

May 22, 1951

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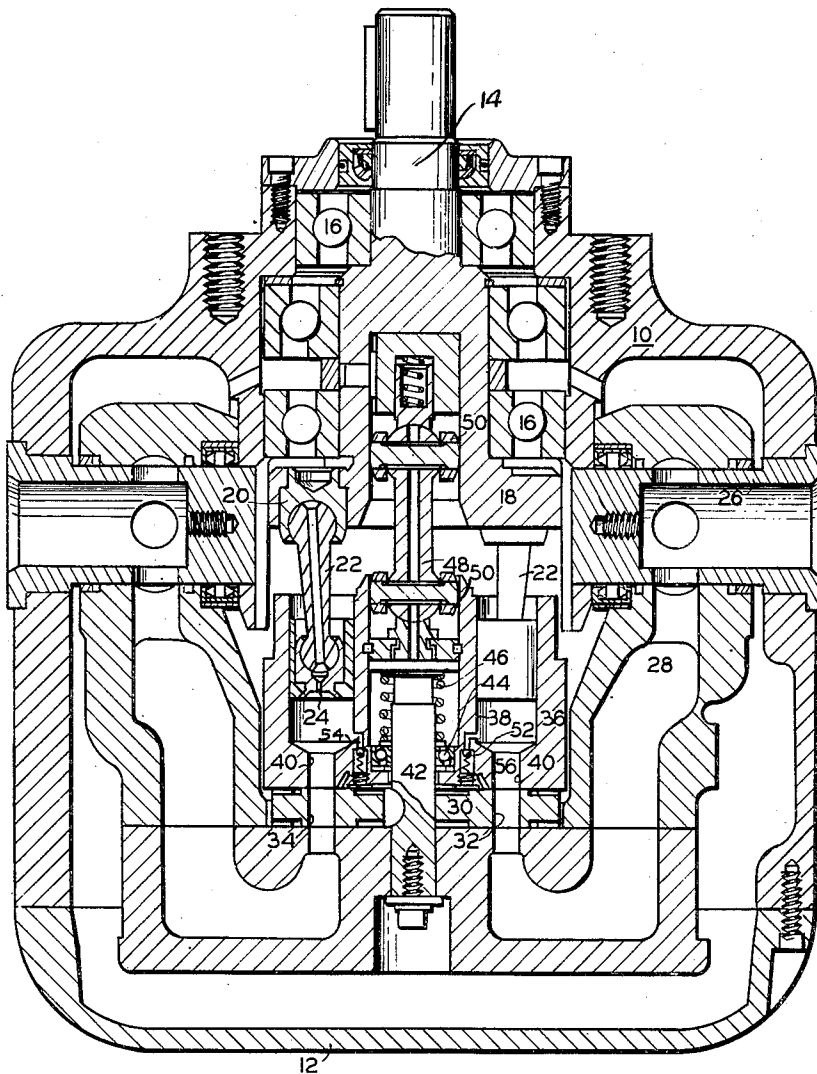
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PUMP

Filed March 14, 1946

2 Sheets-Sheet 1

FIG 1



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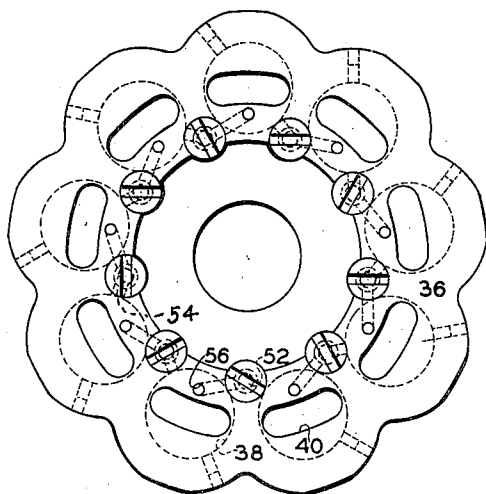


FIG. 2

FIG. 3

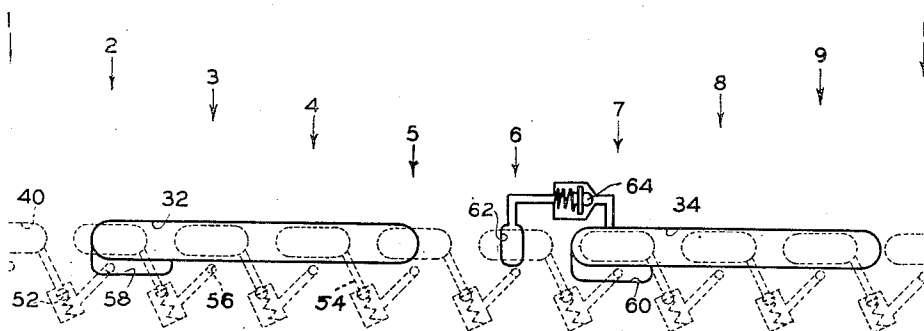
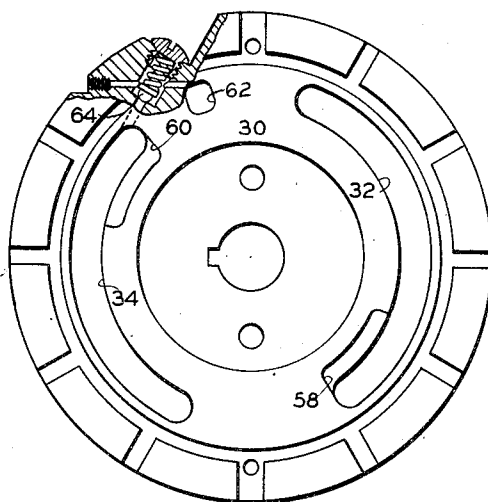


FIG. 4

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2,553,655

PUMP

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Application March 14, 1946, Serial No. 654,314

6 Claims. (Cl. 103—162)

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This invention relates to power transmissions, particularly to those of the type comprising two or more fluid pressure energy translating devices, one of which may function as a pump and another as a fluid motor.

The invention is more particularly concerned with a fluid pressure energy translating device of the multi-piston and cylinder types having mechanically operated positively timed valving for controlling the distribution of fluid to and from the cylinders. Devices of this character are widely used in systems operating at very high pressures and frequently operate at very high speed. One disadvantage frequently encountered with units of this type is the production of considerable noise and a large part of this noise has been found to be generated as fluid pressure shock originating from improper timing of the admission and release of pressure fluid to each cylinder.

Where the device is of the type using a rotating cylinder block having individual ports which cooperate with a stationary valve member having main inlet and outlet ports, the valve timing is not capable of adjustment after the device has been assembled since it is determined by the length of the ports in the valve member. Many attempts have been made to improve the action of this type of valve mechanism so as to make it noise free under all the various operating conditions encountered, but these attempts have heretofore not been entirely successful.

It is an object of the present invention to provide an improved fluid pressure energy translating device which retains the advantages of the positive mechanically operated valving, and yet which is capable of operating silently throughout a greater range of speed, pressure, and piston stroke.

A further object is to provide in a device of this character, a valving structure in which the normal mechanical valving has a lengthened cut-off adjacent dead-center piston position which blocks each cylinder in turn during a substantial part of the piston stroke, and to provide in addition auxiliary valving means utilizing check valves for determining the exact time of opening of each cylinder to the high pressure or low pressure port of the device or to both. In this way the advantages of mechanically operated valving such as their usual large open flow passages are retained without their drawback of noisy operation. Likewise the advantages of quiet operation obtainable when check valves are utilized and, because the check valve can be made small

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and light, no difficulty is experienced from inertia effects, seat pounding, etc., which would be troublesome if the check valves are made large enough to carry the entire cylinder delivery.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred form of the present invention is clearly shown.

In the drawings:

Figure 1 is a longitudinal sectional view of a reversible variable stroke pump embodying a preferred form of the present invention.

Figure 2 is an end view of the cylinder block of the pump of Figure 1.

Figure 3 is an end view of the valve plate of the pump of Figure 1.

Figure 4 is a developed view illustrating diagrammatically the action of the valve mechanism.

Referring now to Figure 1, there is illustrated a pump comprising a main housing 10 having an end cover 12. A drive shaft 14 is journaled on bearings 16 and has a driving flange 18 at its inner end. The flange 18 carries a plurality of sockets 20 which are articulated to connecting rods 22 having pistons 24 articulated thereto at the opposite end. Pivotaly mounted in the casing 10 on hollow trunnions 26 is a two-armed swinging yoke 28, arms of which are hollow for passage of fluid to and from the pintle 26. The yoke carries a stationary valve plate 30 having two arcuate ports 32 and 34 as shown in Figure 3. The valve plate ports communicate respectively with the passages formed in the yoke 28 and provide the main inlet and outlet passages for the pump. A cylinder block 36 is provided with a plurality of axial cylinder bores 38 having individual ports 40 adapted to register with the valve plate ports alternately as the block rotates in contact with the valve plate. The cylinder block 36 is journaled on a pin 42 by means of a bearing 44 while a spring 46 exerts a light pressure urging the cylinder block into contact with the valve plate 30. The cylinder block 36 is driven in synchronism with the drive shaft 14 by means of a Cardan shaft 48 having universal joints 50 at its opposite end.

The structure thus far described is typical of prior art construction, and the present improvement concerns the means for valving the fluid to and from the cylinder bores 38. There is provided in the cylinder block a plurality of individual check valves 52, one for each cylinder. The check valves 52 have their inlet side in com-

munication with their respective cylinders by a right angled passage 54. The outlet side of each check valve is connected to the face of the cylinder block by an angularly disposed passage 56 leading to the face at a point somewhat ahead of the corresponding main cylinder ports 40.

As shown more clearly in Figure 2, each passage 56 has its terminus located substantially opposite the mid-point of the cylinder port 40 for the next adjacent cylinder in a clockwise direction which would be the intended direction of rotation of the cylinder barrel shown in Figure 2. The terminus of each passage 56 is also located radially inward from the edge of the ports 40.

Referring now to Figure 3, and bearing in mind that clockwise rotation of the cylinder barrel in Figure 2 appears as counterclockwise rotation in Figure 3, the valve ports 32 and 34 have their leading edges located a considerable angular distance from the vertical center line which is the point of piston dead-center while their trailing edges are located approximately at the normal distance from the vertical center line—this distance being substantially one-half the length of each cylinder port 40. Each port 32 and 34 also has an inward extension 58 and 60, respectively, which registers with the ends of the passages 56 in turn.

The flat surface between the end of the ports 32 and 34, that is, the portion which effects cut-off of each cylinder from both ports, is thus considerably longer than the cylinder port 40, and would normally block each cylinder for a significant part of its piston stroke. One of these cut-off portions is provided with a depressed cavity or recess 62 of the shape shown. Assuming that the port 32 will be the pressure or outlet port for normal forward delivery of the pump, and port 34 the suction or inlet port, the cavity 62 is connected with the port 34 by means of a check valve 64 in the valve plate 30.

In operation, with the pump connected to a suitable prime mover and hydraulic work circuit, and with the system filled with oil and the drive shaft 14 rotating, when the yoke 28 is in the position illustrated, the axis of cylinder block 36 is coincident with the axis of shaft 14, and no reciprocation of the pistons 24 takes place. The pump is thus in neutral position and its fluid output is zero. If the yoke 28 be swung away from the observer in Figure 1, the port 34 becomes the inlet port and port 32 the outlet port, and the quantitative delivery of the pump will vary with the angle through which the yoke is displaced from neutral position. Likewise, for reverse delivery the yoke may be swung towards the observer in Figure 1 to make the port 34 the inlet port and port 32 the outlet port, rotation of the shaft at all times being in the direction top to the right in Figure 1.

Referring now to Figures 2 and 3, and particularly to Figure 4, the valve action may be considered. In Figure 4, the parts associated with valve plate 30 are shown in solid lines, and the parts associated with the cylinder barrel 36 are shown in dotted lines. The two ends of the figure represent bottom dead-center of Figure 3 while the mid-point represents top dead-center. It will be noted that in the position shown in Figure 4, cylinder port 40 for cylinder No. 1 is at bottom dead-center, and with the yoke 28 swung to full forward displacement position, the arrows along the top of Figure 4 represent the respective piston positions. Port 40 of cylinder

No. 1 has just cut off from inlet port 34 and the terminus of its check valve passage 56 is just starting to connect with the extension 58 of port 32. Thus, on the first downward travel of its piston, the oil which is trapped in the cylinder bore and port at inlet pressure is compressed at first before the check valve 52 opens. As soon as it is compressed to a pressure equal to that in the outlet port 32, a slight additional compression sufficient to overcome the spring behind the check valve, opens the same and provides for the initial delivery of all oil from said cylinder until port 40 opens to port 32. Since the piston movement is substantially simple harmonic motion, the initial travel of the piston is small in relation to the angular travel of the cylinder barrel so that the check valve 52 need not have a large fluid carrying capacity. As soon as port 40 establishes connection with port 32, all further delivery from the cylinder takes place through port 40 until that port is cut off at the trailing edge of port 32 which occurs at top dead-center.

Thereafter, the port 40 is cut off from communication with port 34 for a considerable angular movement of the cylinder block, but is in communication with the recess 62. During the initial retraction movement of the piston, as for example the piston shown at No. 6 in Figure 4, the oil which was trapped in the cylinder bore and port is initially under full delivery pressure, and this holds the check valve 64 tightly on its seat. Retraction of the piston, however, permits this oil to re-expand until it has dropped to a pressure slightly below the pressure in the inlet port 34 at which time check valve 64 opens permitting intake of fluid through this path. Upon a further movement of the cylinder barrel, port 40 connects with the main portion of port 34, and the remaining part of the suction stroke takes place with all oil going through the port 40.

It will thus be seen that the initial connection of each cylinder with both the inlet and the outlet port is established temporarily through a passage containing a check valve. This provides an automatic control of the point at which flow starts, and allows the trapped oil in the cylinder bore and port to be brought up or down in pressure as required to exactly match the pressure in the valve port to which it is to be connected. Thus, the actual timing is varied automatically, depending upon pump speed, operating pressure, and piston stroke, as is necessary under the various conditions. At the same time, the main flow to or from each cylinder takes place through wide clear passages imposing little restriction.

While the form of embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In a multi-piston and cylinder liquid pressure energy translating device the combination of a plurality of pistons and cylinders, means for causing relative reciprocating motion thereof, a main inlet port, a main outlet port, a rotary valve operable in timed relation with the pistons thereof and controlling communication with the main inlet and outlet ports of the device, individual small discharge passages, one for each cylinder, and connecting with the main outlet port during only the beginning of each piston discharging stroke, a check valve in each passage, and separate larger passages, one for each cylinder, connecting with the main outlet

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port during a later phase of the piston stroke and also connecting with the main inlet port during the piston return stroke.

2. In a multi-piston and cylinder liquid pressure energy translating device the combination of a plurality of pistons and cylinders, means for causing relative reciprocating motion thereof, a main inlet port, a main outlet port, a rotary valve carried by the cylinders and operable in timed relation with the pistons thereof and controlling communication with the stationary main inlet and outlet ports of the device, individual small discharge passages, one for each cylinder, and connecting with the main outlet port during only the beginning of each piston discharging stroke, a check valve in each passage, and separate larger passages, one for each cylinder, connecting with the main outlet port during a later phase of the piston stroke and also connecting with the main inlet port during the piston return stroke.

3. In a multi-piston and cylinder liquid pressure energy translating device the combination of a plurality of pistons and cylinders, means for causing relative reciprocating motion thereof, a main inlet port, a main outlet port, a rotary valve operable in timed relation with the pistons thereof and controlling communication with the main inlet and outlet ports of the device, individual small discharge passages, one for each cylinder, and connecting with the main outlet port at the start of each piston discharging stroke, a check valve in each passage, separate larger passages, one for each cylinder, connecting with the main outlet port during a later phase of the piston stroke and also connecting with the main inlet port during the piston return stroke, and a check valve opening out of the main inlet port to each cylinder in turn to establish initial connection with the main inlet port.

4. In a multi-piston and cylinder liquid pressure energy translating device the combination of a plurality of pistons and cylinders, means for causing relative reciprocating motion thereof, a main inlet port, a main outlet port, a rotary valve operable in timed relation with the pistons thereof and controlling communication with the main high and low pressure ports of the device, said valving structure having a lengthened portion at one dead-center position of the pistons at which the normal communication of the cylinder is cut off from both high and low pressure ports, individual check valves for each cylinder, and auxiliary means associated with the high pressure port for establishing communication with the high pressure port through each check valve in turn as the corresponding piston starts away from dead-center.

5. In a multi-piston and cylinder liquid pres-

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sure energy translating device the combination of a plurality of pistons and cylinders, means for causing relative reciprocating motion thereof, a main inlet port, a main outlet port, a rotary valve operable in timed relation with the pistons thereof and controlling communication with the main high and low pressure ports of the device, said valving structure having a lengthened portion at one dead-center position of the pistons at which the normal communication of the cylinder is cut off from both high and low pressure ports, individual check valves for each cylinder, and auxiliary means associated with the high pressure port for establishing communication with the high pressure port through each check valve in turn as the corresponding piston starts away from dead-center, the valving structure having a lengthened portion at the other dead-center position and a check valve opening out of the main inlet port and effective to connect each cylinder in turn to the main inlet as the corresponding piston starts away from dead-center.

6. In a multi-piston and cylinder liquid pressure energy translating device the combination of a plurality of pistons and cylinders, means for causing relative reciprocating motion thereof, a main inlet port, a main outlet port, a rotary valve operable in timed relation with the pistons thereof and controlling communication with the main high and low pressure ports of the device, said valving structure having a lengthened cut-off of the cylinders from both high and low pressure ports at at least one dead-center position, and individual check valves, one for each cylinder, for establishing communication of each cylinder with the high pressure port as the corresponding piston starts away from dead-center.

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