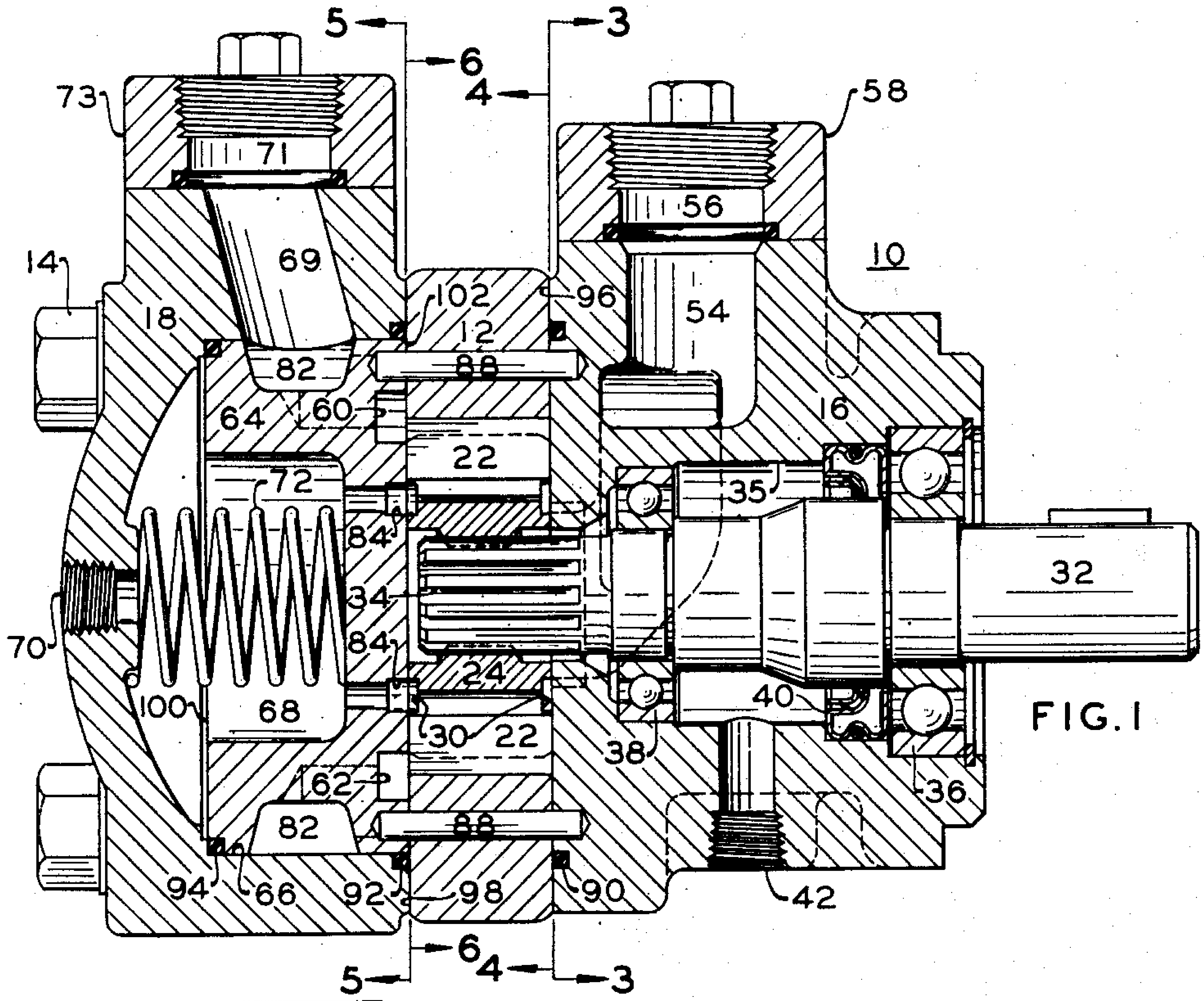

FIG. 1

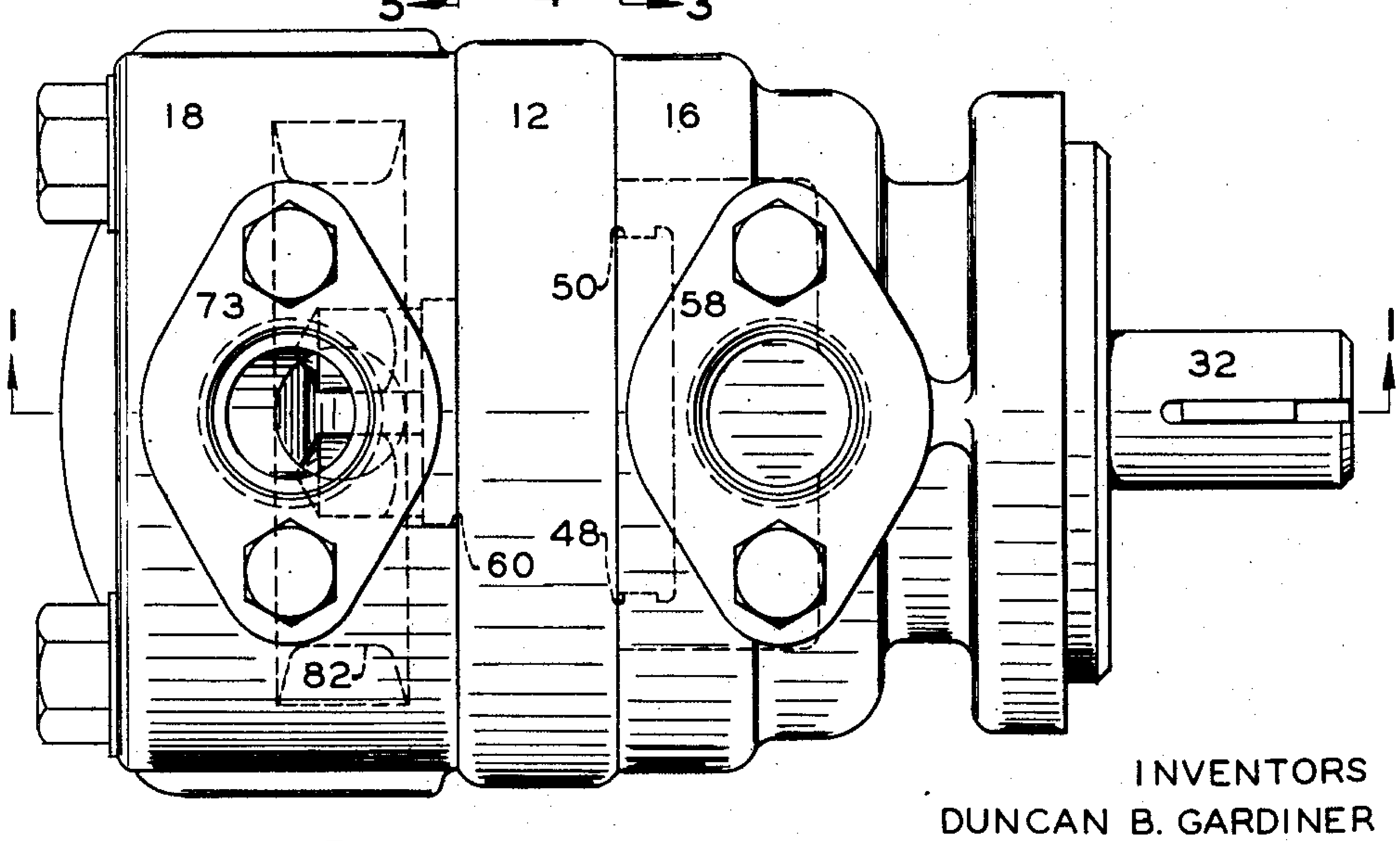

FIG. 2

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POWER TRANSMISSION

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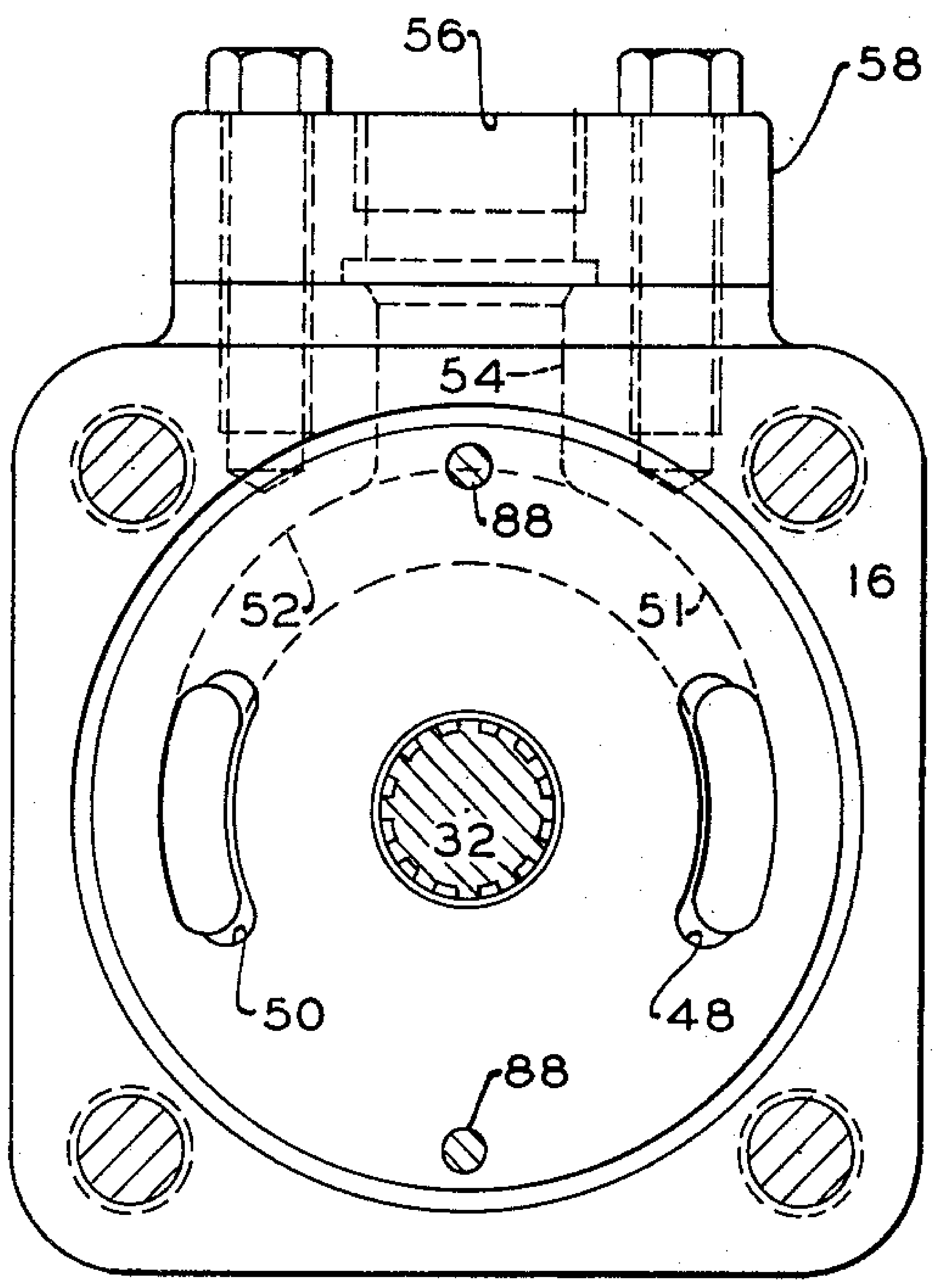
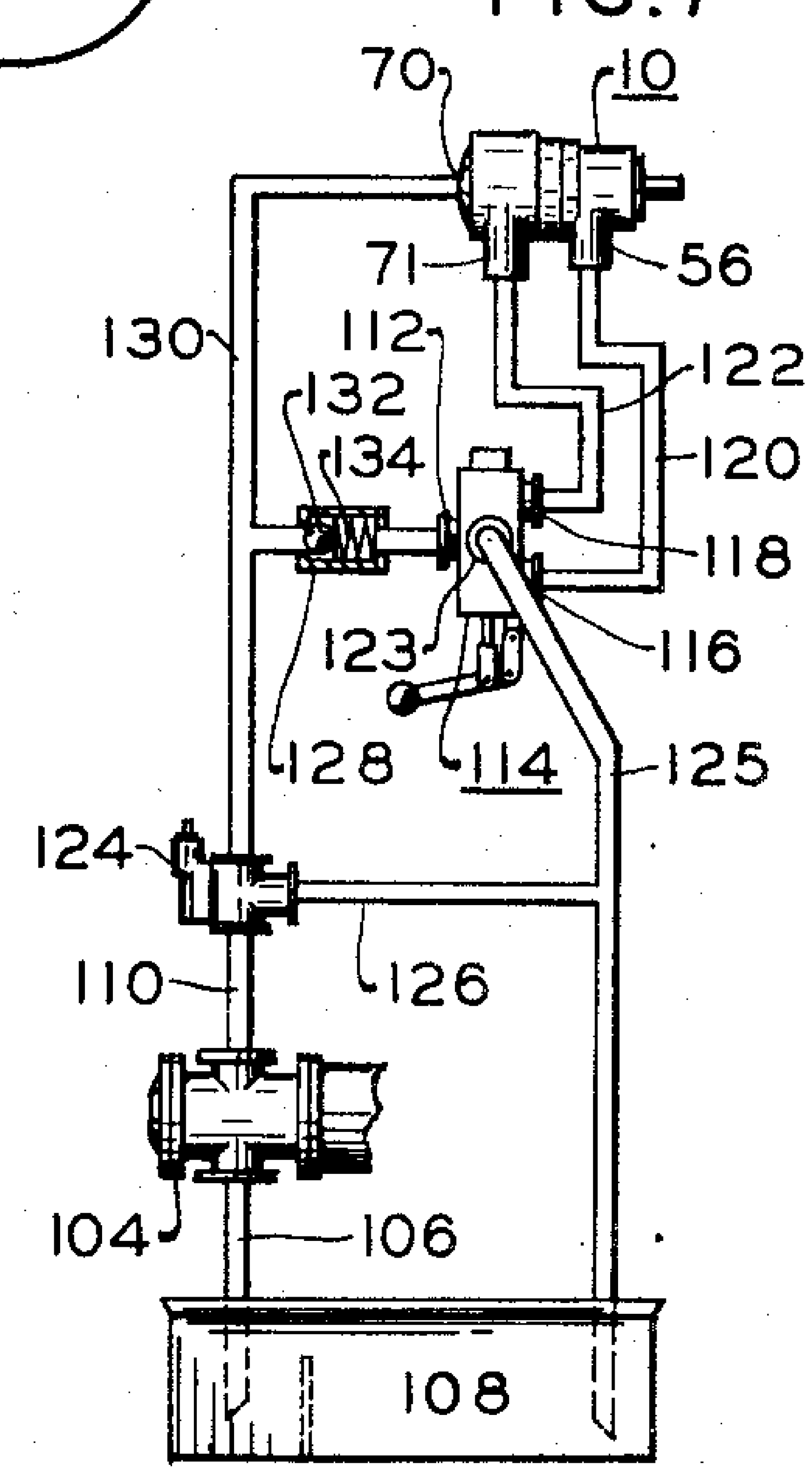


FIG. 3

FIG. 7



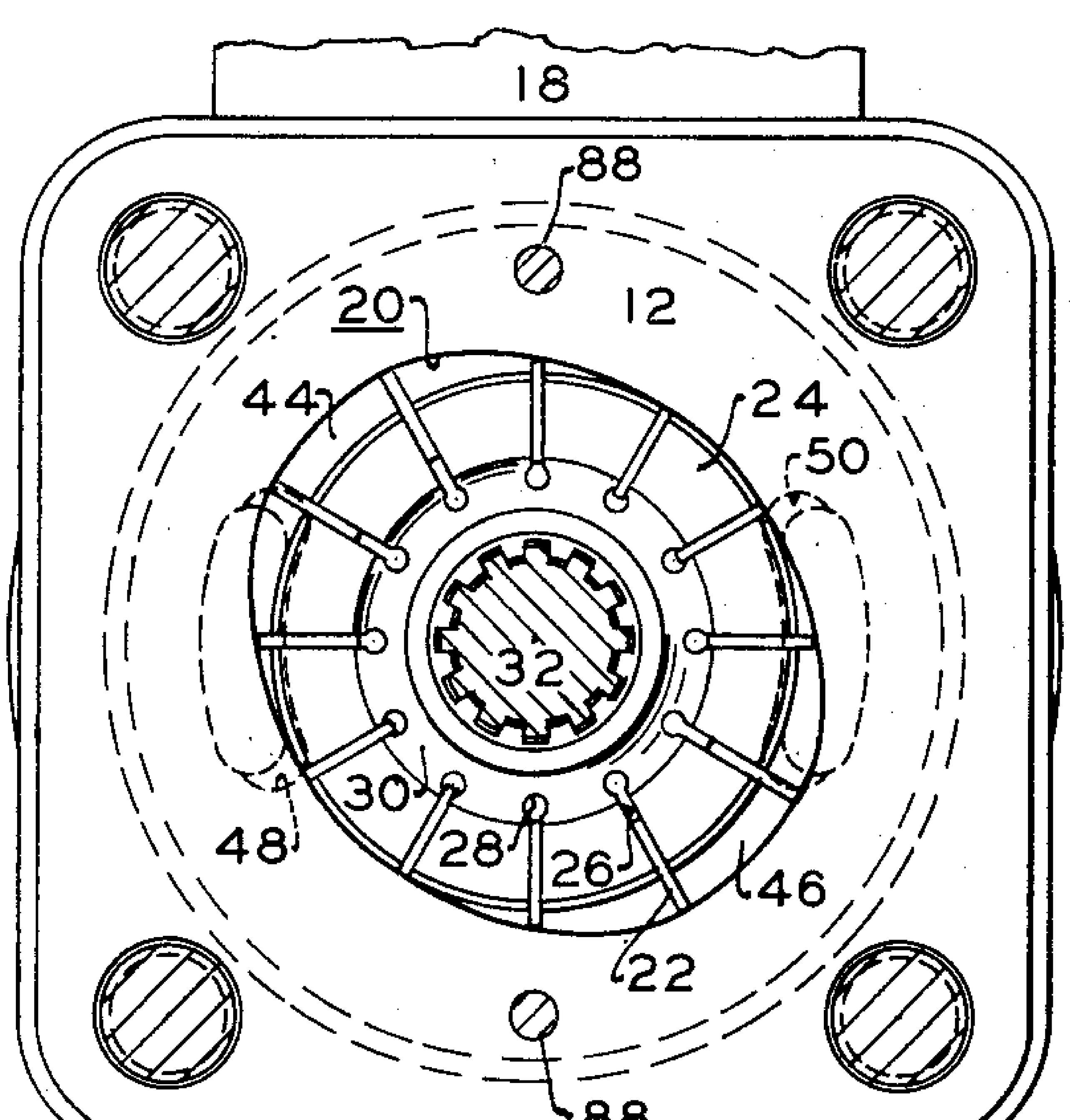


FIG. 4

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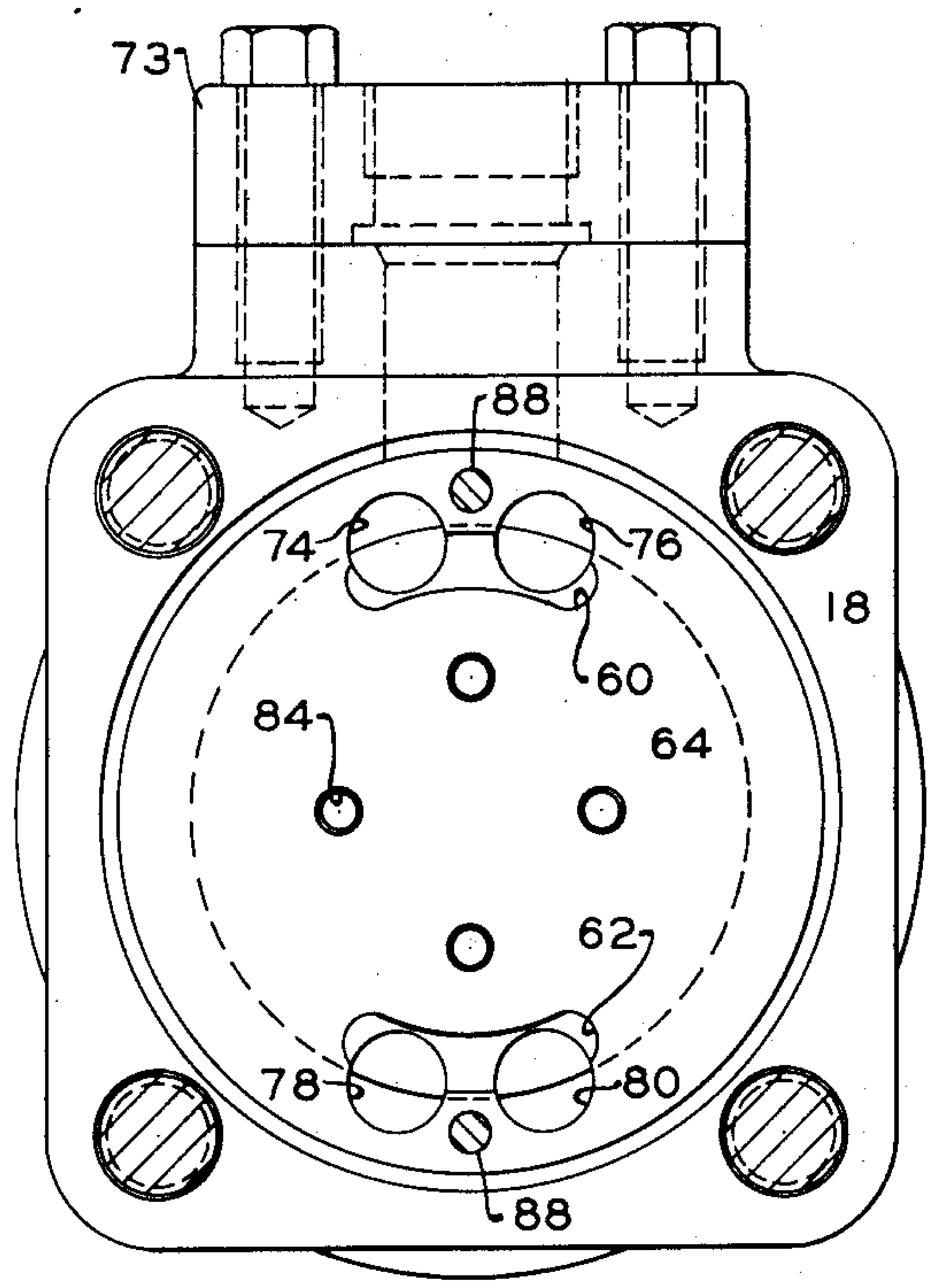

FIG. 5

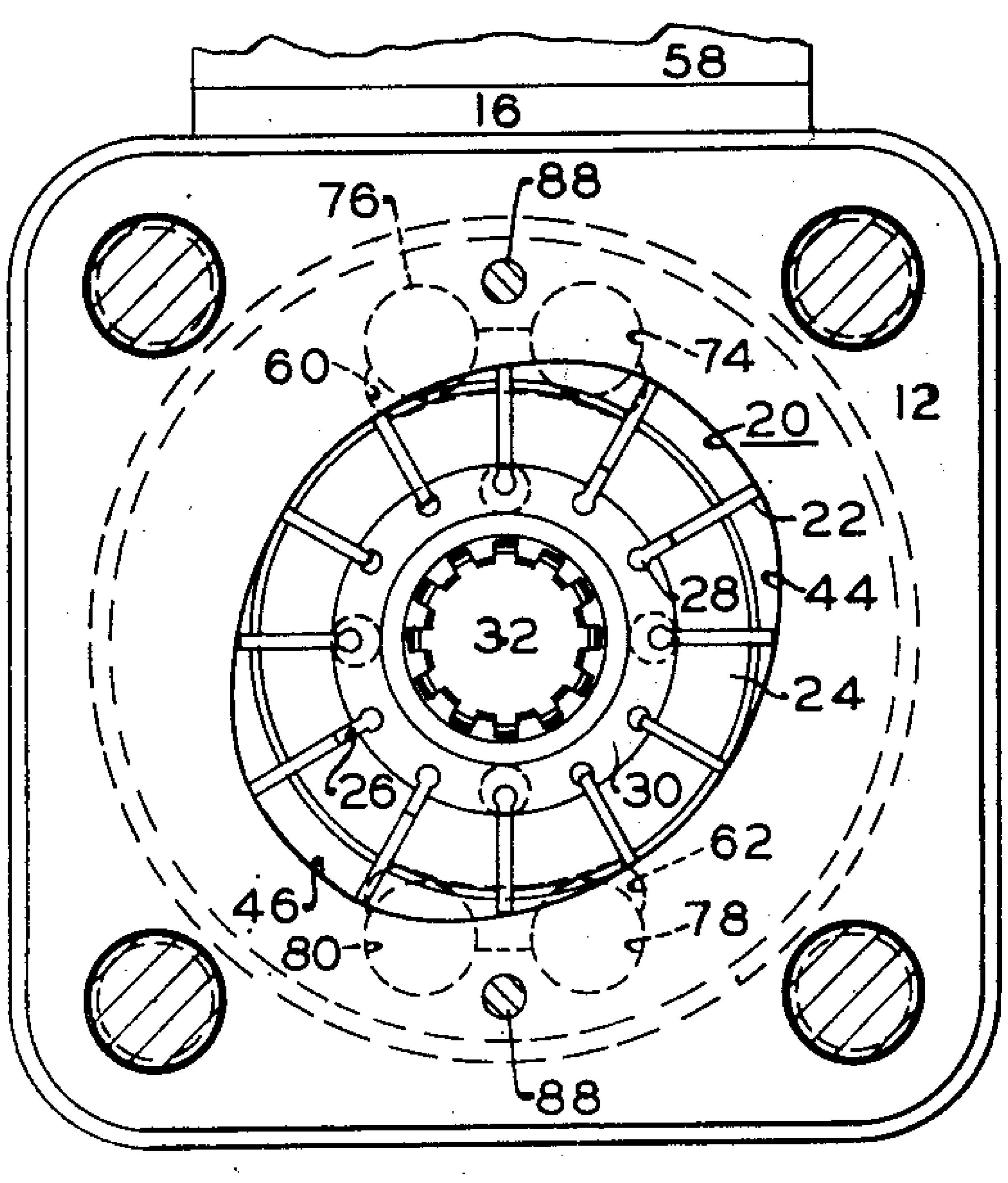

FIG. 6

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UNITED STATES PATENT OFFICE

2,653,550

POWER TRANSMISSION

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Application October 7, 1950, Serial No. 189,028

6 Claims. (Cl. 103—136)

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This invention relates to power transmissions, and is particularly applicable 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 vane type motor or pump for use in power transmissions of this character.

The invention comprises an improvement in devices of this type wherein a slotted rotor carrying a plurality of reciprocating vanes is mounted within a working chamber, the inner contour of which forms a vane track against which the outer ends of the vanes are adapted to be urged into contact.

It is essential for efficient operation to utilize some force in addition to centrifugal force in order to maintain contact of the vanes with the track. In pumps of this type one convenient method has been to connect the high pressure or outlet side of the device to the inner ends of the vanes. However, where the device is to be operated as a motor it is insufficient to connect the inlet side to the inner ends of the vanes. It is necessary to provide a higher pressure at the inner ends of the vanes than is present at the inlet side of the motor. As the vanes pass through the inlet zone of the motor inlet pressure tends to separate the vanes from the track which would cause leakage and free wheeling of the motor. In addition, for proper starting of the motor, at crossover between the fluid zones, and for proper reversal it is essential that the vanes be maintained in contact with the track.

It is also impractical, if the device is to operate as a reversible motor, to continually connect one side of the device to the inner ends of the vane slots. The high pressure or inlet side of the device becomes the low pressure or outlet side of the device upon reversal.

One example of a fluid pump of the type mentioned is disclosed in the copending application of Duncan B. Gardiner, et al., Serial No. 81,146, now Patent No. 2,544,988. The above application discloses a pressure chamber immediately adjacent one side of the rotor. A side plate is floatably mounted in the chamber adapted to be maintained in fluid sealing engagement with the rotor by pressure fluid directed to the chamber. The outlet side of the device is continually connected to this chamber and also delivered from the chamber to the inner ends of the vane slots. Due to the fact that the outlet side of the device is continually connected to the chamber it is not readily adaptable for use as a reversible fluid motor.

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This invention provides the advantages of the device disclosed in the aforementioned application, but in addition may be operated both as a reversible fluid pump or motor. It provides the advantages of a pressure actuated, floating side plate, but in addition may be operated as a reversible motor. This advantage is obtained by providing a pressure chamber which is isolated from the fluid zones of the device and having a separate external connection port. Means are provided for connecting the pressure chamber to the inner ends of the vane slots. Thus, the main pressure source may be connected to the chamber with simple and economical valving providing the differential in pressures between the inner and outer ends of the vanes. An auxiliary source of pressure fluid may also be connected to the chamber.

It is therefore an object of this invention to provide an improved rotary vane pump or motor of the reversible type.

It is another object of this invention to provide in a reversible rotary vane pump or motor an economical and simplified structure for connecting a source of pressure fluid to the inner ends of the vane slots for maintaining the outer ends of the vane in contact with the vane track regardless of the direction of operation of the device. This source of pressure fluid may be either the pressure fluid delivered by the device when operating as a pump or the pressure fluid delivered thereto when operating as a motor, or may constitute an auxiliary source of pressure fluid.

It is still another object of this invention to provide a device of the type mentioned having a floating sideplate which is maintained in fluid sealing engagement against the rotor by pressure fluid delivered to a pressure chamber which is isolated from the fluid inlet and delivery zones of the device.

It is a further object of this invention to provide a device of the type mentioned having a pressure chamber with a sideplate mounted therein, which sideplate isolates the chamber from the fluid zones of the device, which also serves to deliver pressure fluid from the chamber to the inner ends of the vane slots and also connects one of the fluid zones of the device to one of the external connection ports.

It is another object of this invention to provide a low cost device of the above-mentioned type having advantages contributing to efficiency, reliability, and long life as well as ease of maintenance.

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 sectional view of the preferred form of the present invention taken on line 1—1 of Figure 2.

Figure 2 is a plan view of the present invention.

Figure 3 is a view taken on line 3—3 of Figure 1.

Figure 4 is a view taken on line 4—4 of Figure 1.

Figure 5 is a view taken on line 5—5 of Figure 1.

Figure 6 is a view taken on line 6—6 of Figure 1.

Figure 7 is a diagrammatic view of a hydraulic power transmission system incorporating a preferred form of the present invention.

Referring now to Figure 1 there is shown a reversible rotary vane pump or motor designated generally by the numeral 10, the body of which comprises a cam ring 12 suitably sandwiched between and connected by bolts 14 to a main right end housing member 16 and a left end housing member 18.

The inner contour of the cam ring 12 is substantially elliptical in shape as shown more clearly in Figures 4 and 6, and forms a vane track indicated generally by the numeral 20 against which the outer ends of a plurality of reciprocating vanes 22, carried by a rotor 24, are adapted to be held in contact. The vanes 22 reciprocate within substantially radial slots 26 of the rotor 24, said slots having enlarged portions at their inner ends indicated by the numeral 28. Duplicate grooved circular pressure channels 30 extend to a slight depth from each face of the rotor to the inner ends of the slots 26.

The rotor 24 is mounted within the cam ring 12 so that the axis of the rotor 24 is concentric to the axis of the ring by means of a shaft 32, splined at 34 to the mating spline of the rotor. The shaft 32 is rotatably mounted in a stepped bore 35 and supported on radial and thrust bearings 36 and 38 completely within the right end housing member 16. The shaft is provided with a seal 40 and any leakage may be drained by means of an external drain port 42 connected to the stepped bore 35.

With the rotor 24 mounted within the cam ring 12, two opposing working chambers 44 and 46 are formed through which the vanes pass as the rotor turns. These working chambers may be appropriately divided into diametrically opposed sets of fluid zones, each set of which may be either inlet or outlet zones depending on the direction of operation of the device. One set of fluid zones comprises that portion of the working chambers 44 and 46 registering with a pair of diametrically opposed arcuately shaped fluid openings 48 and 50. The fluid openings 48 and 50 comprise the terminus of two branches 51 and 52 (Figure 3) of a fluid passage 54 adapted for either an inlet or outlet passage, which passage registers with an external connection port 56 in a flange member 58 suitably bolted to the housing member 16. The other set of fluid zones comprises that portion of the working chambers 44 and 46 registering with another pair of diametrically opposed arcuately shaped fluid openings 60 and 62 in a side plate 64 which is floatably mounted in a recess 66 of the housing member 18, the open

end of which is closed by the cam ring 12 and rotor 24. The construction of the side plate 64 is such that when mounted in the recess 66 a pressure chamber 68 is formed in the recess 66 which is completely isolated by the side plate from the working chambers and fluid zones, and also isolated by the side plate from a passage 69 in the housing 18 which opens at one end to the recess and which at its opposite end registers with an external port 71 formed in a flange member 73 suitably bolted to the housing member 18.

The side plate 64 is adapted to be maintained in engagement against the cam ring 12 and in fluid sealing engagement with the rotor 24 by means of pressure fluid admitted to the pressure chamber 68 through an external port 70 in the housing 18 leading directly to the chamber. The side plate 64 may be maintained initially, and at extremely low pressures, in engagement against the cam ring 12 and in fluid sealing engagement with the rotor 24 by a spring 72.

The fluid zones in the working chambers 44 and 46, which register with the side plate openings 60 and 62, are connected to the passage 69 by means of a set of drilled passages 74 and 76 in the side plate which are connected to the opening 60, and a duplicate set of drilled passages 78 and 80 connected to the opening 62, and a grooved fluid channel 82 extending around the periphery of the side plate. Each set of drilled passages leads to and connects its respective associated side plate arcuate opening to the grooved channel while the grooved channel connects the drilled passages to the passage 69.

The side plate 64 is also provided with a plurality of ports extending completely therethrough from one face to the other face thereof, indicated by the numeral 84, and which register with the circular pressure channel 30 of the rotor 24. The ports 84 are adapted to conduct pressure fluid from the chamber 68 to the rotor pressure channel 30 from whence it is conducted to the enlarged inner portions 28 of the vane slots 26 for the purpose of maintaining the outer ends of the vane 22 in contact with the vane track 20. The side plate 64 is prevented from rotary movement by means of two dowel pins 88 which extend through the cam ring 12 into both casing member 16 and side plate 64, which dowel pins also serve to correctly align the adjoining members.

Suitable oil seals 90 and 92 are provided in the end housing members 16 and 18 adapted to be on opposite sides of the cam ring 12 to aid in preventing seepage. In addition, the side plate is provided with a groove for the insertion of a seal 94 to prevent seepage from the pressure chamber 68 to the fluid channel 82.

The housing member 16 is provided with a flat end surface indicated by the numeral 96 which serves as an end wall adapted to cooperate with the flat mating surfaces of the cam ring 12 and rotor 24. The end housing member 18 is also provided with a flat surface at the open end of the recess, indicated by the numeral 98, which cooperates with the flat mating surface of the cam ring 12.

The entire surface of the side plate 64, opposite to that facing the rotor 24, and indicated by the numeral 100, is exposed to the pressure in the pressure chamber 68 in order to maintain the side plate in engagement against the cam ring 12 and in fluid sealing engagement with the rotor 24 so as to maintain the proper running clearance therebetween. Running clearance between the rotor **24** and the surface of the side plate **64**, facing the rotor **24**, said surface being indicated by the numeral **102**, is provided by the difference in thickness between the cam ring and that of the rotor.

Referring to Figure 7, there is shown a hydraulic power transmission system wherein the device **10** is adapted to be operated as a reversible fluid motor. There is shown in such figure a fluid pump **104** connected by a supply line **106** to a reservoir **108** and by a pressure delivery conduit **110** to the pressure port **112** of a conventionally constructed four-way directional control valve **114**. The valve **114** is also provided with motor ports **116** and **118** which are respectively connected to the external connection ports **56** and **71** of the motor **10** by means of conduits **120** and **122**, and with a tank port **123**, which is connected to the reservoir by a conduit **125**. A suitable relief valve **124** is incorporated in the pressure delivery conduit **110** which will exhaust to the reservoir **108** excessive pressure fluid by means of an exhaust conduit **126**.

A back pressure valve, indicated by the numeral **128** is also incorporated in the pressure delivery conduit **110** ahead of which is connected a conduit **130** leading to the external port **70** in the housing member **18** of the device **10**. The back pressure valve **128** may be of the type having a ball valve **132** biased to the closed position by a spring **134** which has a resistance predetermined by the difference in pressure required at the inner and outer ends of the vanes. A spring resistance may be provided, for example, of thirty pounds per square inch to maintain a differential pressure of thirty pounds per square inch between the inner and outer ends of the vanes as they pass through the fluid inlet zones.

For the purpose of convenience, the operation of the device will be described as a fluid motor, and as connected in a transmission as disclosed in Figure 7 although it should be understood that an auxiliary source of pressure fluid may be utilized and other means utilized for controlling the pressure of the fluid directed to the pressure chamber **68**, and that the device may also be operated as a reversible fluid pump. It should also be noted that for the purpose of more clearly illustrating the construction and operation of the device that the fluid openings **48** and **50** have been shown in dotted lines in Figure 4 while the fluid openings **60** and **62** and the drilled passages **74**, **76**, **78**, and **80** have been shown in dotted lines in Figure 6.

In operation, assuming that the directional control valve **114** is in a position connecting the pressure port **112** to the motor port **116**, and the motor port **118** to the tank port **123**, pressure fluid is delivered from the pump **104** by means of conduit **110** to the control valve **114**, and from the control valve **114** to the external connection port **56** of the device **10**. From the external connection port **56** fluid is delivered by the passage **54** to the fluid branches **51** and **52** and through the fluid openings **48** and **50** to the fluid zones of the working chambers **44** and **46** registering therewith. Fluid pressure, acting on the outer ends of the vanes **22** in said zones, causes the rotor to be rotated in a clockwise direction as observed from the shaft end.

As the vanes pass over that portion of the working chamber, with which the fluid openings **60** and **62** register, fluid will be displaced to the external connection port **71** by means of the side plate fluid openings **60** and **62**, drilled passages

74 and **76**, and **78** and **80**, fluid channel **82**, and the passage **69**. From the external connection port **71** fluid is displaced to the reservoir **108** by means of conduit **122**, motor port **118**, tank port **123** of control valve **114**, and conduit **125**. Simultaneously, with the conducting of pump fluid to the external connection port **56** of the motor **10**, pressure fluid is also conducted by the conduit **130** to the external connection port **70** thereof, and to the pressure chamber **68**. The pressure of the fluid conducted to the pressure chamber **68** will exceed that delivered to the fluid zones in registry with the fluid openings **48** and **50** by an amount equal to the resistance of the spring **134** of the valve **128**, which for example may be pre-set to establish a differential of thirty pounds per square inch. Due to the fact that the underside of the vane slots are in continuous communication with the pressure chamber **68** by means of the plurality of ports **84** in the side plate, and the rotor pressure channel **30** which registers with said ports, there will be a differential of thirty pounds per square inch between the pressure existing at the outer ends of the vanes passing through the inlet fluid zone and that existing at the inner ends of the vanes. Consequently, the outer ends of the vanes will be constantly maintained in contact with the vane track **20**.

If the directional control valve **114** is operated to reverse the directional operation of the device **10** pressure fluid from the pump **10** will be conducted by the conduits **110** and **122** to the external connection port **71**. Fluid displacement from the motor **10** will be conducted through the external connection port **56** to the reservoir **108** by means of conduit **120**, ports **116** and **123** of control valve **114**, and conduit **125**. Pressure fluid delivered to the external port **71** from pump **104** is directed to the fluid zones of the working chambers registering with the arcuate fluid openings **74** and **76** by means of passage **69**, fluid channel **82** in the side plate **64**, by drilled passages **74** and **76** to the fluid opening **60**, and by drilled passages **78** and **80** to the fluid opening **62**. Pressure fluid acting against the outer ends of the vanes in the fluid zones registering with the openings **60** and **62** will cause counterclockwise rotation of the rotor as observed from the pressure chamber end of the device.

As the vanes pass through the fluid zones registering with the arcuate openings **48** and **50** in the housing **16**, fluid will be displaced therethrough and thence to the tank **108** by means of the branch passages **51** and **52**, passage **54**, external port **56**, conduit **120**, directional control valve ports **116** and **123** and conduit **125**. Regardless of the reversal of rotation of the device the same differential pressure will exist at the inner and outer ends of the vanes. As the vanes pass through the fluid zones, which at the moment happen to be the fluid inlet zones, a lower pressure differential will exist than that existing between the inner and outer ends of the vanes passing over the fluid zones, which at the moment are fluid outlet zones because the latter are connected to the tank. However, a pressure is continually present at the inner ends of the vanes sufficient to maintain the outer ends of the vanes in contact with the vane track **20**, and in particular, a sufficient differential in pressure may be maintained between the inner and outer ends of the vanes as they pass through the fluid zones, which at the moment happen to be a fluid inlet zone.

Pressure fluid is conducted to the inner ends of the vane slots in the same manner as described for the opposite direction of rotation.

It should be noted that the side plate, when mounted in the recess of the housing member 13, aids in forming a pressure chamber which is isolated from the fluid inlet and outlet zones of the device. The side plate is so constructed that it will conduct pressure fluid from the isolated pressure chamber to the rotor pressure channel so as to maintain the outer ends of the vanes in contact with the vane track. The side plate is also so constructed that it will direct fluid in one instance from what is the outlet fluid zone of the device to an external connection port operating as an outlet port, while for reverse operation it will conduct fluid from the same external connection port operating as an inlet port to the aforementioned fluid zone, now functioning as an inlet fluid zone. This formation of the isolated pressure chamber makes it possible to simply and economically selectively control the pressure at the inner ends of the vanes. The device may also be efficiently utilized as a pump.

It should be further noted that the pressure fluid delivered to the isolated pressure chamber is also utilized for maintaining the side plate in fluid sealing engagement against the cam ring and the rotor.

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. A reversible, rotary fluid pressure energy translating device comprising a body forming a main fluid displacement chamber having a rotor therein to provide circumferentially spaced fluid displacement zones either of which may be a fluid receiving zone while the other is a fluid delivery zone, a first fluid passage in the body formed entirely on one side of the displacement chamber and connected to one of said zones, a second fluid passage in the body entirely on the opposite side of the displacement chamber and connected to the other zone, each of said passages having a connection port at the outside of the body, a pressure plate overlying said opposite side of the displacement chamber and rotor and forming with the body a pressure chamber for urging the pressure plate toward the rotor, said pressure plate having means normally separating the said zones and the pressure chamber from each other, and means forming a separate fluid passage for supplying fluid under pressure to said pressure chamber.

2. A reversible, rotary fluid energy translating device comprising a stator having a recess, a rotor mounted in the recess and forming two fluid displacement zones either of which may be a fluid inlet zone or a fluid outlet zone, a fluid passage in the stator completely on one side of the rotor, said passage having a connection port at the outside of the stator and leading to one of the fluid displacement zones, a second recess on the opposite side of the rotor immediately adjacent the first recess and having a greater periphery than the first recess to provide a shoulder forming a rigid abutment at one side of the rotor, a pressure responsive cheek plate slidably mounted in the second recess and forming therewith a pressure chamber, one side of the cheek plate being exposed to pressure in the chamber for maintaining the opposite side

thereof in fluid sealing engagement against the rigid abutment and the rotor, a second passage opening to the second recess at a point intermediate the rotor and the pressure chamber, said passage having a connection port at the outside of the stator, means forming a sliding fluid sealing contact with the walls of the second recess around the periphery of the cheek plate and between the pressure chamber and the opening of the second passage into the recess, and means connecting the second external connection port and passage with the other fluid displacement zone.

3. A reversible, rotary fluid pressure energy translating device comprising a stator having a rotor mounted therein and forming fluid displacement zones either of which may be a fluid inlet zone while the other is a fluid outlet zone, means forming a recess in the stator adjacent the fluid displacement zones and including a rigid abutment, means forming two fluid passages in the stator one on each side of the rotor, each passage having a connection port at the outside of the stator, one passage being connected to one of the fluid zones and the other passage opening to the recess, a pressure plate slidably mounted in the recess and forming a pressure chamber, one side of the plate being exposed to pressure in the chamber for maintaining the opposite side of the plate in fluid sealing engagement against the abutment and the rotor, a flow passage in the pressure plate leading from the other fluid zone to the opening of the other fluid flow terminal passage, said pressure plate separating the zones and the pressure chamber from each other, and means forming a sliding fluid sealing contact with the walls of the recess around the periphery of the pressure plate and between the pressure chamber and the opening of the other fluid flow terminal passage into the recess.

4. A reversible rotary fluid pressure energy translating device comprising a stator, a rotor mounted in the stator and forming two fluid zones either of which may be a fluid inlet zone while the other is a fluid outlet zone, a first passage in the stator completely on one side of the rotor and connected to one of said zones, said passage having a connection port at the outside of the stator, a recess in the stator on the opposite side of the rotor and forming a rigid abutment immediately adjacent the rotor, a pressure plate slidably mounted in the recess and forming therewith a pressure chamber, one side of the pressure plate being exposed to pressure in the chamber for maintaining the opposite side thereof in fluid sealing engagement against the rigid abutment and the rotor, a second passage in the stator completely on the side of the rotor opposite to that of the first passage and opening to the recess at a point intermediate the rotor and the pressure chamber, said passage having a connection port on the outside of the stator, a flow passage in the cheek plate leading from the other fluid zone to the opening of the second passage, and means forming a sliding fluid sealing contact with the walls of the recess around the periphery of the cheek plate and between the pressure chamber and the opening of the second passage into the recess.

5. A reversible rotary vane pump or motor comprising a housing having a working chamber, the contour of which forms a vane track, a slotted rotor in the chamber carrying a plurality of substantially radially movable vanes, the outer ends

of which are adapted to be maintained in engagement with the vane track, said working chamber and rotor forming fluid zones adapted to be either inlet or outlet zones and through which the vanes pass as the rotor turns, a recess in the housing adjacent the working chamber and forming a rigid abutment to one side of the rotor, a pressure plate slidably mounted in the recess and forming a pressure chamber, said plate being maintained in fluid sealing engagement against the abutment and rotor by pressure fluid conducted to the chamber, means forming two terminal passages in the housing one on each side of the rotor, each passage having a connection port at the outside of the stator, one passage leading to one of the fluid zones and the other of which opens to the recess, a flow passage in the pressure plate leading from the other fluid zone to the opening of the other passage, said pressure plate separating the fluid zones and the pressure chamber from each other and separating the pressure chamber from the other passage, and a separate fluid passage for supplying fluid under pressure to the pressure chamber.

6. A reversible rotary vane pump or motor comprising a housing having a working chamber, the contour of which forms a vane track, a slotted rotor in the chamber carrying a plurality of substantially radially movable vanes, the outer ends of which are adapted to be maintained in engagement with the vane track, said working chamber and rotor forming fluid zones adapted to be either inlet or outlet zones and through which the vanes pass as the rotor turns, a recess in the housing adjacent the working chamber and forming a rigid abutment to one side of the rotor, a pressure plate slidably mounted in the recess and forming a pressure chamber, said plate

being maintained in fluid sealing engagement against the abutment and rotor by pressure fluid conducted to the chamber, means forming two terminal passages in the housing one on each side of the rotor, each passage having a connection port at the outside of the stator, one passage leading to one of the fluid zones and the other of which opens to the recess, a flow passage in the pressure plate leading from the other fluid zone to the opening of the other passage, said pressure plate separating the fluid zones and the pressure chamber from each other, means forming a sliding fluid sealing contact with the walls of the recess around the periphery of the pressure plate and between the pressure chamber and the opening of the other passage into the recess and a separate passage for supplying fluid under pressure to the pressure chamber.

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