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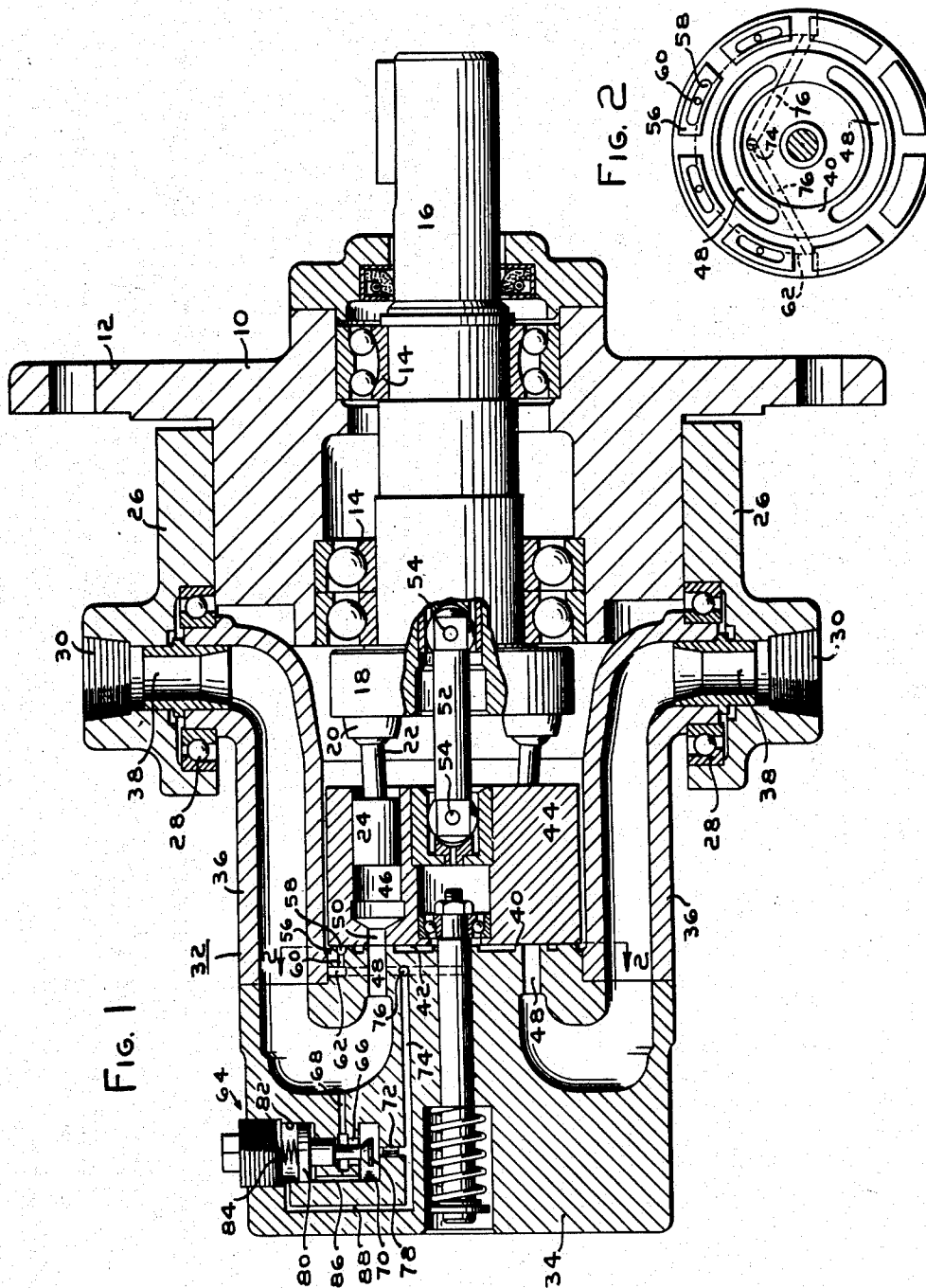


FIG. 2

FIG. 1

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PUMP OR MOTOR

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This invention relates to power transmissions and more 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. In such devices of the type which comprise a revolving cylinder barrel having a plurality of parallel cylinder bores therein within which pistons are reciprocated by a swash plate device, it is customary to provide a rotary valving mechanism which is operated by the rotation of the cylinder barrel itself for the purpose of alternately connecting each cylinder bore with the inlet and outlet passages of the device. Many machines of this character utilize a plate type valve formed by a flat surface of the cylinder barrel which runs in abutting and in fluid sealing relationship on a stationary flat valve plate. The plate type valve may be so constructed that the cylinder barrel is constantly pressed into engagement with the valve plate so that the clearance at the valve is automatically adjusted to take care of variations in oil viscosity and to compensate for wear. This is a distinct advantage and contributes much to the reliability and long life of machines employing a valve of this character.

It is customary with machines of this character to so proportion the size of the distributing ports in the end face of the cylinder barrel relative to the piston area and to the area of the annular surface of contact with the valve plate as to provide approximate hydraulic balance between the fluid pressure forces exerted by piston reaction on the end faces of the cylinder bores and the fluid pressure separating forces exerted in the oil film between the cylinder barrel and valve plate. It is, of course, impossible in practice to provide an exact balance between these forces, and since it is necessary to provide some means for holding the barrel in contact with the valve plate while the machine is idle, a spring or other resilient means is usually provided for urging the barrel into contact with the valve plate with a relatively light force at all times.

It is extremely difficult to predetermine with precision the exact amount of hydraulic unbalance which will exist in a given machine since small variations in dimensions which are entirely within normal manufacturing tolerances produce large changes in the hydraulic balance when the operating pressures are high. If the net unbalance is in a direction holding the barrel in contact and is very large, then the unit bearing pressures at the valve plate are apt to be excessive.

On the other hand, if the machine is designed for a very small net unbalance it occasionally happens, due to manufacturing variations, that the net unbalance of the hydraulic forces on the barrel is in a direction tending to lift the barrel off from the valve plate, and in such cases the spring is sufficient to maintain the barrel in contact with the valve plate at all operating pressures below a certain maximum. When this maximum is exceeded, however, the barrel lifts away from the valve plate, and since the valve is thereby rendered ineffective, the power drive through the transmission is completely and suddenly interrupted. This difficulty can be extremely troublesome at times, particularly where the transmission is used to operate a device, such as a hoist, which has to overcome a gravity load and in which complete dependence upon the transmission is placed for sustaining that load. In such cases it occasionally happens that the critical pressure at which the barrel will blow off is slightly above the normal operating pressure required for lifting the usual loads and that on rare occasions, due to snagging of hoisting lines or some other momentary small overload during hoisting, the critical pressure is exceeded causing the barrel to lift and resulting in dropping of the load with consequent damage thereto.

It is an object of the present invention to provide a valve plate construction for a fluid pressure energy translating device of the class described in which the above problems are avoided by the provision of an auxiliary bearing means between the barrel and valve plate together with means for supplying fluid thereto at a metered rate which may be rather small and whereby the cylinder barrel is maintained out of metal-to-metal contact with the valve plate sealing surface at any operating pressure of the device.

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

In the drawing:

Figure 1 is a longitudinal cross section of a fluid pressure energy translating device incorporating a preferred form of the present invention.

Figure 2 is a fragmentary cross section on line 2—2 of Figure 1.

The embodiment of the invention selected for illustration comprises a pump of the same general class as that illustrated in the patent to Hans Thoma, No. 1,931,969, and comprises gen-

erally a main ring-like frame member 10 having a mounting flange 12 thereon and provided with bearings 14 on which a main shaft 16 is journaled. The shaft 16 is provided with a socket flange 18 carrying a plurality of ball sockets 20 in which are mounted ball-ended connecting rods 22 carrying reciprocating pistons 24.

Rigidly secured to the frame member 10 by suitable bolts not shown are a pair of plates 26 provided with bearings 28 and with fluid connections 30. Journalled on the bearings 28 is a swinging yoke generally designated as 32 comprising a valve plate 34 with rigidly attached hollow arms 36 providing trunnions for the yoke and connected to the fluid connection 30 by sealing sleeves 38.

The valve plate 34 is provided with an arcuate raised sealing surface 40 against which runs the flat end face 42 of a cylinder barrel 44 provided with a plurality of cylinder bores 46 therein. Formed in the valve plate 34 are two arcuate fluid distributing ports 48 each of which extends through an arc somewhat less than 180 degrees and communicates with the passages in the hollow arms 36. Formed at the left-hand end of the cylinder bores 46 are a plurality of fluid distributing ports 50 opening into the flat face 42 and adapted to alternately register with each of the distributing ports 48. A shaft 52 provided with universal joints 54 at its opposite ends connects the barrel 44 to rotate with the shaft 16 in any position of the yoke 32. The parts thus far described are in a broad aspect well known in the art and per se form no part of the present invention.

The hydraulic balance of the cylinder barrel 44 is, of course, determined by suitable proportioning of the radial width of the flat pressure surface 40 relative to the total area of all of the ports 50 and the total area of all of the pistons 24. With the present invention these areas are so proportioned as to produce a net fluid pressure force on the cylinder barrel 44 tending to urge the barrel into contact with the surface 40. This unbalance is made as small as possible, however, and is, of course, proportional to the operating pressure.

According to the present invention there is provided in the valve plate 34 an additional bearing means which comprises a plurality of segmental pads 56 located radially outward of the flat surface 40 and lying in the same plane. Those pads which lie in the upper half of Figure 2 are each provided with a depressed portion 58 forming a fluid-receiving chamber. Each of these chambers communicates by a bore 60 with a semi-annular groove 62 formed in the valve plate 34.

For the purpose of supplying oil from the upper one of the distributing ports 48 to the groove 62 and chambers 58 there is provided a hydrostatic flow-rate controlling valve generally designated at 64 which is mounted in a bore 66. A passage 68 connects between the port 48 and the mid portion of bore 66. In the lower end of bore 66 there is provided a chamber 70 which communicates through a restrictor 72 and bores 74 and 76 with the semi-annular groove 62.

A pressure-operated, balanced poppet valve 78 is adapted to variably open or close communication between the passage 68 and chamber 70 in accordance with the pressure drop across the restrictor 72. For this purpose the valve 78 is connected with a piston 80 slidable in a cylinder 82 and normally biased downwardly with a light force by a spring 84. The lower side of the piston 80 is in communication with the chamber 70

and the entrance of the restrictor 72 through a passage 86 while the upper side of the piston 80 is in communication with the passage 74 and the exit of the restrictor through a passage 88.

In operation, assuming that the conduits 30 are connected into a power transmission circuit in the usual manner so that the upper conduit 30 is the pressure supply connection while the lower one is the suction connection and that the shaft 16 is connected to a suitable prime mover and rotated thereby at a constant speed, with the top moving away from the observer the pistons 24 are reciprocated in the cylinder bores 46 in the well-known manner with a stroke depending upon the angular displacement of the yoke 32.

With the left-hand end of the yoke moved away from the observer each piston 24 will travel to the left during its top-half revolution and will be withdrawn to the right during its bottom-half revolution, thus withdrawing fluid from the lower port 48 into the cylinder 46 and discharging it out of them into the upper port 48.

The flow-rate controlling means 64, by the provision of the restrictor 72 and the hydrostatic valve 78 for maintaining a constant pressure drop across the restrictor, acts to deliver oil from the upper or pressure port 48 to the passages 74, 76, 62 and 60 at a constant rate of flow. This rate depends upon the size of the orifice 72 and the setting of the spring 84 and is preferably arranged so as to feed fluid to the chambers 58 at a relatively minute rate.

Since oil is positively delivered to the chambers 58 at this constant rate it follows that the oil must escape therefrom at the same rate, and in order to do so must leak across between the flat surfaces of the auxiliary bearing pads 56 and the flat face 40 of the barrel 44. In order for this leakage to take place it follows that the barrel must lift away from the pads 56 and the sealing surface 40 a small amount. This amount depends upon the amount of net unbalance between barrel 44 and sealing surface 40 which determines the pressure which is necessary to be exerted over the auxiliary pads 56 in order to cause the barrel 44 to lift slightly away from the pads. It will be seen that a stable condition is reached such that the clearance between surface 42 and pads 56 provides a path of such size that at the pressure required to overcome the net unbalance of the barrel the leakage out of the chambers 58 will exactly equal the metered flow into the chambers.

Should for any reason the barrel tend to close down this clearance it will require a higher pressure at the chambers 58 to force the same quantity of leakage across the clearance space and will thus create a force tending to separate the barrel and valve plate, restoring the clearance to its original value. Likewise, should for any reason the clearance tend to increase, less pressure will be required at chambers 58 to force the same quantity of fluid through the clearance space thus permitting the clearance to close down to its original value.

It will be understood that the invention comprehends the use of any number of auxiliary bearing pads as may be suitable to a particular machine. Likewise the pads may be individually fed with fluid from separate flow controlling valves. The latter arrangement is particularly suitable for larger size machines where the possible deflection of the valve plate and cylinder barrel out of a true plane under high pressure loads is greater.

The invention may also be utilized, for balancing thrust in other situations as, for example, between the socket flange 18 and the casing in place of or in addition to the thrust bearings 14 disclosed.

While the invention has been shown in connection with a device where one port is always the pressure port, it will be understood that the advantages of the invention may be utilized in reversible machines where either port may be the pressure port at any time. In such instances duplicate means for feeding fluid to the auxiliary pads in the lower half of Figure 2 may be provided in the valve plate 34 and connected to receive fluid from the lower port 48.

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 fluid pressure energy translating device having a plurality of cylinders and pistons reciprocable therein, a rotary valve structure comprising two relatively rotatable members provided with flat, annular, sealing surfaces in running engagement and containing fluid distributing ports communicating with said cylinders, means forming an auxiliary bearing surface between said members, and means for feeding fluid from one distributing port of the valve to the auxiliary bearing at a constant volumetric rate under sufficient pressure to maintain the members out of metal-to-metal contact, said means including a valve responsive to pressures existing intermediate the distributing port and the auxiliary bearing

for regulating the flow to the auxiliary bearing.

2. In a fluid pressure energy translating device having a plurality of cylinders and pistons reciprocable therein, a rotary thrust bearing structure comprising two relatively rotatable members provided with flat annular bearing surfaces in running engagement, at least one member containing fluid distributing ports communicating with said cylinders, means forming an auxiliary bearing surface between said members, and means for feeding fluid to the auxiliary bearing at a constant volumetric rate under sufficient pressure to maintain the members out of metal-to-metal contact, said means including a valve responsive to pressure of the fluid flowing to the auxiliary bearing for regulating such flow.

3. In a fluid pressure energy translating device having a plurality of cylinders and pistons reciprocable therein, a rotary thrust bearing structure comprising two relatively rotatable members provided with flat annular bearing surfaces in running engagement, at least one member containing fluid distributing ports communicating with said cylinders, means forming auxiliary bearing surface between said members, and means for feeding fluid from the high side of the device to the auxiliary bearing at a constant volumetric rate under sufficient pressure to maintain the members out of metal-to-metal contact, said means including a valve responsive to pressure of the fluid flowing to the auxiliary bearing for regulating such flow.

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