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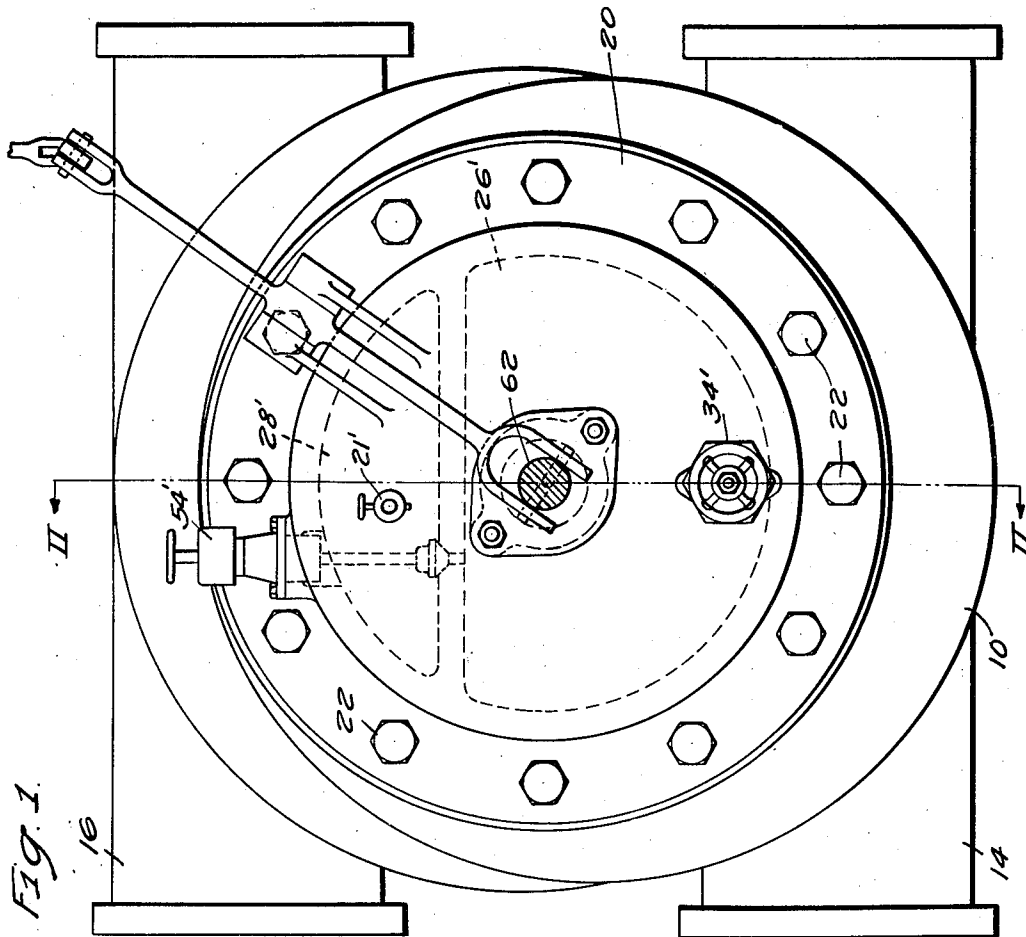
E. E. ARNOLD

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RECIPROCATING HYDRAULIC MOTOR

Filed July 16, 1938

6 Sheets-Sheet 1



WITNESSES:

E. A. McLaughlin
Joe A. Weber

INVENTOR

Edwin E. Arnold

BY *G. M. Crawford*
ATTORNEY

May 7, 1940.

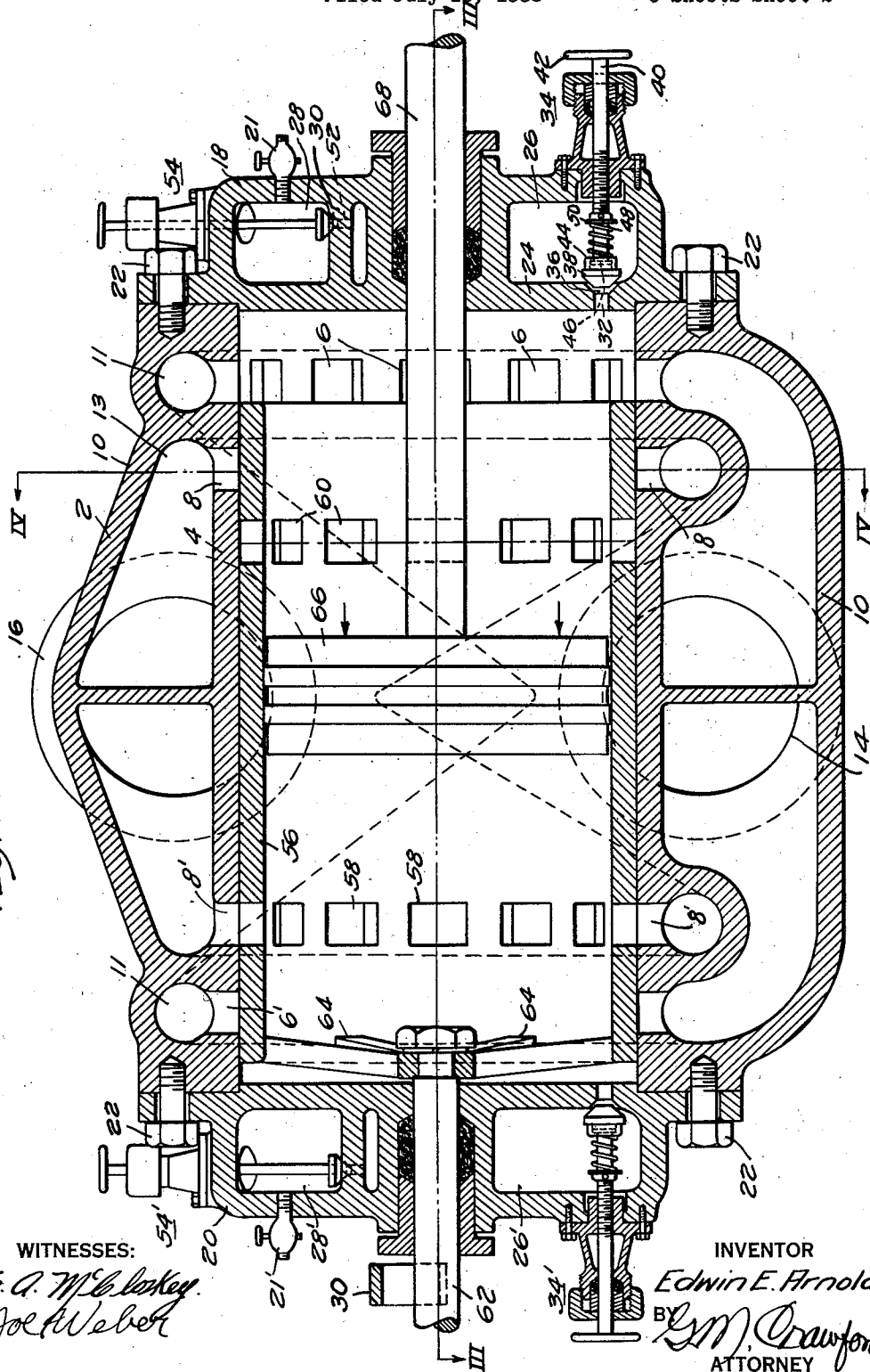
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E. E. ARNOLD
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Fig. 2.



May 7, 1940.

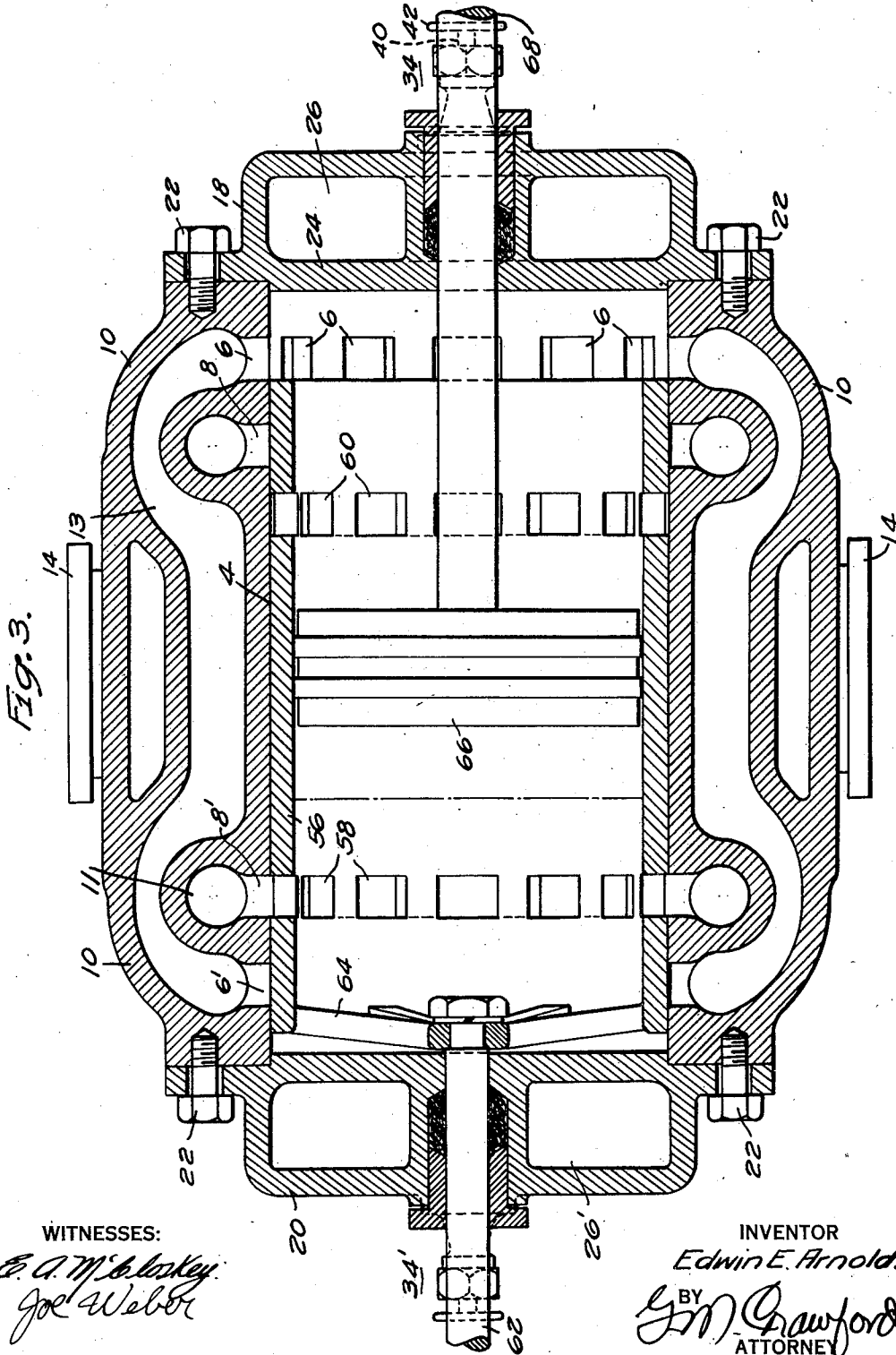
E. E. ARNOLD

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RECIPROCATING HYDRAULIC MOTOR

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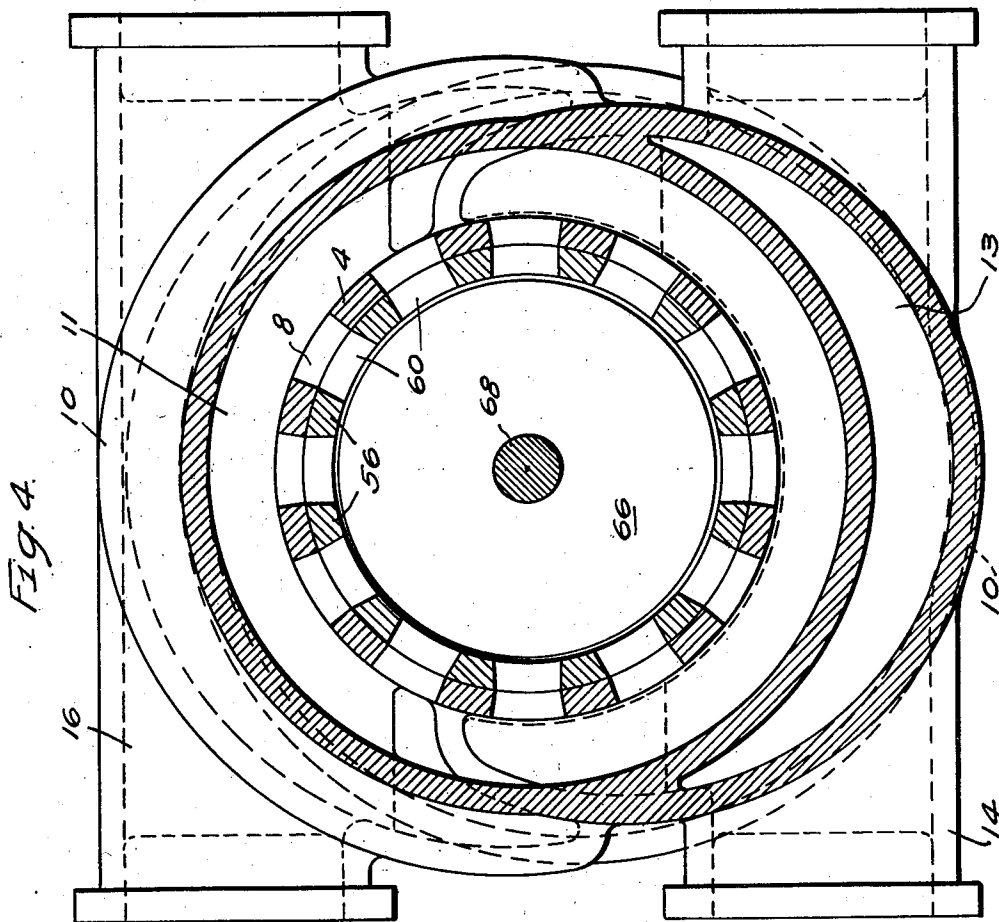
E. E. ARNOLD

2,200,071

RECIPROCATING HYDRAULIC MOTOR

Filed July 16, 1938

6 Sheets-Sheet 4



WITNESSES:

E. A. M. C. Lasker
John Weber

INVENTOR

Edwin E. Arnold

BY *G. M. Crawford*
ATTORNEY

May 7, 1940.

E. E. ARNOLD

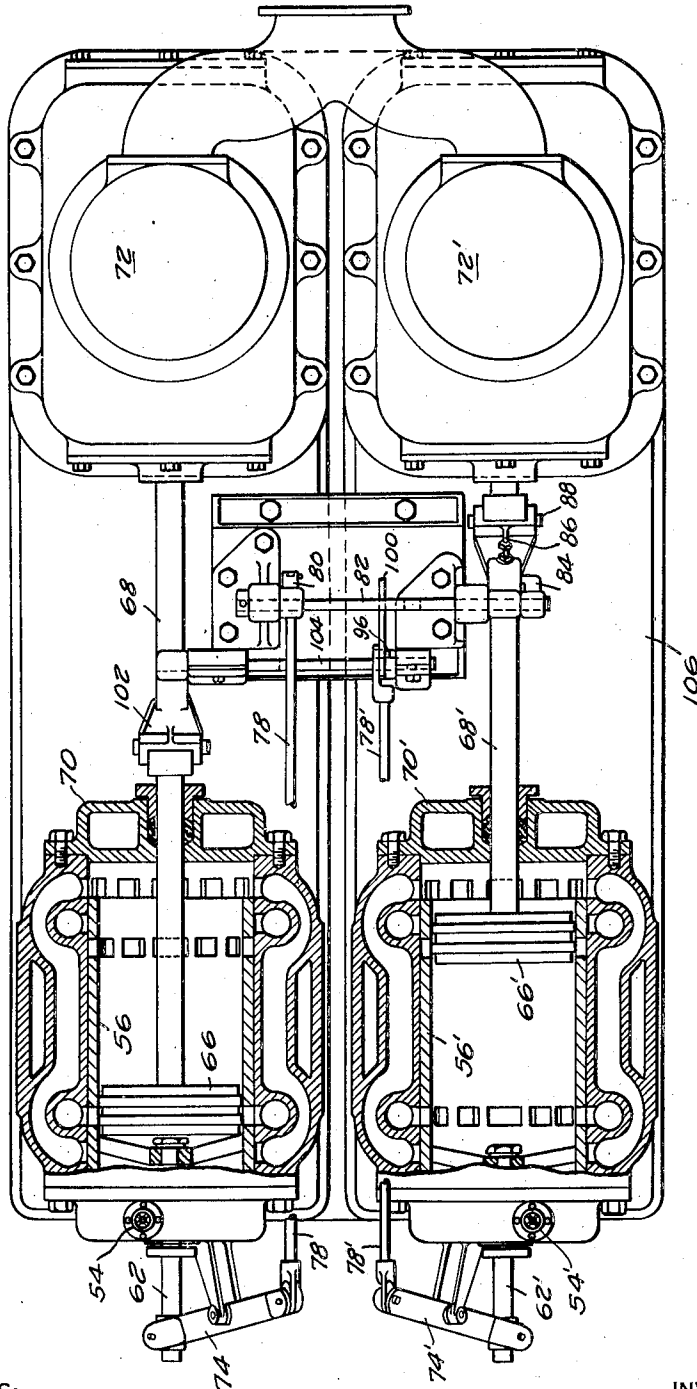
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RECIPROCATING HYDRAULIC MOTOR

Filed July 16, 1938

6 Sheets-Sheet 5

Fig. 5.



WITNESSES:

E. A. McLaughlin
Joe Weber

INVENTOR

Edwin E. Arnold

BY *J. M. Crawford*
ATTORNEY

May 7, 1940.

E. E. ARNOLD

2,200,071

RECIPROCATING HYDRAULIC MOTOR

Filed July 16, 1938

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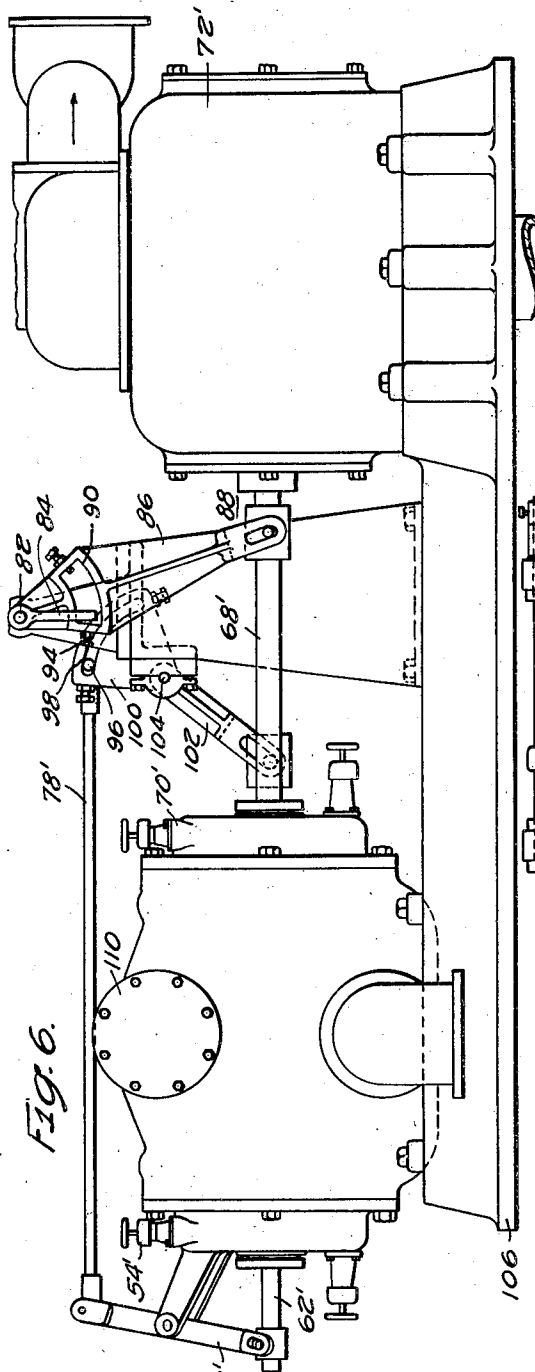


Fig. 6.

WITNESSES:

E. A. McManis
Joe Weber

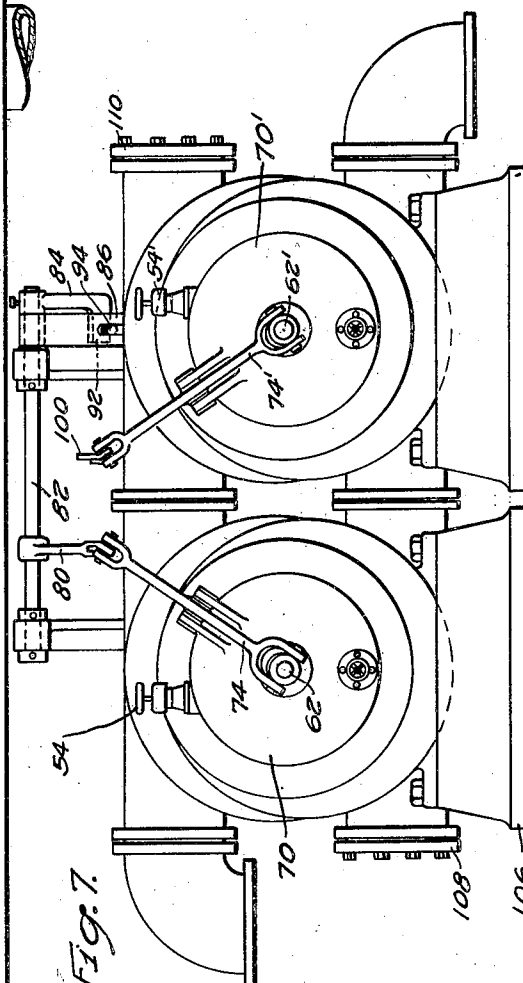


Fig. 7.

INVENTOR

Edwin E. Arnold.

BY G. M. Crawford
ATTORNEY

UNITED STATES PATENT OFFICE

2,200,071

RECIPROCATING HYDRAULIC MOTOR

Edwin E. Arnold, Pittsburgh, Pa., assignor to
Westinghouse Electric & Manufacturing Com-
pany, East Pittsburgh, Pa., a corporation of
Pennsylvania

Application July 16, 1938, Serial No. 219,528

14 Claims. (Cl. 121—114)

My invention relates, generally, to hydraulic motors, and particularly to reciprocating hydraulic motors operated by an incompressible fluid under pressure.

5 In certain pumping operations such as the pumping of mud through the bore while drilling an oil well to remove the material displaced by the drill, the pumps are actuated by reciprocating steam driven pistons or by electric motors con-
10 nected thereto by means of reduction gearing.

The object of my invention, generally, is to provide a pressure fluid operated reciprocating motor which shall be simple and compact, efficient in operation and inexpensive to manufacture and
15 install.

A more specific object of my invention is to provide for controlling the flow of pressure fluid in a pressure fluid operated reciprocating motor by means of a sleeve valve positioned within the
20 cylinder member of the motor.

Another object of my invention is to provide a system for driving reciprocating pumps which will have certain of the advantages of a steam piston driven pump and at the same time have
25 the advantage of deriving its primary power from an electric motor driven pump actuating system.

A further object of the invention is to provide a hydraulic system for transmitting the power output of a rotating electric motor to a recip-
30 roating energy translating device.

These and other objects and advantages of the invention will be apparent from the following detailed description taken in connection with the accompanying drawings:

35 Figure 1 is an end elevation view of the hydraulic motor embodying the principal features of my invention;

Fig. 2 is a sectional view taken along line II—II of Fig. 1;

40 Fig. 3 is a sectional view taken along line III—III of Fig. 2;

Fig. 4 is a sectional view taken along line IV—IV of Fig. 2;

45 Fig. 5 is a plan view, partly in section, of a pair of the motor units of my invention connected to drive a dual cylinder mud pump and showing the interconnection of the valve actuating means of the motor units;

Fig. 6 is a view in side elevation of the pumping unit of Fig. 5; and

Fig. 7 is a view in elevation of the pumping unit of Figs. 5 and 6 as viewed from the hydraulic motor end of the unit.

55 In practicing my invention, I provide a cylinder and a cooperating double acting piston with valve

means for automatically admitting fluid under pressure to the cylinder alternately on one side and then the other side of the piston to produce a reciprocating movement of the piston. Inlet and outlet ports for the cylinder chamber on
5 each side of the piston, cooperating with a sleeve valve in the cylinder, govern the flow of fluid from a source of fluid pressure to the cylinder chambers and the return of the fluid from the cylinder chambers to the fluid pressure generat-
10 ing device. The valve ports are of sufficient area to handle a non-compressible fluid without shock. Shock chambers provide an air cushion to prevent excessive stresses due to inertia hammer and to compensate for irregularities of valve and pis-
15 ton operation and timing. In practice, these units are used in pairs and the piston of each governs the valve of the other similar to duplex valve operation with steam pistons.

Referring to Figs. 1, 2, 3 and 4 of the drawings, 20 a cylinder body 2 has an inner cylindrical wall 4. The cylindrical wall 4 is provided with a series of inlet ports 6 and 6', respectively, adjacent each end and also with a series of outlet ports 8 and 8', respectively, spaced inwardly from the inlet ports
25 as shown in Fig. 2. These series of ports extend circumferentially about the cylinder wall. The cylinder body is so formed as to provide an envelope member 10 containing fluid passages 11 and 13 and extending about the cylinder bore and connecting respectively with all of each series
30 of outlet and inlet ports. A pipe member 14 having two inlets is connected to conduct fluid into the fluid passages 11 from a source of fluid pressure and a pipe member 16 having two outlets is
35 connected to the fluid passages 13 to conduct discharge fluid away from the cylinder.

The ends of cylinder body 2 are closed by the cylinder heads 18 and 20 which may be secured to the cylinder body by a plurality of stud bolts 40 22. The cylinder head 18 comprises a plate member 24 having chambers 26 and 28 formed integrally therewith, the chambers 26 and 28 being separated by a web portion 30 which is so positioned as to form the chamber 28 above
45 chamber 26 and to provide that the chamber 28 shall have a smaller volume than chamber 26 as shown best in Fig. 1. An opening or passage 32 is provided in the inner plate 24 of the cylinder head to provide fluid communication between
50 lower chamber 26 and the cylinder chamber, and the fluid flow through the opening 32 is controlled by a valve unit 34.

The valve unit 34 comprises a valve seat 36 formed in the plate 24 and a valve member 38 55

cooperating therewith. The valve member 38 may be moved by the valve stem 40 which is controlled by the handle 42. The valve stem 40 has a shoulder 44 fitted behind shoulder member 46 of the valve member 38 so that there may be longitudinal movement of the valve member 38 with respect to the valve stem 40. A spring member 48 bears against a shoulder member 50 fixed on the valve stem 40 and on the shoulder members 46 of the valve member 38 to bias the valve member 38 toward the valve seat 36.

An opening 52 is provided in the web 30 to provide fluid connection between the chambers 26 and 28 and this opening is controlled by a valve unit 54 which is similar to the valve unit 34 described in the preceding paragraph, except that no spring connection between the valve and valve stem is provided.

The cylinder head 20 closing the opposite end of the cylinder body 2 is substantially identical with the cylinder head 18 and has valve units 34' and 54' governing the fluid flow into chambers 26' and 28', respectively, corresponding to the chambers 26 and 28 of the cylinder head 18.

Chambers 26, 26', 28 and 28' are filled with a compressible fluid such as air.

A main valve is provided for conducting fluid to and from the cylinder chamber and comprises a cylindrical sleeve member 56 fitted into the cylinder bore 4 and slidable longitudinally therein having two series of ports 58 and 60. The length of the sleeve member 56 of the main valve and the spacing of the two series of ports 58 and 60 is such as to provide fluid connection with the series of inlet ports 6 on one end of the cylinder and with the series of outlet ports 8 on the other end of the cylinder, while closing off the inlet ports 6' and outlet ports 8 while in one extreme position of its sliding movement and to reverse this fluid connection when in the other extreme position of its sliding movement. The main valve sleeve 56 is operated by a stem 62 which extends through the cylinder head 20 and is bolted onto the web members 54 which are attached to the sleeve 56. The stem for the valve sleeve 56 may be extended through the other cylinder head 18 offset from and parallel to the piston rod 68 if such construction is desired.

A working piston 66 is disposed within the valve sleeve 56 and is connected to a piston rod 68 which extends through the cylinder head 18. Suitable packing is provided between the valve stem 62 and the piston rod 68 and the cylinder heads 20 and 18, respectively, through which they extend.

In order that any of the compressible fluid contained in the chambers 26, 28, 26' and 28' that may be absorbed in the non-compressible working fluid or may in any other way be depleted, and thus allow the working fluid to fill these chambers may be replaced, purging valves 21 and 21' are provided. Air or any compressible fluid may be inserted into or taken from the chambers 28 and 28' through the purging valves 21 and 21', respectively, by any suitable pump means which can be connected to the threaded portion of the valves so that a sufficient volume of compressible fluid may be maintained in these chambers to properly perform the function of absorbing the shocks in the system.

In the operation of the motor unit, which is best understood by reference to Fig. 2, the inlet pipe 14 will be connected with the source of pressure fluid which may be oil, water or any similar non-compressible liquid. This source of pressure fluid may be any suitable means for supplying

fluid under pressure such as a pump driven by an electric motor or any other suitable source of power.

With the valve sleeve 56 in the position shown in Fig. 2, the series of inlet ports 6 on the right hand end of the cylinder are uncovered and the series of outlet ports 8 on the same end are covered by the sleeve 56 and fluid pressure is being applied to the piston 66 which is moving in the direction shown by the arrows adjacent the piston. At the same time the series of ports 58 in the sleeve 56 are in cooperative relationship with the series of outlet ports 8' on the left hand end of the cylinder so that the fluid is flowing from the cylinder chamber on the left of the piston 66 through the fluid passage 13, provided in the envelope member 13, to the discharge pipe 16. At the same time the left hand end of the valve sleeve 56 is covering the series of inlet ports 6' on the left hand end of the cylinder. Under these conditions the piston will be moved to the left to its extreme position which is shown in the upper motor unit of Fig. 5 later to be referred to. If now the valve stem 62 is actuated to move the valve sleeve 56 to its extreme right hand position, the left hand series of inlet ports 6' will be uncovered to permit fluid flow into the cylinder chamber to the left of the piston 66 and at the same time the left hand end of the sleeve 56 will cover the left hand series of outlet ports 8' and the right end of the sleeve 56 will cover the right hand series of inlet ports 6, and the series of outlet ports 60 of the sleeve 56 will cooperate with the right hand series of outlet ports 8 in the cylinder 4 to permit discharge of fluid from the cylinder chamber to the right of the piston 66, which actuates it in the opposite direction. Thus the piston 66 is caused to reciprocate and thereby drive the piston rod 68 by the proper manipulation of the main valve sleeve 56 by the valve stem 62.

To relieve the shock and to thus avoid excessive stresses that might be set up in the motor due to inertia hammer and to irregularities of valve and piston operation and timing, the shock chambers 26, 28, 26' and 28', which are normally filled with air or some other compressible fluid, have their valves so adjusted as to permit liquid flow from the cylinder into the shock chambers 26 and 26' and to permit flow of the compressible fluid between the shock chambers 26 and 28, and between the chambers 26' and 28'. The valve member 38 will be normally spaced from its valve seat 36 an amount determined by test, which will give the best operation of the device and the valve unit 54 may be adjusted similarly.

The web 30 is positioned considerably above the valve 32 so that the pressure fluid which operates the fluid motor and some of which flows into and out of the shock chamber 26, may not flow into the shock chamber 28. Thus the valve 54 functions to regulate the flow of air or whatever compressible fluid is employed in the shock chambers, while the valve 34 regulates the flow of pressure fluid only.

For the best operation of the motor, the spacing of the valve member 38 from the valve seat 36 will vary with the pressure of the fluid used in operating the motor and this spacing may be adjusted as required for the best operation by the valve operating handle 42. The spring restrained motion of the valve member 38 on the stem 40 against the compression of spring 48 is provided to permit larger valve opening should any irregularity of motion be imparted to the piston so that

quicker relief for the pressure in the cylinder chamber may be provided than could be provided by the normal rigid valve setting. The valve members 34' and 54' operate in substantially the same manner as the valve members 34 and 54.

The main valve is constructed in the form of a sleeve valve so that it may handle a non-compressible working fluid, such as oil or water, without shock. With such a sleeve valve the total area of the ports in each series of inlet and outlet ports may be made equal to $\frac{1}{2}$ the piston area or even greater. This large valve portion area makes for good efficiency and operation.

While the motor described in connection with Figs. 1, 2, 3 and 4 may be put to any use where a reciprocating movement is desired, it has been designed primarily for driving mud pumps which are in common use for pumping mud through the bore while drilling an oil well to remove the material displaced by the drill. In Figs. 5, 6 and 7 a pair of the hydraulic motors of the present invention are shown connected to drive a pair of such mud pumps. Referring to Figs. 5, 6 and 7, a hydraulic motor 70 has its piston rod 68 connected to drive a mud pump 72 and a motor 70' has its piston rod 68' connected to drive a mud pump 72'. When used in this manner, the movement of the sleeve valves of each of the two co-operating resistors may be controlled in accordance with the movement of the piston of the other motor. The valve stem 62 of the motor 70 is connected through a linkage comprising a rocker arm 74, a rod 78, a crank 80, a rotatable shaft 82, and a crank 84 to an actuating crank 86 which has a pin and slot connection 88 with the piston rod 68' of the motor 70'. There is a lost motion connection between the cranks 84 and 86 provided by a slot 90 in the crank 86 into which an offset portion 92 of the crank 84 extends, and a set screw 94 is provided for adjusting the amount of this lost motion. By this lost motion connection the valve of one motor is moved from its one extreme position to its other extreme position by the piston rod of the other motor only during a portion of the movement of the piston rod as the piston rod is approaching the limit of its travel.

A similar drive is provided for the main valve sleeve 56' of the motor 70' where the valve stem 62' is connected by a linkage comprising a rocker arm 74', a rod 78' which carries a pin 96 engaging a slot 98 in an arcuate member 100 mounted in fixed relation on a shaft 104 which, in turn, is connected to an actuating crank 102 which has pin and slot lost motion connection with the piston rod 68 of the motor 70. The pin and slot lost motion connection between the arcuate member 100 and the rod 78' provide lost motion between the valve sleeve 56' and its driving piston rod 68 similar to that described in connection with the operation of the valve sleeve 56 by the piston rod 68'.

With the piston rods 68 and 68' and the main valve sleeves 56 and 56' in the positions shown in Fig. 5, the piston 66 has just reached its extreme limit of movement to the left and has moved the valve sleeve 56' to the left to open the inlet port to the right of the piston 66' and the outlet ports to the left of piston 66' to thus cause movement of piston 66' to the left. Near the end of the movement of piston 66' to the left, the actuating mechanism connected therewith for operating valve sleeve 56 will move it to the right to open the inlet ports to the left of

piston 66 and the outlet ports to the right of piston 66, closing the left hand outlet ports and the right hand inlet ports and causing the piston 66 to be moved to the right under the influence of the pressure fluid. In this manner one of the pistons 66 and 66' is always in motion, each piston beginning its stroke just as the other piston is finishing its stroke.

When operated together in this manner, the two motors may be mounted on a common base plate 106 so that their corresponding inlet and outlet pipes may be connected together as shown in Fig. 7, and the source of pressure fluid and the fluid discharge connected to the other end of the inlet and outlet pipes of the motors, the unused ends of the outlet and inlet pipes being sealed off by suitable cover members 108 and 110. Since the pumps 72 and 72' driven by the motors 70 and 70' are of well known construction and are not a part of the present invention, it has been deemed unnecessary to illustrate or describe them in detail.

It will be seen that I have provided a compact and efficient hydraulic motor adapted to be operated by a non-compressible fluid under pressure and which may be successfully and advantageously used to operate reciprocating pumps instead of the direct acting duplex steam cylinders commonly employed for that purpose. Provision is made for adjusting the motor for operation at different pressures, speeds and loads without shock.

In compliance with the requirements of the patent statutes, I have shown and described herein the preferred embodiment of my invention. It is understood, however, that the invention is not limited to the precise construction shown and described, but is capable of modifications by one skilled in the art, the embodiments herein shown being merely illustrative of the principles of my invention.

I claim as my invention:

1. In a hydraulic motor, a closed chamber member, a piston slidable within said chamber member, inlet port means in said chamber on each side of said piston, outlet port means in said chamber on each side of said piston, and valve means for alternately on the one hand opening the inlet port means and closing the outlet port means on one side of said piston while closing the inlet port means and opening the outlet port means on the other side of said piston, and on the other hand closing the inlet port means and opening the outlet port means on the said one side of said piston while opening the inlet port means and closing the outlet port means on the said other side of said piston, and a shock chamber containing a compressible fluid connected with each end of said chamber members, said shock chambers each comprising a main and an auxiliary chamber connected by an opening and valve means for controlling the flow of fluid through the opening between said main and auxiliary chambers.

2. In a hydraulic motor, a working piston, a closed cylinder member, said piston being slidably supported in said cylinder member, said cylinder member having a series of circumferentially spaced inlet ports and a series of circumferentially spaced outlet ports for the cylinder chamber on each side of said piston, an envelope member interconnecting said inlet ports and enclosing both of said series of inlet ports for conducting liquid under pressure thereto, an envelope member interconnecting said outlet ports

and enclosing both of said series of outlet ports for conducting liquid therefrom, valve means so positioned with respect to said inlet and outlet ports as to govern the flow of liquid to and from the cylinder chambers on each side of said piston, and means for so controlling the positioning of said valve means as to cause said piston to reciprocate.

3. In a hydraulic motor, a working piston, a closed cylinder member, said piston being slidably supported in said cylinder member, said cylinder member having a series of circumferentially spaced inlet ports and a series of circumferentially spaced outlet ports for the cylinder chamber on each side of said piston, an envelope member interconnecting said inlet ports and enclosing both of said series of inlet ports for conducting liquid under pressure thereto, an envelope member interconnecting said outlet ports and enclosing both of said series of outlet ports for conducting liquid therefrom, valve means so positioned with respect to said inlet and outlet ports as to control the flow of liquid to and from the cylinder chambers on each side of said piston, and means for so controlling the positioning of said valve means as to cause said piston to reciprocate, said valve means comprising a sleeve member fitted to and reciprocable in said cylinder member and having porting means positioned to cooperate with said inlet and outlet port means.

4. In a hydraulic motor, a working piston, a closed cylinder member, said piston being slidably supported in said cylinder member, said cylinder member having a series of circumferentially spaced inlet ports and a series of circumferentially spaced outlet ports for the cylinder chamber on each side of said piston, an envelope member interconnecting said inlet ports and enclosing both of said series of inlet ports for conducting liquid under pressure thereto, an envelope member interconnecting said outlet ports and enclosing both of said series of outlet ports for conducting liquid therefrom, valve means so positioned with respect to said inlet and outlet ports as to govern the flow of liquid to and from the cylinder chambers on each side of said piston, means for so controlling the positioning of said valve means as to cause said piston to reciprocate, a cylinder head on each end of said cylinder and shock chambers formed integral with said cylinder heads and connected to the respective ends of the cylinder, said shock chambers containing a compressible fluid.

5. In a hydraulic motor, a working piston, a closed cylinder member slidably supporting said piston, said cylinder member having a series of circumferentially spaced inlet ports and a series of circumferentially spaced outlet ports for the cylinder chamber on each side of said piston, an envelope member interconnecting said inlet ports and enclosing both of said series of inlet ports for conducting liquid under pressure thereto, an envelope member interconnecting said outlet ports and enclosing both of said series of outlet ports for conducting liquid therefrom, valve means so positioned with respect to said inlet and outlet ports as to govern the flow of liquid to and from the cylinder chambers on each side of said piston, and means for so controlling the positioning of said valve means as to cause said piston to reciprocate, said envelope members being formed integral with said cylinder member.

6. In a hydraulic motor, a cylinder member, a valve comprising a sleeve member fitted into and reciprocable longitudinally of said cylinder

member, a work piston fitted into and reciprocable longitudinally of said sleeve member, inlet and outlet port means in said cylinder body on each side of said piston controlled by said valve, cylinder heads closing the ends of the cylinder member, and two shock chambers formed integral with the cylinder head, said cylinder head having a fluid passage into one of said chambers and there being a fluid passage between said one chamber and the other of said chambers.

7. In a hydraulic motor in which a piston is reciprocated in a cylinder by a substantially incompressible fluid, a cylinder head for the cylinder comprising a plate member, two shock chambers formed integral with said plate member, a fluid passage through said plate member into one of said chambers and a fluid passage between said one chamber and said other chamber.

8. In a hydraulic motor in which a piston is reciprocated in a cylinder by a substantially incompressible pressure fluid, a cylinder head for the cylinder comprising a plate member, two shock chambers formed integral with said plate member, said plate member having a fluid passage therethrough into one of said chambers, there being a fluid passage between said one chamber and said other chamber, and valve means for each of said passages for regulating the fluid flow through said passages.

9. In a hydraulic motor in which a piston is reciprocated in a cylinder by a substantially incompressible pressure fluid, a cylinder head for the cylinder comprising a plate member, two shock chambers formed integral with said plate member and containing a compressible fluid, said plate member having a fluid passage therethrough disposed to permit flow of the pressure fluid between the cylinder and one of said shock chambers, there being a fluid passage between said one chamber and said other chamber so disposed as to permit flow of the compressible fluid between said two chambers.

10. In a hydraulic motor in which a piston is reciprocated in a cylinder by a substantially incompressible pressure fluid, a cylinder head for the cylinder comprising a plate member, two shock chambers formed integral with said plate member and containing a compressible fluid, said plate member having a fluid passage therethrough disposed to permit flow of the pressure fluid between the cylinder and one of said shock chambers, there being a fluid passage between said one chamber and said other chamber so disposed as to permit flow of the compressible fluid between said two chambers, adjustable valve means for the passage between the shock chambers for controlling the rate of flow of compressible fluid therethrough, and adjustable valve means in the passage between the cylinder and the one shock chamber, said last-named valve means including a relief valve whereby excessive shock in the cylinder may be relieved by increased fluid flow from the cylinder and the one shock chamber.

11. In a hydraulic motor having a piston reciprocated in a cylinder by a substantially incompressible fluid, two shock chambers one of which is normally filled with a compressible fluid the other being normally partly filled with the incompressible fluid, the second of said chambers being connected by a fluid passage to the cylinder chamber, the first of said chambers being connected by a fluid passage to the second chamber, the end of the passage between said second cham-

ber and the cylinder chamber being relatively near the lower portion of the second chamber, and the end of the passage between the first and second chambers, in the second chamber, being above the lower portion of the second chamber.

12. In a hydraulic motor, a cylinder member, a piston reciprocable in said cylinder, valve means in said cylinder for controlling the flow of working fluid to and from said cylinder, a cylinder head on each end of said cylinder, a shock chamber formed integral with each of said cylinder heads, a piston stem extending through one of said cylinder heads and its associated shock chamber and an operating stem for said valve means extending through the other of the cylinder heads and its associated shock chamber.

13. In a hydraulic power translating device having a substantially non-compressible fluid as a working medium and having a piston reciprocated in a cylinder occupied by the non-compressible medium, a plate member fitted to close the end of the cylinder, shock chambers formed on the plate member, one wall of each of which comprises said plate member, said shock chambers being interconnected by fluid passages, certain of said chambers being connected by a fluid passage through said plate member with the cylinder, and purging valve means connected to certain of said chambers.

14. In a hydraulic motor, a closed cylinder member, a sleeve valve slidably disposed within said cylinder, a piston slidably disposed within said sleeve valve, a first series of ports in the wall of said cylinder circumferentially spaced about the cylinder adjacent each of the ends of the cylinder, a second series of ports in the wall of said cylinder circumferentially spaced about the cylinder and spaced inwardly from said first series of ports, means connecting one of said series of ports to a source of fluid pressure, said valve being so constructed and arranged as to alternately, on the one hand, close the first series of ports in one end of the cylinder, open the first series of ports in the other end of the cylinder, open the second series of ports in the said one end of the cylinder and close the second series of ports in the other end of the cylinder and, on the other hand, open the first series of ports in the one end of the cylinder, close the first series of ports in the other end of the cylinder, close the second series of ports in the one end of the cylinder and open the second series of ports in the other end of the cylinder, when the valve is reciprocated in the cylinder, and means for reciprocating said valve in said cylinder.

EDWIN E. ARNOLD.