Jan. 25, 1949. B. BEAMAN ET AL 2,459,786

HYDRAULIC PRESSURE PUMP OR MOTOR

Filed March 12, 1945 2 Sheets-Sheet 1

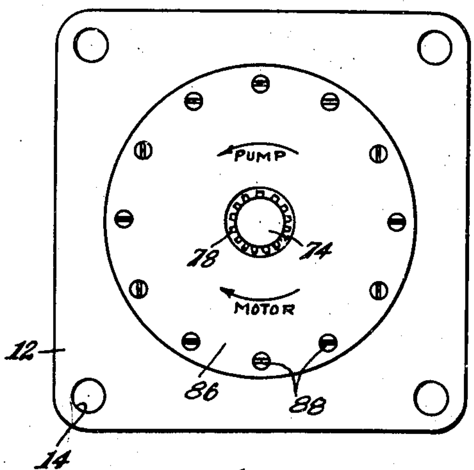

Fig. 1.

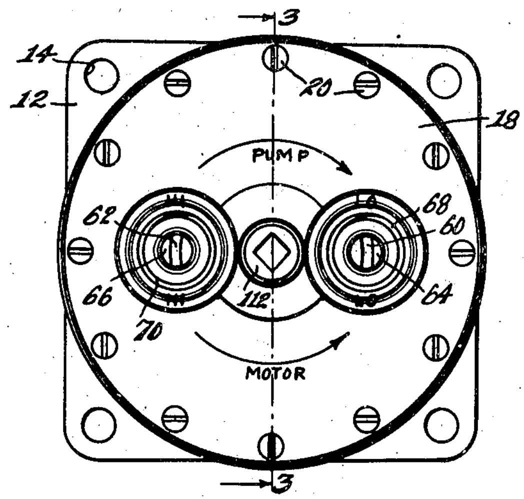

Fig. 2.

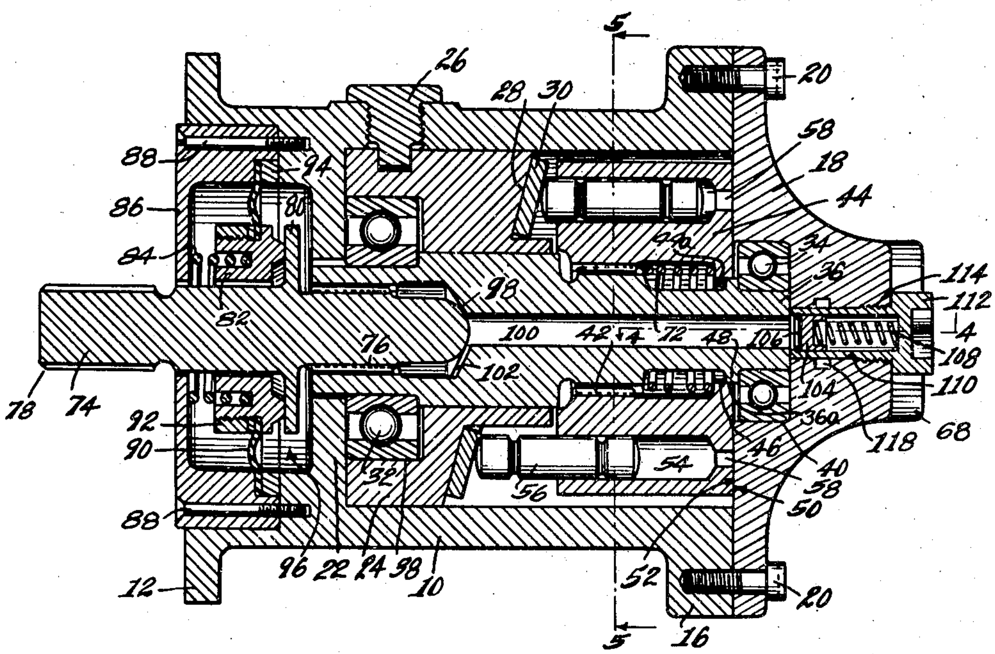

Fig. 3.

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Fig. 4.

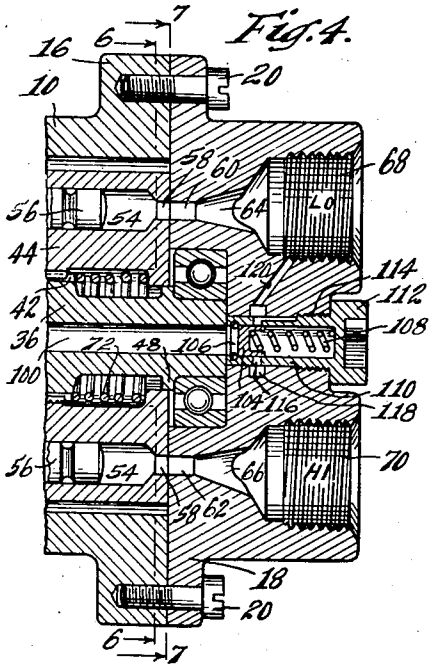
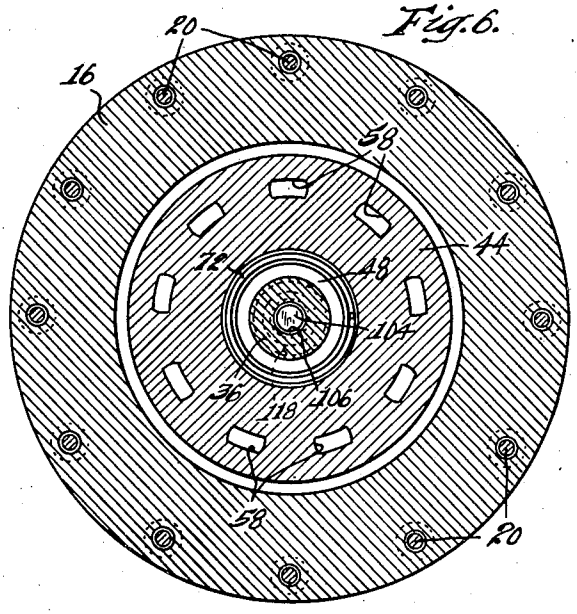


Fig. 6.



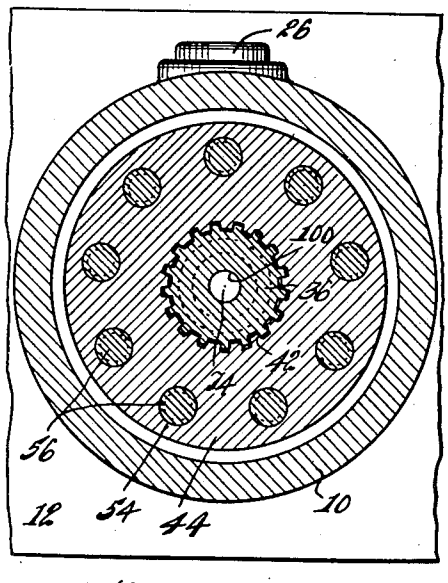


Fig. 5.

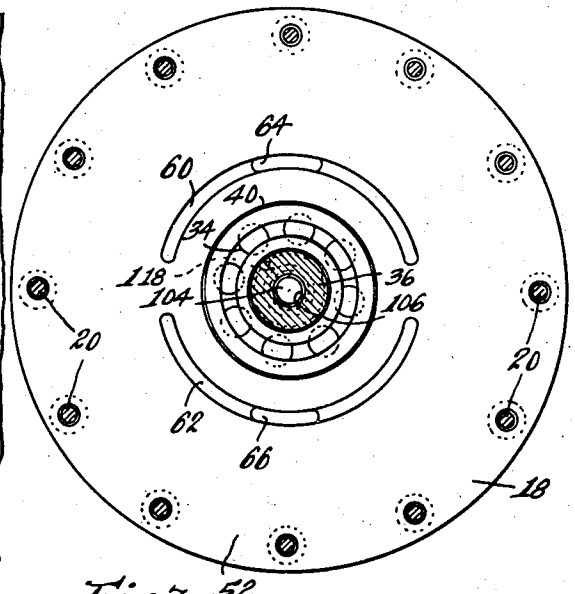


Fig. 7.

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UNITED STATES PATENT OFFICE

2,459,786

HYDRAULIC PRESSURE PUMP OR MOTOR

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13 Claims. (Cl. 103—162)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to us of any royalty thereon.

Our present invention relates to a hydraulic pressure pump or motor which is designed for proper operation at extremely high pressures.

One object of the invention is to provide a structure which is readily suitable to operate either as a pump or a motor with no changes whatever, the design being simple and involving but few parts which can be readily fabricated and assembled.

Another object is to provide a pump or motor design wherein loaded bearings are minimized, the thrust forces being taken by stationary thrust surfaces.

Still another object is to provide a pump wherein effective seals against fluid loss may be provided in a very simple manner.

A further object is to provide a rotating barrel having cylinder bores therein and pistons slidable in the bores and operated by a cam, a creep plate being interposed between the cam and the pistons.

Still a further object is to floatingly mount the barrel so that it will effectively seat against an end plate of the pump or motor under the force of internal pressure acting on partially closed cylinder bore ends and to provide a relief valve for pressure in the housing of the structure to maintain a desired value thereof somewhat lower than the pressure in the outlet of the pump (or the inlet of the motor).

An additional object is to provide pistons in the cylinder bores which have similar ends so that they cannot be installed improperly and to arrange the parts in relation to each other so that return springs are not required for the pistons.

With these and other objects in view, our invention consists in the construction, arrangement and combination of the various parts of our invention whereby the objects contemplated are attained, as hereinafter more fully set forth, pointed out in our claims and illustrated in the accompanying drawings, wherein:

Fig. 1 is a front elevation of our pump or motor;

Fig. 2 is a rear elevation thereof;

Fig. 3 is a vertical sectional view on the line 3—3 of Fig. 2;

Fig. 4 is a sectional view on the line 4—4 of Fig. 3 to illustrate the intake and outlet port arrangements of the pump or motor;

Fig. 5 is a sectional view on the line 5—5 of Fig. 3 showing the pistons in the cylinder bores of the barrel;

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Fig. 6 is a sectional view on the line 6—6 of Fig. 4 further showing the piston porting arrangement; and

Fig. 7 is a sectional view on the line 7—7 of Fig. 4 showing an inside elevation of one end plate of the pump or motor wherein arcuate intake and outlet ports are provided.

On the accompanying drawings we have used the reference numeral 10 to indicate a cylindrical housing. The housing has a flange 12 at one of its ends for mounting the housing as a pump or motor. For this purpose bolts or screws may extend through perforations 14 of the flange and thread into a suitable support in the usual manner. The housing 10 has a flange 16 at its other end to which an end plate 18 is secured as by cap screws 20, with a suitable gasket or sealing compound between the flange and the end plate.

The housing 10 has an internal partition 22 against which a cam 24 is positioned. The cam fits the interior of the housing and is retained against rotation relative thereto by a set screw 26. The cam 24 has a cam face 28 which is in the form of a truncated cylinder end, and a hardened creep plate 30 of washer-like form is engaged against this cam face.

Rotatable in bearings 32 and 34, supported in fixed position relative to the housing 10, is a barrel drive shaft 36. The bearing 32 is seated in an annular counterbore 38 of the cam 24, whereas the bearing 34 is seated in a counterbore 40 of the end plate 18.

Loosely splined at 42 on the barrel drive shaft 36 is a barrel 44 having an annular shoulder 46 engaging a narrow flange 48 on the shaft 36 for guide purposes. The barrel 44 has a flat sealing face 50 to contact with a flat sealing face 52 of the end plate 18. The loose splining of the barrel 44 to the shaft 36 permits ready conformity of the face 50 to the face 52, as will hereinafter appear.

Circumferentially spaced cylinder bores 54 are provided in the barrel 44, and in each a plunger-like piston 56 is reciprocable. Each cylinder has a cylinder port 58 of the shape shown in Fig. 6. The ports are of somewhat less cross-sectional area than the area of the cylinder bore in order to provide the necessary thrust force between the barrel 44 and the end plate 18 by internal pressure acting on the cylinder bore ends surrounding the ports.

Considering our invention as a pump, each of the ports 58 is adapted to register at times with

an arcuate intake port 60 and at other times with an arcuate outlet port 62 of the end plate 18. The shapes of these ports are shown in Fig. 7. The ports 60 and 62 communicate by means of passageways 64 and 66, with an intake or low pressure boss 68 and an outlet or high pressure boss 70, respectively. When the device operates as a motor, the boss 70 is the intake and the boss 68 is the outlet. In both cases there is low pressure in the boss 68 and high pressure in the boss 70, as indicated by the legends "HI" and "LO" in Figs. 2 and 4.

The barrel 44 is adapted to be seated against the end plate 18 by pressure within the housing 10, as will hereinafter appear. During starting of the pump, when pressure has not yet built up it is desirable to make sure that the faces 50 and 52 are in contact, and this may be accomplished by a light spring 72, shown in Fig. 3.

For driving the barrel shaft 36 we provide a drive shaft 74 which is loosely splined at 76 to the drive shaft, and has splines 78 on its other end for connection to a power take-off shaft of the aircraft engine or any other suitable means to drive the pump, or, in case the device is operated as a motor, then to the device driven thereby. Such device or the power take-off shaft, as the case may be, would include a means to align the outer end of the drive shaft 74 for proper operation without binding.

The drive shaft 74 has a flange 80 surrounding it, with which a seal plate 82 in the form of a ring is engageable. A spring 84 effects such engagement initially, whereas fluid pressure within the housing effects the engagement after the pump or motor is in operation, as will hereinafter appear. The spring 84 is seated against a second end plate 86 secured to the partition 22 by suitable means, such as screws 88.

The seal plate 82 is sealed relative to the housing 10 by means of a diaphragm 90 having its inner edge clamped to the seal plate by a spanner nut 92, and its outer edge clamped between a washer 94 and the end plate 86 by the screws 88. This provides a pressure chamber, indicated at 96, inside of the flange 80.

The inner end of the drive shaft 74 is seated against a shoulder 98 of the barrel shaft 36 which serves merely as a thrust connection, but, normally, when the pump or motor is operating, the two are spaced from each other. A passageway 100 is provided through the center of the barrel shaft 36, and liquid is adapted to flow through this passageway after passing through the splined connection 76. A relief groove 102 is provided for such flow in the event that the inner end of the drive shaft 74 is seated against the shoulder 98.

The passageway 100 communicates with a pressure relief valve in the form of a valve plug 104 seated against a ring 106 by a spring 108. The valve plug acts as a piston in a sleeve 110 which serves to guide its sliding movement. The sleeve 110 has a head 112 for screwing the sleeve into the end plate 18 at the screw-threaded connection 114. The sleeve 110 has ports 116 communicating with an annular groove 118 which, in turn, communicates by means of a passageway 120 with the low pressure boss 68, as best shown in Figure 4.

Practical operation

Considering our structure as operating as a pump, the shaft 74 is driven by any suitable power means to thereby drive the barrel shaft

36 and the barrel 44. A reservoir of fluid, such as lubricating oil, fuel oil or the like, is connected with the low pressure boss 68, and the high pressure boss 70 is connected with any suitable device for receiving the fluid at high pressure. The spring 72 keeps the barrel 44 in engagement with the end plate 18, and the spring 84 keeps the seal plate 82 in engagement with the flange 80 so that there is a sealed chamber within the housing 10 all the way from the end plate 18 to the diaphragm 90. These springs, particularly the spring 72, maintain the seal necessary for priming the pump.

The pistons 56 are held against the creep plate 30 by fluid pressure from the low pressure boss 68 which would be under the pressure produced by a booster pump or any other means. Accordingly, as the barrel 44 rotates, the pistons 56 will be reciprocated because of the angular position of the creep plate with respect to a plane normal to the axis of rotation of the barrel. During one half of the revolution, when some of the pistons 56 are moving inward toward the final position in the lower half of Fig. 3, there will be intake of liquid from the intake port 60, and during the other half of the revolution, when some of the pistons are moving outwardly to the position in the upper half of Fig. 3, the fluid will be expelled under high pressure to the outlet port 62.

There is some leakage of liquid past the faces 50 and 52, especially before pressure is built up in the housing 10, and this liquid, together with the small amount which creeps past the pistons 56, will charge the interior of the housing 10 for lubricating the bearings 32 and 34 and producing pressure within the housing. The lubricant passes along clearances between surfaces 36*a* and 44*a* on the drive shaft 36 and barrel 44, respectively. The barrel 44 will be seated against the end plate 18 by a combination of forces tending to maintain such relation including the charging pressure for the housing plus the force of spring 72 and the internal pressure of the cylinder bores acting on the partially closed cylinder ends. Pressure of the fluid passing the bearing 32 also acts on the flange 80 to compress the spring 84 somewhat, and thereafter maintain the flange 80 against the sealing face of the seal plate 82 under such pressure. The pressure is limited, however, by the relief valve 104 which, depending upon the strength of the spring 108, will move to a relief position, permitting excess liquid to flow through the ports 116 and the passageways 118 and 120 back to the low pressure boss 68. A selected spring 108 may be used, as required, to keep a desired pressure within the housing. The valve 104, therefore, acts as a pressure regulating valve.

In the operation of our device as a motor, high pressure fluid is supplied to the boss 70 which acts upon the pistons 56 to cause them to exert a side thrust in a circumferential direction against the creep plate 30, thereby transforming the fluid pressure into rotation of the shaft 74. In this instance the shaft 74 would be connected to any device to be driven by the motor. The relief valve 104 will operate in its same capacity, and the only difference in the operation of the device will be that it rotates in the opposite direction from that required to operate it as a pump.

The direction of rotation can be readily reversed by reversing the end plate 18, or in cases

where the piping is such that it is desirable to turn the end plate 180 degrees, this can be done if the direction of rotation is immaterial.

From the foregoing specification we believe it will be obvious that we have provided a structure which may be operated either as a high pressure pump or a high pressure motor. It is well suited for pressures on the order of three thousand pounds per square inch, and when so used has high torque and power. The design is such that there are few parts, and they are simple to form, machine and assemble. The device may be used either as a pump or a motor with no changes.

The necessary thrust of the rotating barrel to effect pressure seal is had without the necessity of providing the spring 72 other than for the purpose of the initial thrust before pressure is built up within the housing. The spring can therefore be comparatively light, yet will insure proper priming of the pump or starting of the motor. The seal at 80—82 remains effective even if the shaft 74 is out of alignment or eccentric, or if the spline 76 should happen to stick.

The pistons 56 are spherical on both ends, and are symmetrical so that they can be installed either way without improper operation resulting therefrom. The barrel 44 is fully floating on the barrel shaft so that it can properly seat against the end plate 18 and maintain good face contact therewith.

Some changes may be made in the construction and arrangement of the parts of our pump or motor without departing from the real spirit and purpose of our invention, and it is our intention to cover by our claims any modified forms of structure or use of mechanical equivalents which may be reasonably included within their scope.

We claim as our invention:

1. In a hydraulic pressure pump or motor, a housing, a power shaft extending inside and outside of said housing, a barrel driving shaft secured to said power shaft and journaled in said housing, a barrel loosely mounted on said driving shaft and operatively connected thereto, said barrel having cylindrical bores therein substantially parallel to the axis of rotation of the barrel and its drive shaft, a piston in each of said bores, said barrel having one of its ends seated against an end of said housing, ports in said end of said barrel and communicating with said cylinder bores, a stationary cam in said housing having a cam surface surrounding said barrel driving shaft and in the shape of a truncated cylinder end, said cam cooperating with said pistons to reciprocate them upon rotation of said barrel, and intake and discharge ports in said end of said housing for communicating with said cylinder ports of said barrel.

2. In a device of the class described, a housing, a power shaft extending inside and outside of the housing, a barrel driving shaft secured to the power shaft and journaled in said housing, a barrel loosely splined on said driving shaft, said barrel having cylindrical bores parallel to the axis of rotation of the barrel drive shaft, a piston in each of said bores, an end plate on said housing, said barrel having one of its ends seated thereagainst, ports in said end of said barrel and communicating with said cylinder bores, said ports being smaller than the bores whereby fluid pressure within said bores tend to seat said barrel against said end plate, a cam in the shape of a truncated cylinder end, a creep plate interposed between said cam and said pistons, the ends of said pistons being similar in shape, and intake and discharge ports in said end plate and communicating with said cylinder ports in said barrel.

3. In a hydraulic device of the class described, a housing, a power shaft extending inside and outside of the housing, a barrel driving shaft secured to said power shaft and journaled in said housing, a barrel loosely splined on said driving shaft, said barrel having cylindrical bores parallel to the axis of rotation of the barrel drive shaft, a piston in each of said bores, an end plate on said housing, said barrel having one of its ends seated thereagainst, ports in said end of said barrel and communicating with said cylinder bores, a cam for driving said pistons in the shape of a truncated cylinder end, and intake and discharge ports in said end plate and communicating with said cylinder ports of said barrel.

4. In a hydraulic pressure pump or motor, a housing, a barrel driving shaft journaled in said housing, a barrel loosely mounted on said shaft and splined thereto, said barrel having cylindrical bores parallel to the axis of rotation of said shaft, a piston in each of said bores, said barrel having one of its ends seated against an end of said housing, ports in said end of said barrel and communicating with said cylinder bores, a cam having a cam surface surrounding said shaft and in the shape of a truncated cylinder end, said cam drivingly coacting with said pistons, intake and discharge ports in said end of said housing for communicating with said cylinder ports of said barrel, a drive shaft loosely splined to said first shaft, said drive shaft having an annular flange affixed thereto, a seal plate contacting with said flange and surrounding said drive shaft, a diaphragm connection between said housing and said seal plate, and a spring interposed between said housing and said seal plate to urge said seal plate into contact with said flange, said diaphragm providing a pressure chamber inside of said seal plate communicating with the interior of said housing and subjected to the pressure therein.

5. In a hydraulic pressure pump or motor, a housing, a barrel driving shaft journaled in said housing, a barrel loosely mounted on said shaft and splined thereto, said barrel having cylindrical bores parallel to the axis of rotation of said shaft, a piston in each of said bores, said barrel having one of its ends seated against an end of said housing, ports in said end of said barrel and communicating with said cylinder bores, a cam having a cam surface surrounding said shaft and in the shape of a truncated cylinder end, said cam drivingly coacting with said pistons, intake and discharge ports in said end of said housing for communicating with said cylinder ports of said barrel, a drive shaft loosely splined to said first shaft, said drive shaft having an annular flange affixed thereto, a seal plate contacting with said flange and surrounding said drive shaft, and a diaphragm connection between said housing and said seal plate.

6. In a hydraulic pressure device of the class described, a housing, a shaft journaled therein, a barrel operatively connected thereto, said barrel having cylindrical bores, a piston in each of said bores, said barrel having one of its ends seated against an end of said housing, ports in said end of said barrel and communicating with said cylinder bores, a cam for driving coaction with said pistons, intake and discharge ports in

said end of said housing for communicating with said cylinder ports of said barrel, a drive shaft connected to said first shaft, said drive shaft having an annular flange affixed thereto, a seal plate contacting with said flange and surrounding said drive shaft, and a diaphragm connection between said housing and said seal plate to urge said seal plate into contact with said flange.

7. In a hydraulic pump or motor of the class described, a housing, a barrel driving shaft journaled in said housing, a barrel mounted on said shaft and operatively connected thereto, said barrel having cylindrical bores therethrough parallel to the axis of rotation of said shaft, a piston in each of said bores, said barrel having one of its ends seated against an end of said housing, ports in said end of said barrel and communicating with said cylinder bores, a cam having a cam surface surrounding said shaft and in the shape of a truncated cylinder end coacting with said pistons, intake and discharge ports in said end of said housing for communicating with said cylinder ports of said barrel, said shaft having a bore therethrough into which fluid which leaks past said pistons may flow after passing through one of said bearings, and said housing having a relief valve for regulating the pressure within the housing, said relief valve communicating with said bore and discharging into the low pressure side of said pump or motor.

8. In a hydraulic pressure pump or motor, a housing, a shaft journaled in said housing, a barrel operatively connected thereto, said barrel having cylinder bores, a piston in each of said bores, said barrel having one of its ends seated against an end of said housing, ports in said end of said barrel and communicating with said cylinder bores, a cam coacting with said pistons for reciprocating them, intake and discharge ports in said end of said housing for communicating with said cylinder ports of said barrel, a diaphragm seal between said housing and said shaft, said cam having a bore therethrough into which fluid which leaks past said pistons may flow, and said housing having a relief valve for regulating the pressure within the housing, a passageway formed in said housing, said relief valve communicating with said last passageway and with the low pressure side of said pump or motor.

9. In a hydraulic pressure pump, a housing, a barrel driving shaft journaled in said housing, a barrel operatively connected thereto, said barrel having cylindrical bores substantially parallel to the axis of rotation of the barrel, a piston in each of said bores, said barrel having one of its ends seated against an end of said housing, ports in said end of said barrel and communicating with said cylinder bores, a cam having a cam surface surrounding said shaft and in the shape of a truncated cylinder end for coaction with said pistons, intake and discharge ports in said end of said housing for communicating with said cylinder ports of said barrel, a drive shaft connected to said barrel drive shaft, said drive shaft having an annular flange affixed thereto, a seal plate contacting with said flange and surrounding said barrel drive shaft, a diaphragm connection between said housing and said seal plate, said diaphragm providing a pressure chamber within said seal plate communicating with the interior of said housing and subjected to the pressure therein, said barrel drive shaft having a bore therethrough into which fluid which leaks past said pistons and into said pressure chamber may flow, and said housing having a relief valve for regulating the pressure within the housing, said relief valve communicating with said bore and the intake side of said pump.

10. In a hydraulic pressure pump or motor of the class described, a housing, a shaft journaled in said housing, a barrel loosely mounted on said shaft and operatively connected thereto, said barrel having cylindrical bores, a piston in each of said bores, said barrel having one of its ends seated against an end of said housing by internal pressure in said housing tending to force said barrel against said seat, ports in said end of said barrel and communicating with said cylinder bores, a cam for coaction with said pistons to reciprocate them, intake and discharge ports in said end of said housing for communicating with said cylinder ports of said barrel, a drive shaft for said first shaft, said drive shaft having a flange, a seal plate contacting with said flange, a diaphragm connection between said housing and said seal plate, said diaphragm providing a pressure chamber communicating with the interior of said housing, and said housing having a relief valve for regulating the pressure within said housing.

11. A motor or pump structure of the character disclosed for operation by hydraulic fluid under pressure or for pumping such fluid comprising a housing, a partition therein, a cam against said partition, a barrel drive shaft journaled in said housing, a barrel in said housing driven by said barrel drive shaft, said barrel having cylinder bores provided with partially closed ends, pistons slidable in said cylinder bores and co-acting with said cam for reciprocation thereby upon rotation of the barrel, an end plate for said housing, said barrel being positioned between said cam and said end plate and tending to be biased by fluid pressure within said cylinder bores into contact with said end plate, said barrel having a port for each partially closed cylinder end and said end plate having intake and outlet ports for alternate registry with said ports of said cylinder ends during rotation of the barrel, a drive shaft for said barrel shaft loosely connected therewith and having a flange beyond said partition, a seal plate positioned against said flange, a diaphragm connection between said seal plate and said housing, a spring interposed between said housing and said seal plate, and a relief valve from the interior of said housing discharging to the low pressure side of said motor or pump.

12. A pump of the character disclosed comprising a housing, a cam therein, a barrel drive shaft journaled in said housing, a barrel in said housing driven by said barrel drive shaft, said barrel having cylinder bores, pistons slidable therein and coacting with said cam for reciprocation thereby upon rotation of the barrel, an end plate for said housing, said barrel being positioned between said cam and said end plate and tending to be biased by fluid pressure within said housing into contact with said end plate, said barrel having a port for each cylinder and said end plate having intake and outlet ports for alternate registry with said ports of said barrel during rotation of the barrel, a drive shaft for said barrel shaft having a flange, a seal plate positioned against said flange, and a diaphragm connection between said seal plate and said housing.

13. A pump of the character disclosed comprising a housing, a cam therein, a barrel drive shaft journaled in said housing, a barrel in said housing driven by said barrel drive shaft, said barrel having cylinder bores, pistons slidable therein

and coacting with said cam for reciprocation thereby upon rotation of the barrel, an end plate for said housing, said barrel being positioned between said cam and said end plate and tending to be biased by fluid pressure within said housing into contact with said end plate, said barrel having a port for each cylinder and said end plate having intake and outlet ports for alternate registry with said ports of said barrel during rotation of the barrel, a drive shaft for said barrel shaft having a flange, a seal plate positioned against said flange, a diaphragm connection between said seal plate and said housing, and a relief valve from the interior of said housing and discharging to the intake of said pump.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,925,378	Ferris et al.	Sept. 5, 1933
1,945,391	Benedek	Jan. 30, 1934
2,161,143	Doe, et al.	June 6, 1939
2,299,235	Snader, et al.	Oct. 20, 1942
2,300,009	Rose	Oct. 27, 1942
2,331,694	Jeffrey	Oct. 12, 1943
2,337,821	Huber	Dec. 28, 1943