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E. H. BORN
HYDRAULIC MOTOR

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2 Sheets-Sheet 1

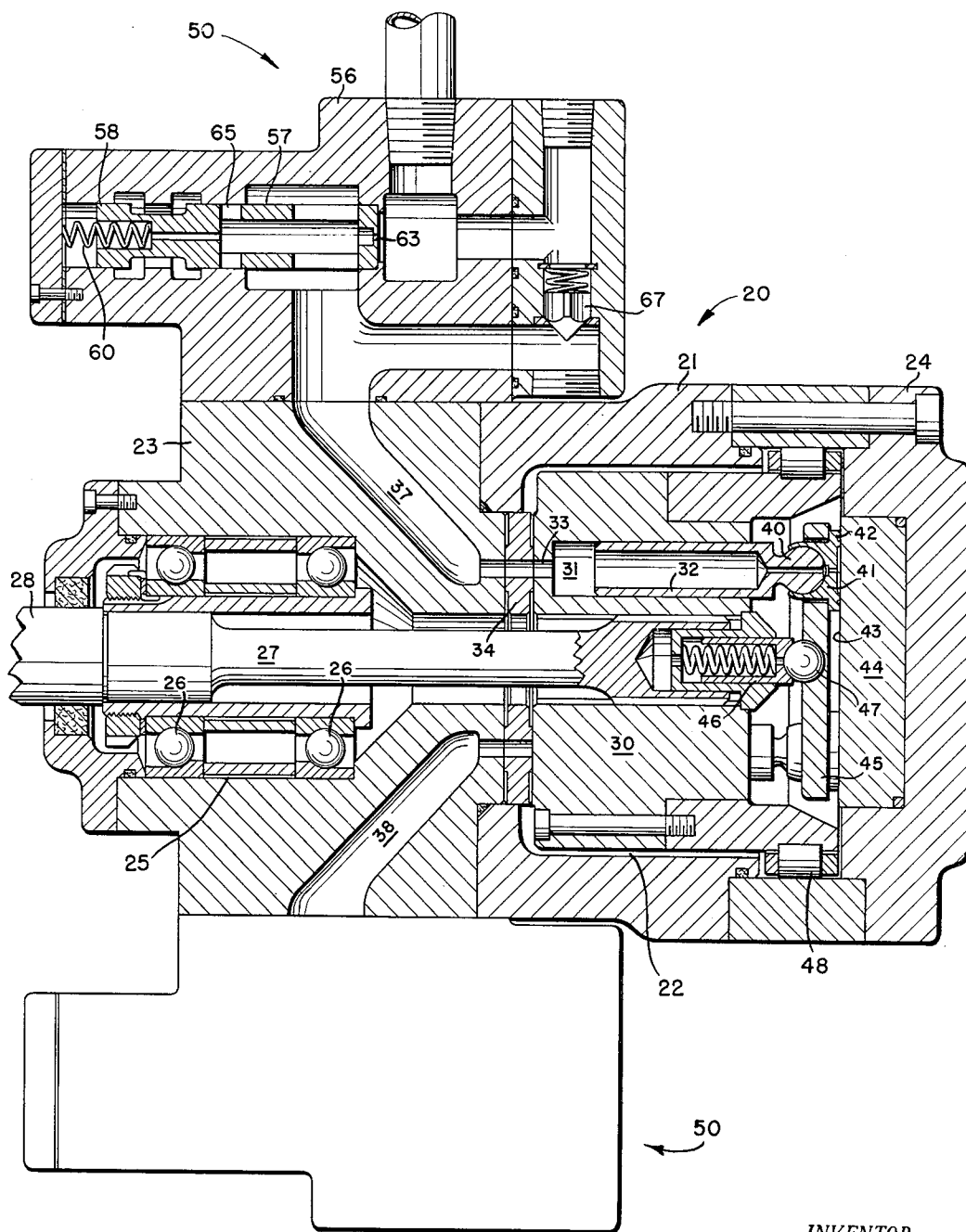


FIG. 1

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2 Sheets-Sheet 2

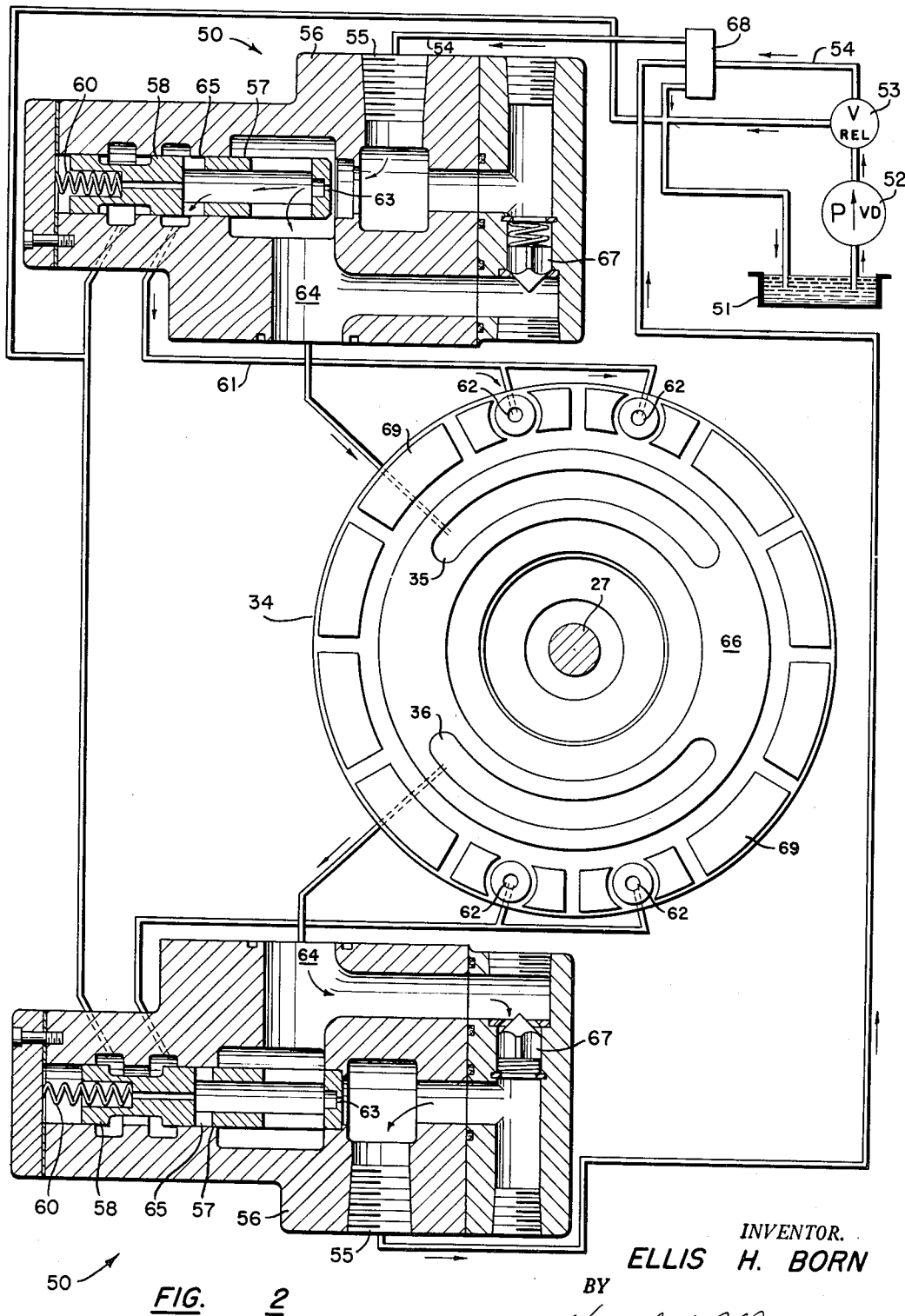


FIG. 2

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HYDRAULIC MOTOR

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3 Claims. (Cl. 121—62)

This invention relates to hydraulics and in its more particular aspects is directed to improvements in fluid pressure energy translating devices commonly referred to as fluid pumps and motors. Still more particularly the invention relates to pumps and motors of the type having relatively movable, slidably engaged valving members.

In devices of the character referred to, and particularly those of the axial piston type having cylinder barrels and port plates in relatively rotatable sliding engagement, the areas of contacting and other surfaces exposed, either entirely or partially, to pressures tending to separate the engaging members in relation to the areas exposed to pressures tending to cause their engagement is quite critical. In fluid motors, especially, the rate of movement of the operating parts also enters into the problem. It has been discovered that when devices of the type mentioned are operated at relatively low speeds, the oil film generally present between the reciprocating pistons and the cylinder barrel is expelled due to the side thrust of the pistons and the fact that the pistons move too slowly to replace it. This lack of oil causes an undue drag of the pistons in their bores and oil under pressure supplied to the piston chambers then has a greater tendency to move the cylinder barrel away from the port plate. This tendency added to that resulting from oil tending to seep between the port plate and cylinder barrel may become sufficient to cause the cylinder barrel to separate from the port plate and permit the oil to escape and render the motor inoperative. It has also been discovered that when the speed of operation is increased beyond a certain rate the pistons become more effectively coated with oil and move more easily with the result of lowering the tendency to move the cylinder barrel away from the port plate. This decrease in separating forces increases the friction between the cylinder barrel and port plate and interferes with the operation of the motor. It is, therefore, an object of the invention to provide means for varying the area exposed to fluid pressures tending to separate the cylinder barrel and port plate so that when the motor is operated at a reduced rate and the drag of the pistons causes an increase in the tendency to separate, the areas of the contacting surfaces exposed to separating pressure may be reduced; this area is increased when the rate of operation is increased.

Another object of the invention is to vary the area exposed to pressure tending to separate the relatively movable elements of a fluid motor by controlling the flow of fluid under pressure to certain contacting areas in response to change in rate of operation of the motor.

A further object of the invention is to provide a fluid motor with one or more ports, recesses, openings or similar structure in addition to the inlet and outlet ports and a valve controlled passage through which fluid from a source of pressure may be supplied thereto, the valve being responsive to fluid flow to operate the motor when the volume of fluid flow is insufficient to cause the motor to operate faster than a predetermined minimum the valve will remain closed and no fluid will be supplied to the additional ports, the area exposed to fluid pressure tending

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to separate the relatively movable elements will thus be reduced. When the volume of fluid flow is increased to cause operation at a rate in excess of such minimum, the valve will be opened and the additional ports will receive fluid under pressure which exerts a force tending to separate the elements. Through the proper calculation of the areas of the surfaces exposed to such pressures the ratio of areas exposed to pressure tending to separate the cylinder barrel and port plate to those exposed to pressure tending to cause engagement may be maintained irrespective of the speed of operation of the motor.

A still further object of the invention is to provide a fluid motor with two sets of additional port means of the type mentioned in the preceding paragraph and two valve controlled passages, these elements being so arranged and connected that the motor may be operated in either direction and still have the benefits of the invention.

Another object is to provide valve means for motors of the type mentioned above to control the flow of fluid to the additional ports, the valve means having a spool valve with an orifice to cause a pressure drop which is employed to move the spool, a flow of predetermined volume being necessary to cause the spool to move.

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 embodiment of the invention is clearly shown.

In the drawings:

Fig. 1 is a longitudinal sectional view taken through a fluid motor formed in accordance with the present invention.

Fig. 2 is a diagrammatic view of hydraulic system with the fluid motor shown in Fig. 1 incorporated therein, parts of the mechanism shown in Fig. 1 being illustrated in section.

Referring more particularly to the drawings, numeral 20 designates a fluid motor in its entirety. The fluid motor illustrated is of the axial piston type and includes a casing 21 which forms a chamber 22 closed at one end by a head 23 and at the other by a cap 24. The head 23 is formed with a recess 25 in which bearings 26 are provided to rotatably support a shaft 27. One end of this shaft projects exteriorly of the casing, as at 28, for connection with mechanism to be driven by the motor. The opposite end of the shaft projects into the chamber 22 and is connected therein to a cylinder barrel 30. As usual this cylinder barrel has piston chambers 31 for the reception of reciprocating pistons 32. The cylinder barrel is provided at one end with ports 33 communicating with the piston chambers 31 and opening to one end of the cylinder barrel, this end of the barrel being formed for engagement with a valve plate 34 which is disposed in engagement with and carried by the head 23. The valve plate 34 is provided, as shown in Fig. 2, with a pair of arcuate ports 35 and 36 serving as inlet and outlet ports and communicating with openings 37 and 38 formed in the head 23. The openings in the head constitute inlet and outlet passages and conduct fluid to and from the inlet and outlet ports 35 and 36.

The pistons 32 project from the cylinder barrel and are formed with ball shaped heads 40 which have bearing shoes 41 connected thereto for universal movement. These bearing shoes have disc shaped portions 42 for engagement with the flat surface 43 of a cam element 44 which is carried by the cap 24 and serves to control the reciprocation of the pistons in the cylinder barrel. The cam surface 43 is inclined, relative to a plane extending at right angles to the plane of the section shown in Fig. 1, so that the pistons will react, when fluid is supplied to the piston chambers, to cause the cylinder barrel to revolve. The shoes 41 are maintained in sliding engage-

ment with the cam surfaces 43 by a retainer plate 45 which engages shoulders on the bearing shoes and is urged toward the cam plate by a spring pressed plunger 46, this member transmitting its force through a ball 47 to the plate 45. The spring pressed plunger is received in a socket formed in the inner end of the shaft 27. As in certain devices of the type illustrated, the cylinder barrel is partially supported for rotation by roller bearings 48 arranged adjacent the end of the cylinder barrel opposite that contacting the port plate.

The motor thus far described is substantially conventional with the exception of details and operates in the usual manner, fluid being introduced through one of the ports 35 or 36 to cause the pistons to be urged outwardly of the chambers in the cylinder barrel and the bearings shoes to react against the cam surface and impart rotary movement to the cylinder barrel, this member in turn transmitting such movement to the shaft. When fluid under pressure is applied to the inlet port to cause the operation of the motor, this fluid tends to force the cylinder barrel away from the port plate. The fluid tends to seep between the port plate and the engaging face of the cylinder barrel, the force of fluid tending to separate these engaging surfaces.

It has been found that the areas of the contacting surfaces of the cylinder barrel and port plate must be held within certain dimensions relative to the areas of the cylinder barrel exposed to pressures tending to force the cylinder barrel toward the port plate. If the latter areas are too great, undue friction will be caused which will decrease the efficiency of the fluid motor and cause excess wear. It has also been found that, if too great an area is exposed to the pressure tending to separate the cylinder barrel and port plate, the fluid pressure will cause the cylinder barrel to, in effect, "blow off" the port plate and permit fluid under pressure to escape thus rendering the pump inoperative. As mentioned previously when the motor is operated at slow speeds of the order, for example, of twenty-five to fifty revolutions per minute the drag of the pistons on the sides of the piston chambers is greater than when the motor is operated at an increased speed. The increased drag increases the force tending to move the cylinder barrel away from the port plate and disturbs the ratio between the forces tending to separate the cylinder barrel and port plate and those tending to cause their engagement. It has also been found that advantageous results may be secured by causing changes in areas exposed to fluid pressure tending to separate the cylinder barrel and port plate while the motor is in operation and during the change from slower to faster rates of operation.

This invention is directed to mechanism for accomplishing this last stated purpose. One manner in which the invention may be practiced is disclosed in the drawings. It consists in providing the port plate, as shown in Fig. 2, with additional ports to which fluid under pressure is supplied when the motor is operated at a speed in excess of a predetermined rate. The application of fluid pressure is controlled by valve mechanisms designated generally by the numeral 50. In the adaptation of the invention shown, two valves are employed. These valve mechanisms are arranged in the lines leading to the ports 35 and 36 and are so constructed that fluid flowing through either of these lines toward the motor at a rate greater than a predetermined value will cause the valve to open to admit some of the fluid to the additional ports. This fluid will exert a force tending to cause the cylinder barrel to be forced away from the port plate and thus will decrease the friction between such plates. Since the forces ordinarily tending to move the elements of a motor toward one another increase as the rate of operation is advanced, this increase in forces will be counter-acted by the forces exerted by the fluid supplied to the additional ports.

In the circuit diagrammatically illustrated in Fig. 2,

there has been shown a reservoir 51, a motor driven pump 52 and a relief valve 53. Fluid flows from the pump to the relief valve and from the latter through line 54 to one of the valve mechanisms 50, the inlet port of this valve 50 being connected with the line 54. Port 53 is formed in a body 56 which is provided with a bore 57 to slidably receive a valve spool 58. This valve spool is urged by a spring 60 to a position in which communication between the line 54 and the line 61 extending to the additional ports is obstructed. The additional ports are indicated by the numeral 62. The valve spool 58 has an orifice 63 formed therein through which fluid flows from the inlet 55 to a passage 64 which is connected with the inlet port 35 in the port plate. When the volume of fluid supplied by the pump 52 is below a predetermined amount, the fluid will flow through the orifice 63 to the motor and cause its operation at a relatively slow rate. When this volume is increased sufficiently, the orifice 63 will create a pressure drop, the higher force of which will tend to move the spool 58 in opposition to the spring 60. A sufficient volume will move this spool to a position in which ports 65 formed in the spool establish communication between the interior of the spool and the line 61. Fluid will then be admitted to the additional ports 62 which are arranged on the same side of the port plate as the port 35 or 36 then receiving fluid from the pressure source. The force of this fluid will cause the effect previously mentioned.

The additional ports 62 are formed in bearing pads 69 provided on the port plate. The surface of these bearing pads is in the same plane as the surface of an annular bearing or sealing pad 66 in which the inlet and outlet ports 35 and 36 are formed.

In the drawings, two valve mechanisms 50 are provided. Only one mechanism 50 operates at a time, the mechanism in the line through which fluid is flowing to the motor being the one in operation. The valve mechanisms 50 are provided with poppet type check members 67 to permit reverse flow through the mechanisms when fluid flows thereto from the pump. In other words, the spool valve of the mechanism 50 in the line serving as the exhaust line is inoperative, the check valve in such valve mechanism permitting this reverse flow. The direction of the operation of the motor is controlled by a four-way or directional control valve 68 disposed between the source of fluid pressure and the valve mechanisms 50. This directional control valve serves to alternately connect the inlet ports of the valve mechanisms 50 with the source of fluid pressure and the reservoir. When the directional control valve is shifted, the direction of operation of motor will be reversed.

It will be obvious, from the foregoing, that the application of the fluid under pressure to the additional ports will depend upon the rate of fluid flow to the motor and, consequently, the rate of operation of such motor. It will also be obvious that, when the direction of rotation of fluid motor is reversed, the additional ports at the side of the port plate opposite from that receiving fluid under pressure immediately before will then receive fluid under pressure, the ports on the same side of the port plate as the inlet being the ports to receive the additional fluid pressure. It will be evident that, although the additional ports are disclosed as being circular and only two in number at each side of the port plate, these ports may be made of different shapes, if necessary, or the number increased without changing the spirit of the invention.

While the form of embodiment of the present 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.

I claim:

1. Hydraulic apparatus comprising a fluid pressure energy translating device having a casing forming a chamber; a cylinder barrel disposed in said chamber; a port plate in said chamber, said cylinder barrel and port plate

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being in relative rotary sliding engagement; an annular bearing area on the surface of said port plate engaged by said cylinder barrel, said port plate having spaced ports in said annular bearing area alternately communicating with ports formed in the complemental surface of said cylinder barrel upon relative rotary movement; an additional bearing area on the engaging surface of one of said members, said additional bearing area being provided with port means; a source of fluid under pressure; a fluid conductor leading from said pressure source to one of the ports in the annular bearing area on said port plate; a branch passage leading from said conductor to the port means in said additional bearing area; and normally closed valve means between said conductor and said branch passage, fluid flow through said conductor tending to open said valve to admit fluid to said branch passage.

2. Hydraulic apparatus comprising a fluid pressure energy translating device having a casing forming a chamber; a cylinder barrel disposed in said chamber; a port plate in said chamber, said cylinder barrel and port plate being in relative rotary sliding engagement; an annular bearing area on the surface of said port plate engaged by said cylinder barrel, said port plate having spaced ports in said annular bearing area alternately communicating with ports formed in the complemental surface of said cylinder barrel upon relative rotary movement; an additional bearing area on the surface of said plate engaged by said cylinder barrel, said additional bearing area being provided with port means; a source of fluid under pressure; fluid conducting means leading from said pressure source to one of the ports in the annular bearing area on said port plate; a branch passage leading from said conducting means to the port means in said additional bearing area; a normally closed valve means controlling communication between said conducting means and said branch passage; and means responsive to fluid flow in excess of a predetermined volume through said conducting means to move said valve to a position admitting fluid to said branch passage.

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3. A fluid pressure energy translating device comprising a casing forming a chamber; a cylinder barrel disposed in said chamber; a port plate in said chamber, said cylinder barrel and port plate being in relative rotary sliding engagement; an annular bearing area on the surface of said port plate engaged by said cylinder barrel, said port plate having spaced ports in said annular bearing area alternately communicating with ports formed in the complemental surface of said cylinder barrel upon relative rotary movement; fluid pressure in either of said ports tending to separate said cylinder barrel and port plate; means forming additional ports in at least one of the contacting surfaces of said cylinder barrel and port plate; a fluid passage leading from a source of fluid pressure to said additional ports; a valve means responsive to fluid flow from said pressure source to the device to control the flow of fluid through said fluid passage, said valve means having a spool; means forming a seat for engagement by said spool; and spring means tending to urge said spool toward a position to prevent fluid flow through said passage and to restrict the flow of operating fluid to said device, said spool forming an orifice to admit a limited amount of operating fluid to said device and create a pressure differential when operating fluid in excess of a predetermined volume is supplied to said devices, the contrasting pressures of said differential being applied to said spool to move it toward a position to admit fluid through said passage to said additional ports and admit an increased volume of operating fluid to said device.

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