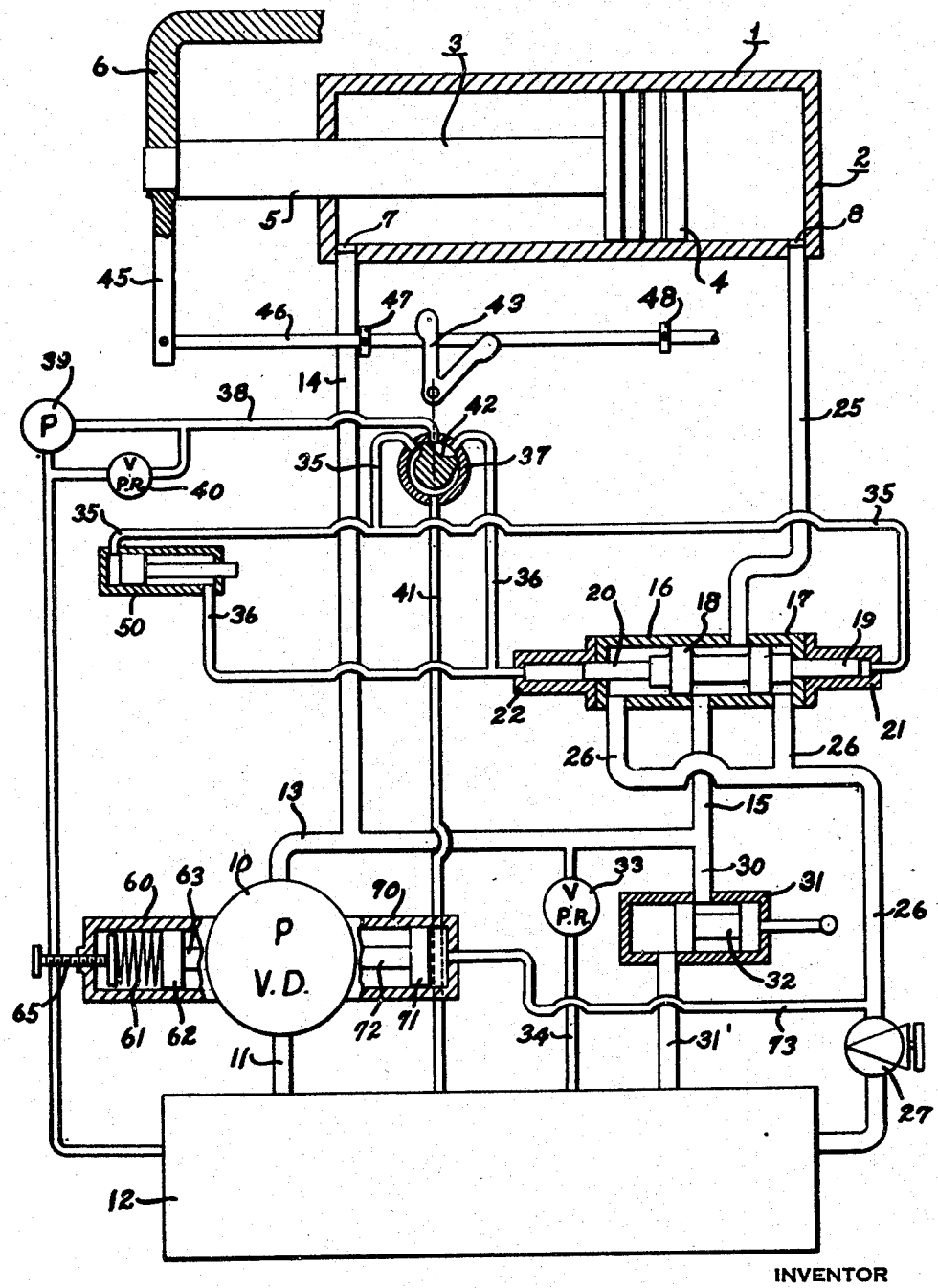
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HYDRAULIC OPERATING CIRCUIT FOR MACHINE TOOLS AND THE LIKE

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INVENTOR
GEORGE M. GEIGER.
BY
Toulmin & Toulmin
ATTORNEYS

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HYDRAULIC OPERATING CIRCUIT FOR MACHINE TOOLS AND THE LIKE

George M. Geiger, Mount Gilead, Ohio, assignor to H-P-M Development Corporation, Wilmington, Del., a corporation of Delaware

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This invention relates to fluid operable systems and, in particular, to fluid operable systems wherein it is desired to control the speed of movement of a driven element.

In many hydraulic applications, such as machine tools, it is desired to control the speed of a rotary or a reciprocating element in order to improve the operating characteristics of the machine. Accordingly, it is a primary object of this invention to provide a hydraulic circuit including a motor wherein the speed of the motor is controlled.

It is another object of this invention to provide, in such a circuit, a means for adjusting the aforementioned control means in order to regulate the speed of the driven motor.

These and other objects will be apparent upon reference to the following description taken in connection with the accompanying drawing.

General arrangement

According to this invention, a fluid operable motor, which may be of either the rotary or reciprocating type, is supplied with pressure fluid from a source of variable delivery, which latter includes means for controlling the flow therefrom.

Valve means is provided for by-passing the delivery of said fluid source when the driven motor is idle. Other valve means are provided for directing the delivery of the said pump to the motor and is operable to cause the said motor to move in a forward or in a reverse direction.

The discharge of the motor is passed through a throttling valve thereby to generate a pressure on the inlet side of the said valve. This pressure, in combination with a suitable yielding means, is effective to actuate the flow controlling device associated with the fluid source.

Detailed description

Referring now to the drawing more in detail, there is shown a fluid operable motor 1 which comprises a pressure casing 2 having mounted therein a movable work member 3. If the fluid operable motor 1 is of the reciprocating type, as shown, the work member 3 comprises a piston 4 and a ram 5 reciprocably mounted within the casing or cylinder 2. Attached to the end of the ram 5 is a work table or other object which it is desired to move such as is shown at 6.

The motor 1 is provided with fluid inlet and outlet connections at 7 and 8 and pressure fluid for reciprocating the said ram and piston is introduced into the cylinder therethrough.

For the purpose of supplying actuating fluid to

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the motor 1 a pump 10 is provided which draws fluid through a conduit 11 from a reservoir 12 and expels the same at increased pressure into a conduit 13.

The conduit 13 is connected by a branch conduit 14 with the port 7 in the cylinder 2, and by a conduit 15 with the inlet port of a 3-way valve 16.

The 3-way valve 16 comprises a casing 17 within which is reciprocably mounted a valve member 18 which is adapted to be reciprocated within the said valve casing by a pair of pilot plungers 19 and 20. The pilot plungers 19 and 20 are reciprocably mounted in the pilot cylinders 21 and 22 which are suitably secured to the opposite ends of the casing 17.

The valve 16 is connected to the port 8 in the cylinder 2 by a conduit 25 and by the conduits 26 with the inlet of an adjustable choke or throttling valve 27, which latter has its outlet in continuous fluid communication with the reservoir 12. The valve member 18 is adapted, in its right hand position to effect fluid communication between the conduits 15 and 25 and, in its left hand position, to establish fluid connection between conduits 25 and 26.

Also branching off from the conduit 13 is a conduit 30 which leads to a 2-way valve 31. The 2-way valve 31 also comprises a movable valve member 32 which is selectively movable into position to effect fluid connection between conduit 30 and the conduit 31' leading to the reservoir 12 and into position to interrupt the said fluid connection. The valve 31 may be operated in any convenient manner such as the manual means shown in the drawing and is for the purpose of freely by-passing the pump delivery in order to cause the motor 1 to idle.

A relief valve 33 is included in a conduit 34 which leads from the conduit 13 to the reservoir 12. The function of the relief valve is to relieve excessive pressures within the conduit 13 during the operation of the hydraulic system.

The pilot cylinders 21 and 22 of the valve 16 are connected by the conduits 35 and 36 respectively with the 4-way pilot valve 37. Pressure fluid is supplied to the pilot valve 37 through a conduit 38 from any suitable pressure fluid source such as the auxiliary pump 39. The pump 39 may be of any type such as a gear pump and may be by-passed by a relief valve such as at 40 in order to by-pass excessive delivery therefrom. The 4-way pilot valve 37 also has connected thereto the exhaust conduit 41 which leads directly to the reservoir 12 and serves as a channel to

conduct exhaust fluid away from the said valve during the operation of the hydraulic system.

Rotatably mounted within the valve 37 is a valve member 42 which serves to control the fluid communication between the conduits entering the valve. Attached to the valve rotor is a bifurcated lever 43 which is adapted to shift the valve rotor from a position where the conduits 38 and 36 are interconnected while the conduits 35 and 41 are interconnected into a position where the conduits 38 and 35 are interconnected while the conduits 36 and 41 are also interconnected.

Suitably attached to the ram 5 is an arm 45 which carries a rod 46 which has attached thereto the collars 47 and 48. The collars 47 and 48 are positioned so as to engage the arms of the lever 43 to move the same and thereby to shift the valve rotor 42. The arrangement is such that, when the ram 5 completes its travel in either direction and engages the lever 43 and shifts the same, the fluid connection established within the valve 37 and will be such that the valve 16 will be shifted into position to reverse the travel of the said ram.

Also associated with the pilot valve 37 is a reciprocating fluid motor 50 which is provided for the purpose of feeding the work or tools toward one another during the operation of the machine which is to be driven by the hydraulic circuit of this invention. The motor 50 is provided with opposed areas, one of which is connected with the conduit 35 and the other of which is connected with the conduit 36. Since one of the said conduits is always under pressure while the other is being exhausted, the motor 50 is moved first in one direction and then in the other as the valve member 42 of the valve 37 is moved from its first position to its second position during the operation of the machine. It will be noted that the actuation of the motor 50 occurs at the instant of reversal of the motor 1.

Referring more particularly to the pump 10, this will be seen to comprise a variable delivery pump having a movable flow control member to which is attached a yielding means urging it towards maximum delivery position and a fluid operable means arranged in opposition to the said yielding means. The yielding means is contained within the cylinder 60 and comprises a spring 61 which bears against the head 62 of a rod 63 which is attached to the pump flow control member. The thrust of the spring 61 is adjusted by means of an adjusting member 65 which may be, as shown, a rod threadedly engaging the end wall of the cylinder 60. Arranged on the opposite side of the pump is a cylinder 70 within which is reciprocably mounted a piston 71 attached to a piston rod 72 which latter abuts or is connected with the said flow control member of the pump 10. Fluid pressure is introduced into the cylinder 70 through a conduit 73 which leads from the said cylinder to the inlet of the choke valve 27.

Operation

In operation the pumps 10 and 39 are driven from any suitable source such as individual motors or a single motor and the ram 5 is caused to reciprocate in the following manner: assume that the motor 1 is standing idle with the delivery of the pump 10 being by-passed through the conduits 13, 30 and 31'. A working stroke of the ram 5 is instituted by moving the valve member 32 to the right thereby to close off the aforementioned by-pass connection. If the valve member 18 of the valve 16 occupies the position shown in the drawing then the delivery of the pump 10 is directed through the conduits 13 and 15 to the valve 16 and thence through the conduit 25 to the right side of the piston 4. Pressure also stands through the conduits 13 and 14 to the cylinder 2 and on the left side of the piston 4. The right side of the piston 4, being the larger, will cause the piston 4 of the ram 5 to move leftwardly and at a relatively high rate of speed.

When the leftward movement has progressed to the point where the collar 48 engages the lever 43 and shifts the same counter-clockwise, the valve member 42 is likewise shifted counter-clockwise and fluid connection between the conduits 38 and 35 and between the conduits 36 and 41 is established. The first of these connections is effective to cause pressure from the pilot pump 39 to be delivered to the pilot cylinder 21 and, through the plunger 19, to move the valve member 18 into its lefthand position. At this time, the fluid within the pilot cylinder 22 is exhausted to the conduit 36, the valve 37 and the conduit 41 to the reservoir.

The shifting of the valve member 18 to the left cuts off fluid communication between the conduits 15 and 25 and establishes fluid communication between the conduits 25 and 26.

The right hand side of the piston 4 now being exhausted, while the left hand side remains under pressure, the piston and ram will move to the right, with the full delivery of the pump passing through the conduits 13 and 14 into the cylinder 2 to the left of the piston 4.

The rightward or working movement of the ram 5 is accomplished at a controlled rate of speed by controlling the delivery from the pump in accordance with the pressure created at the inlet of the choke 27 by the passage therethrough of the exhaust fluid from the cylinder 2. It will be noted that, when the ram 5 is performing its working or rightward stroke, the entire discharge from the right end of the cylinder 2 is conducted through the conduits 25 and 26 to the inlet of the flow responsive means or choke 27 and therethrough to the reservoir 12. The pressure created at the inlet of the said flow responsive means is, in accordance with well known hydraulic laws, in direct proportion to the rate of fluid flow through the said means. Thus, the pressure created at the inlet of the choke valve 27 and, therefore, in the conduit 73, is directly proportional to the speed at which the ram 5 moves during its working stroke. Also the thrust on the piston 71 created by the pressure conducted thereto by the conduit 73 is proportional to the rate of travel of the ram 5 and is effective to urge the flow control member of the pump 10 toward reduced delivery position until the latter occupies such a position that the rate of delivery of fluid from the pump to the motor causes the motor to travel at a speed in accordance with the setting of the choke 27 and the spring adjusting means 65. That is, the speed of the motor will be such that the rate of fluid exhaust therefrom will create a pressure at the inlet of the choke 27 and, therefore, a thrust on the piston 71 which is exactly equal to the thrust of the spring 61.

It will be apparent that the speed of the working stroke of the ram 5 may be varied by adjusting the setting of the choke or flow responsive means 27 or by adjusting the thrust of the yielding means 61. It will also be apparent that, in operation, the flow responsive means 27 in cooperation with the fluid operable means 70, 71 and the yielding means 61 is effective automatically

to maintain the speed of the ram 5 at any predetermined value.

Inasmuch as various modifications and substitution of equivalents or alterations in structural arrangements may be made without departing from the spirit of this invention, it will be understood that I do not wish to be limited to the specific structure shown and described, but desire to comprehend such modifications as come within the spirit of the claims.

Having thus fully described my invention what I claim as new and desire to secure by Letters Patent is:

1. In a hydraulic system; a reciprocable ram having associated therewith an advancing area and a larger retraction area; a variable delivery pump in continuous hydraulic communication with said advancing area and including a movable flow control member; a valve means having a first port connected with said pump, a second port connected with said retraction area, and including a third port; a choke valve having its outlet connected to exhaust and its inlet connected to said third port; said valve being movable selectively to interconnect said retraction area with said pump or with the inlet of said choke valve; opposed fluid operable plungers associated with said valve for moving the same from one position to the other; a source of pilot fluid for supplying actuating fluid to said plungers; a rotary pilot valve for controlling the supply of fluid from said source to said plungers and adapted, in response to a predetermined movement of said ram in either direction, to be engaged and moved thereby to vary the supply of pilot fluid to said plungers thereby to cause the same to move said first mentioned valve into position to bring about the reversal of said ram; said pump flow control member having associated therewith yielding means continuously urging the same toward increased delivery position and a fluid operable plunger hydraulically connected with the inlet of said choke valve and adapted to urge said flow control member toward reduced delivery position, said yielding means and said fluid operable plunger cooperating automatically to maintain the speed of said motor substantially constant; means for adjusting the thrust of said yielding means; means for adjusting the throttling effect of said choke valve; and valve means selectively operable for bypassing the entire delivery of said pump.

2. In a hydraulic circuit for a machine tool having a reciprocable work table and a work or tool feed; a first fluid operable motor for actuating said table; a second fluid operable motor for actuating said feed; a variable delivery pump; a reversing valve connecting said pump with said first motor and movable for supplying fluid to said motor in both directions of movement thereof; a pair of fluid pressure responsive actuating means associated with said reversing valve for moving the same into its positions; a pilot pump; a rotary valve interconnecting said pilot pump with said fluid pressure responsive actuating means and movable to direct fluid to one or the other thereof; said second motor being connected in parallel with said fluid pressure responsive actuating means for receiving fluid from said pilot pump when said rotary valve is shifted.

3. In a hydraulic circuit for a machine tool having a work table and a work or tool feed; a differential plunger connected with said table; a fluid operable motor for actuating said feed; a fluid source of variable delivery; a reversing valve interconnecting said source with said plunger and movable into a first position to direct fluid to both sides of said plunger and into a second position to exhaust the larger end of said plunger; a pair of opposed fluid operable means for actuating said reversible valve; a pilot pump for supplying actuating fluid to said fluid operable means; a rotary pilot valve adapted for actuation by said plunger at the opposite ends of its stroke alternately to direct fluid from said pump to said pair of fluid operable means while the other of said pair is exhausting; said fluid operable motor also being connected to receive fluid from said rotary pilot valve thereby to be actuated at opposite ends of the stroke of said plunger; and means operable when said reversing valve is positioned to direct fluid to the smaller area of said plunger and to exhaust the larger area thereof for maintaining the delivery of said source substantially constant to maintain the speed of said plunger substantially constant.

GEORGE M. GEIGER.

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