

March 14, 1933.

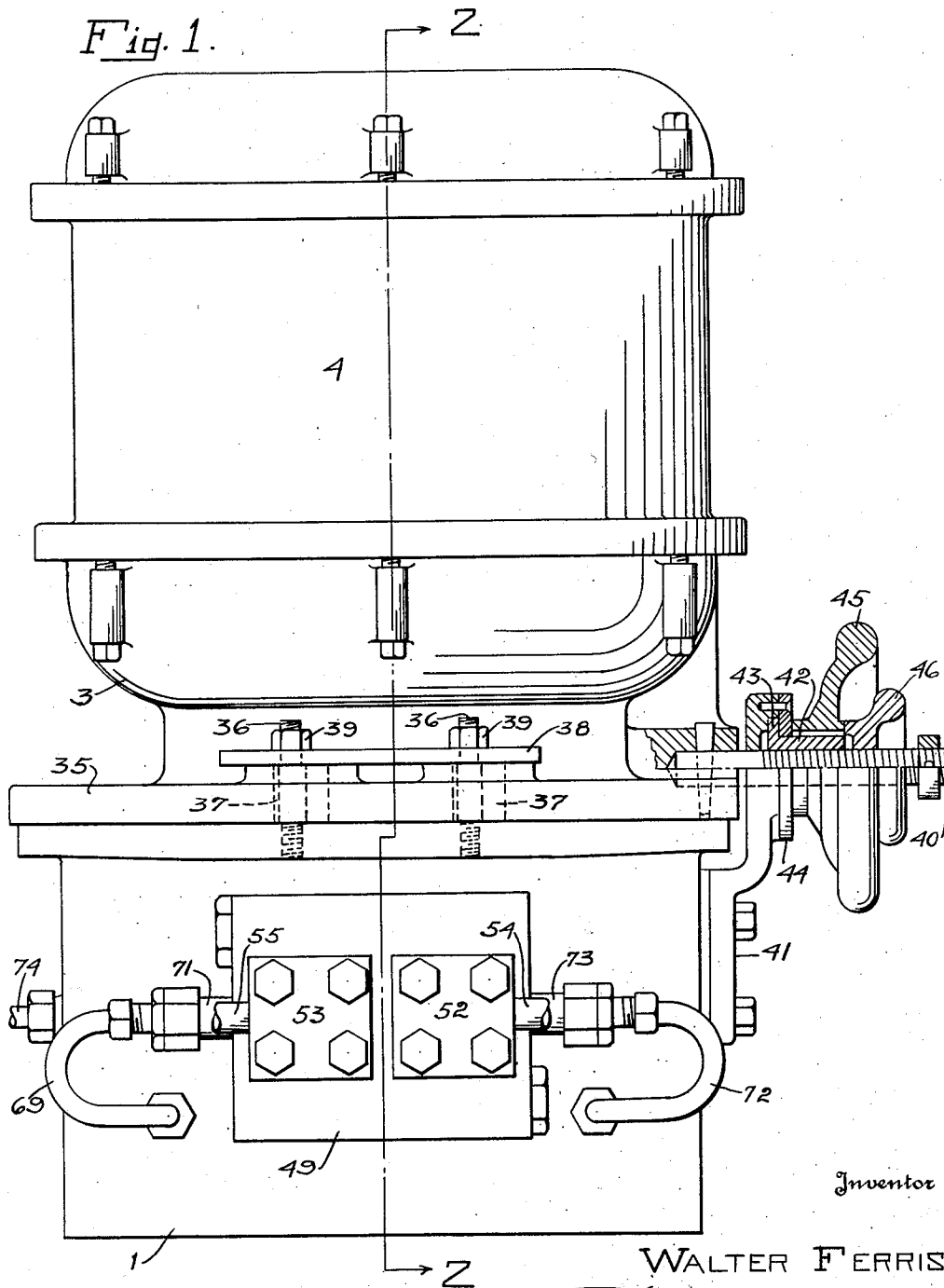
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1,901,501

PUMP

Filed July 9, 1931

4 Sheets-Sheet 1



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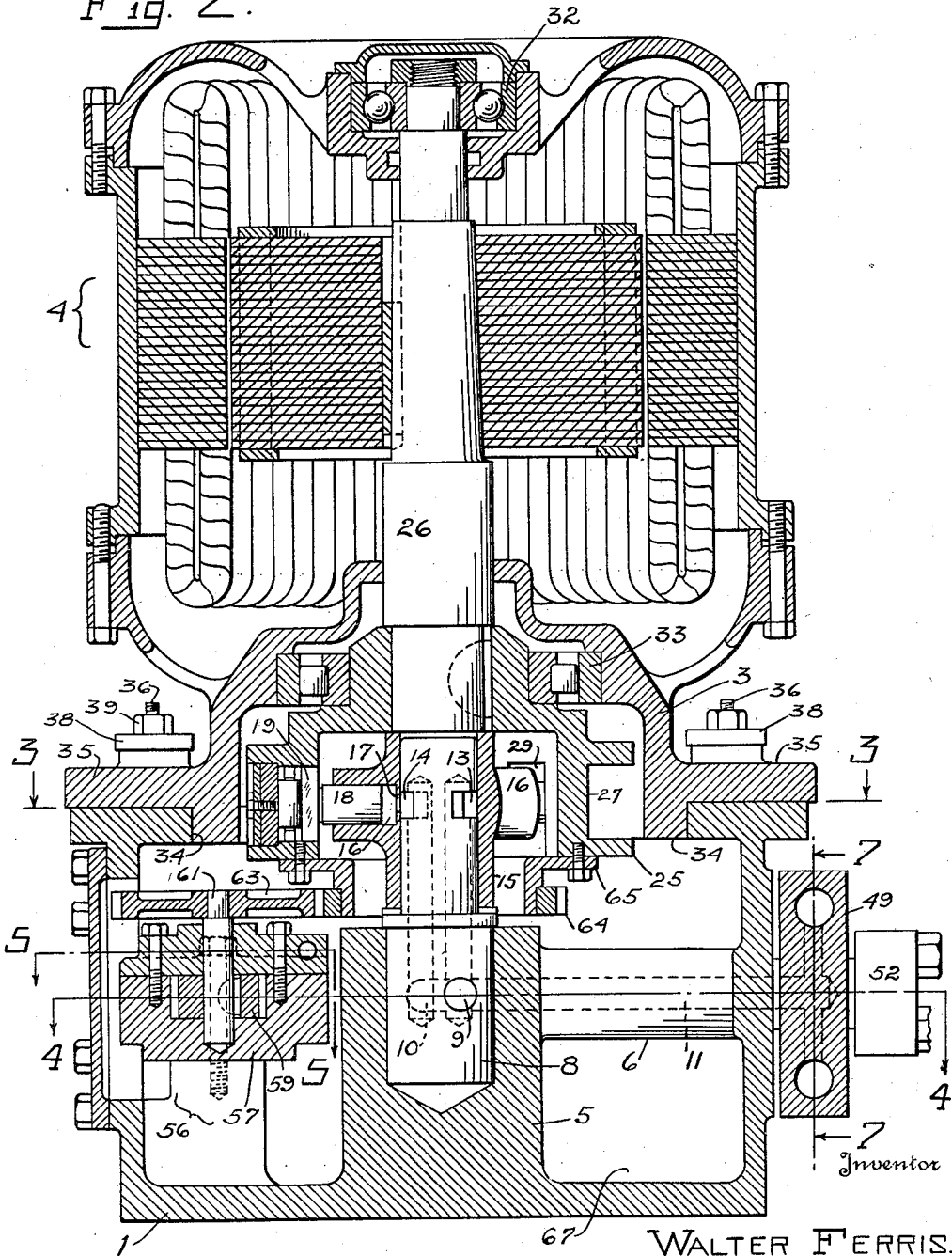
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Fig. 2.



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Fig. 3.

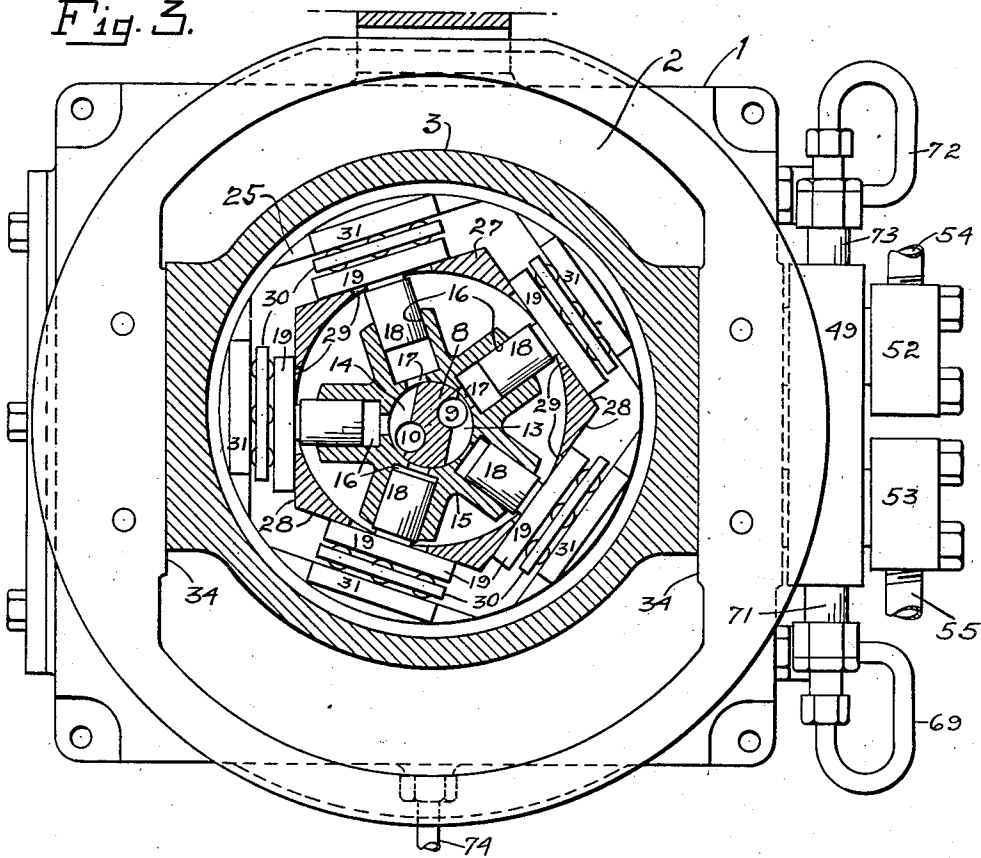


Fig. 6.

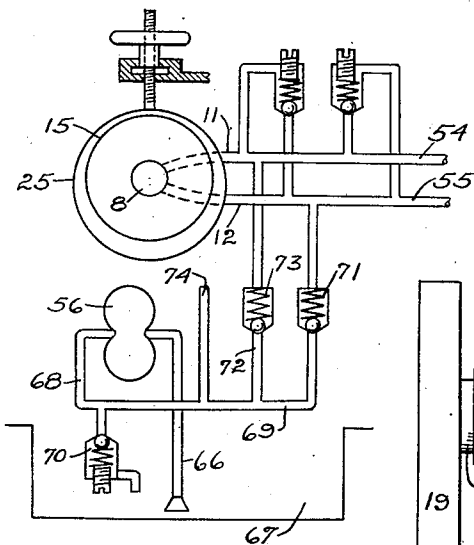


Fig. 7.

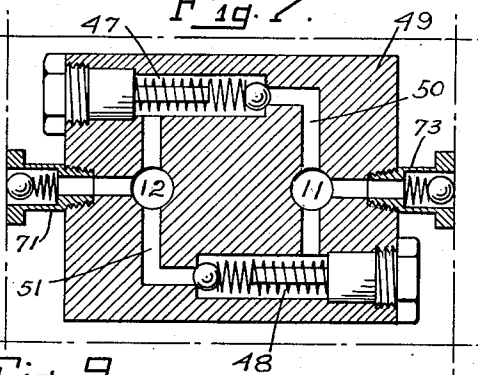
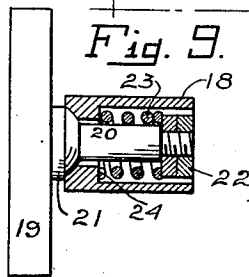


Fig. 9.



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Fig. 4.

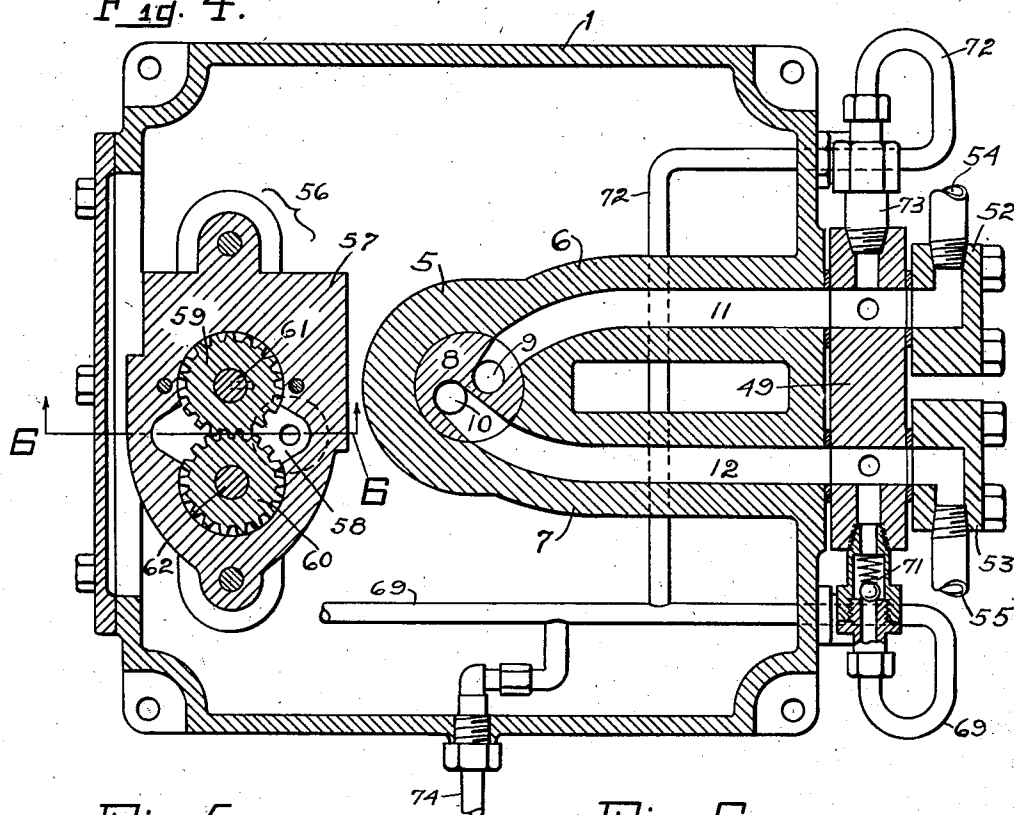


Fig. 5.

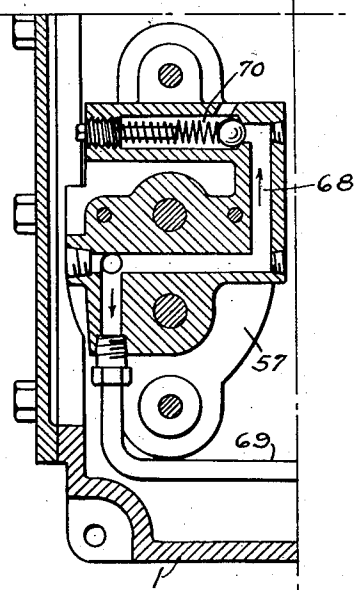
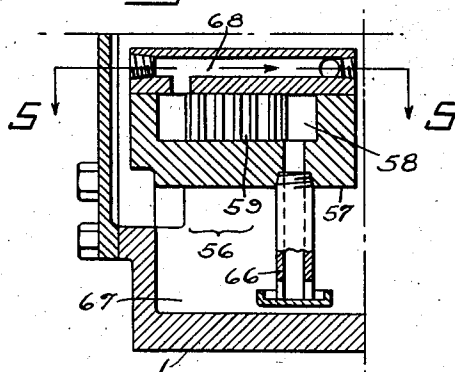


Fig. 6.



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UNITED STATES PATENT OFFICE

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PUMP

Application filed July 9, 1931. Serial No. 549,664.

This invention relates to variable displacement pumps.

The pump to which the invention applies in particular has its pistons arranged radially in a cylinder barrel which is journaled upon a hollow shaft or pintle through which liquid flows to and from the cylinders, the cylinder barrel is rotated and the pistons reciprocated in the cylinders by a circular driver whose axis is eccentric to the axis of the pintle, and the stroke of the pump is proportional to the degree of eccentricity between the axes of the pintle and the driver, such as the pump shown in Patent 1,753,562 issued April 8, 1930 to John P. Ferris.

As high lateral forces are created between the driver and the pintle upon the pressure side of the pump and as these forces must be resisted by the driver and its shaft, the driver ordinarily rotates on a stationary axis and the pintle is moved toward and from this axis to change the stroke of the pump.

The pintle is ordinarily carried by a swinging arm or pendulum which vibrates under the violent sidethrusts exerted upon the pintle by the driving liquid, and it is necessary to conduct the liquid to and from the pintle through flexible connections.

An object of the invention is to provide a pump of this character in which the pump displacement is varied by moving the axis of the driver toward and from the axis of the pintle and in which the driver is firmly supported to withstand the high lateral forces created upon the pressure side of the pump.

Another object is to provide a pump of this character having an electric motor secured thereto as an integral part thereof.

Another object is to provide a variable displacement pump in which flexible connections are not employed.

According to the invention in one of its aspects, the pump has its driver journaled in a cradle or carrier which is movable in a straight line transverse to the pintle axis and is firmly restrained from movement in all other directions, and a driving shaft movable with the cradle is fastened to the driver to drive the same from an external source of power.

According to the invention in another aspect, an electric motor has its shaft secured to or formed integral with the pump driving shaft and its stator carried by the pump casing and adapted to move thereon to change the stroke of the pump.

The invention is embodied in the pump illustrated in the accompanying drawings in which the views are as follows:

Fig. 1 is a side elevation of the pump, a part of the stroke changing mechanism arranged upon the front thereof being shown in section.

Fig. 2 is a central vertical section taken in the plane of the irregular line 2—2 of Fig. 1.

Fig. 3 is a sectional plan view of the pumping mechanism, taken on the line 3—3 of Fig. 2.

Fig. 4 is a sectional plan view taken on the line 4—4 of Fig. 2.

Fig. 5 is a sectional plan view taken on the line 5—5 of Fig. 2.

Fig. 6 is a vertical section taken on the line 6—6 of Fig. 4.

Fig. 7 is a vertical section taken on the line 7—7 of Fig. 2.

Fig. 8 is a diagram of the hydraulic circuit.

Fig. 9 is a detail view of a cylinder and piston assembly.

This pump has its mechanism arranged within and carried by a rectangular casing 1 having an opening 2 formed in the top thereof and closed by a slidable head 3 which constitutes the head of the casing 1 and the base of a vertical electric motor 4.

The casing 1 has a central boss or support 5 rigidly secured to or formed integral with its bottom wall and provided with two arms 6 and 7 which are connected to or formed integral with one of its side walls.

The support 5 has rigidly secured therein the enlarged lower end of a vertical pintle 8 which has two axial passageways 9 and 10 formed therein and communicating, respectively, at the lower ends thereof with two passageways 11 and 12 formed in the support 5 and in the arms 6 and 7.

The upper ends of the passageways 9 and 10 communicate, respectively, with two seg-

mental ports 13, and 14 which are formed in opposite sides of the pintle 8.

The upper part of the pintle 8 is tapered slightly, for instance .005" per inch of length, and has a cylinder barrel 15 fitted thereon and provided with a number of cylinders 16, for instance five cylinders, each of which has a port 17 formed in its inner end to communicate alternately with the ports 13 and 14 as the cylinder barrel 15 rotates.

Each cylinder 16 has a piston 18 fitted therein and provided with a crosshead 19 by means of which it is reciprocated.

As shown in Fig. 9, the piston 18 is hollow and connected to the crosshead 19 by a bolt 20 which has its head 21 formed integral with the crosshead 19 and provided with a spherical face to seat upon a complementary face formed in the end of the piston 18.

The bolt 20 extends substantially through the piston 18 and has its end provided with locknuts 22 to engage one end of a helical compression spring 23 which encircles the bolt 20 and has its other end in engagement with a shoulder 24 formed in the piston 18.

The spring 23 holds the piston 18 firmly against the head 21 and the complementary spherical faces thereon form a liquid-tight joint and allow the piston 18 to rock slightly upon the bolt 20.

The cylinder barrel 15 is rotated upon the pintle 8 and the pistons 18 are reciprocated in the cylinders 16 by a circular driver 25 which is fixed upon the lower end of the rotor shaft 26 of the motor 4 and has a vertical inner flange 27 provided with straight bearing faces 28 to engage the crosshead 19.

Each face 28 is arranged at a right angle to the axis of a cylinder 16 and provided at its center with an opening 29 through which the head 21 of the piston bolt 20 extends.

The crossheads 19 are held in contact with the faces 28 by roller bearings 30 arranged between the same and an equal number of segmental flanges 31 which are carried by the driver 25 at the periphery thereof and have suitable wearing plates inserted in their inner faces and arranged parallel to the corresponding faces 28.

When the driver 25 is rotated, the cylinder barrel 15 will be rotated and, if its axis is offset from the axis of the pintle 8, each piston 18 will be drawn outward during one-half of a revolution by its crosshead 19 riding upon the face 28 and will be forced inward during the other half of the revolution by its crosshead 19 bearing against the bearing 30 which is supported by the flange 31.

If the driver 25 is offset as shown in Fig. 3 and is rotating in a clockwise direction, each piston 18 will be drawn outward and draw liquid into its cylinder 16 during the time that its port 17 is in communication with the pintle port 14 and will be forced inward and expel liquid from its cylinder during the

time that its port 17 is in communication with the pintle port 13.

The pump thus draws liquid into its cylinders through the passageways 10 and 12 and exhausts liquid through the passageways 9 and 11. If the driver 25 is rotated in the opposite direction or if the axis of the driver is moved to the opposite side of the axis of the pintle, the pump will deliver liquid in the opposite direction.

The rotor shaft 26 is supported at its upper end by a ball thrust bearing 32 which is carried by the upper end plate of the motor 4, and the driver 25 has its hub arranged in an anti-friction bearing 33 which is carried by the head 3.

The pump is capable of delivering liquid at high working pressures, for instance 2500# per square inch, and high lateral forces are created upon the pressure side of the pump which would move the driver relatively to the pintle and decrease the stroke of the pump unless the driver and the pintle are positively held against lateral movement.

The pintle is held against movement by being embedded in the support 5 and the driver 25 is held against lateral movement relatively to the head 3 by the bearings 32 and 33.

The lateral forces are exerted upon the driver 25 at a point below the bearing 33 and, if the driver 25 was fixed upon a separate shaft which was connected to a prime mover by gears or otherwise, the upper end of that shaft would have to be supported in a bearing arranged at a considerable height above the bearing 33 in order to prevent those forces from rocking the shaft laterally in the bearing 33, thereby materially increasing both the height and the cost of the pump.

The head 3 is movable longitudinally of the casing 1 to vary pump displacement but is held against movement transversely thereof by two parallel guiding faces 34 which form opposite sides of the opening 2 and engage opposite sides of that part of the head 3 below the bottom flange or base 35 thereof which rests upon the top of the casing 1.

The head 3 is retained in position upon the casing 1 by four shouldered bolts 36 two of which are threaded into the casing 1 alongside each guiding face 34 and extend upward through slots 37 formed in the flange 35 and through a guide bar 38 which is held against the upper shoulders of the bolts 36 by nuts 39. The bolts 36 retain the head 3 in position upon the casing 1 but allow it to be moved longitudinally thereof.

Moving the head 3 longitudinally of the casing 1 moves the motor 4 and the driver 25 relatively to the pintle 8 and thereby varies pump displacement, and the slots 37 have sufficient length to allow the driver 25 to move to full stroke position in either direction from its central or neutral position.

The head 3 is moved longitudinally of the

casing 1 by a screw 40 which is secured to the front end thereof and extends through a bearing bracket 41 carried by the casing 1.

The screw 40 has a nut 42 threaded thereon and provided at its inner end with an annular flange 43 which is arranged between the bracket 41 and a thrust plate 44 attached thereto.

The nut 42 is rotated by a handwheel 45 which is fitted thereon and fixed in adjusted position by a locking wheel 46 threaded upon the screw 40.

When the locking wheel 46 is loosened and the handwheel 45 is rotated in one direction, the flange 43 presses against the bracket 41 and the head 3 is drawn forward and, when the handwheel 45 is rotated in the opposite direction, the flange 43 presses against the thrust plate 44 and the head 3 is forced rearward. After the stroke of the pump has been adjusted, the locking wheel 46 is tightened to hold the head 3 in adjusted position.

The pump is shown equipped for supplying liquid under pressure to a closed hydraulic circuit through which it circulates the liquid in either direction, depending upon the position of the driver 25 relatively to the axis of the pintle 8, and the pressure created by the pump is limited by either one of two high pressure relief valves 47 and 48 arranged in a valve box 49 which is secured to a side wall of the casing 1 and has two passageways extending therethrough and forming continuations of the passageways 11 and 12.

The valve box 49 has a vertical duct 50, which connects the passageway 11 with the inlet of the relief valve 47 and with the outlet of the relief valve 48, and a vertical passageway 51 which connects the passageway 12 with the inlet of the relief valve 48 and with the outlet of the relief valve 47.

If the pump is delivering liquid through the passageway 11, an excess of pressure in the circuit will open the valve 47 and allow liquid to return to the intake side of the pump through the passageway 12 and, if the pump is delivering liquid through the passageway 12, an excess of pressure in the circuit will open the valve 48 to allow liquid to return to the intake side of the pump through the passageway 11.

The pump is connected into a hydraulic circuit by means of two pipe connections 52 and 53 which are connected to the outer face of the valve box 49 in communication, respectively, with the passageways 11 and 12 and have the pipes 54 and 55 of the hydraulic circuit connected thereto.

The circuit is kept flooded at all times with liquid supplied by a gear pump 56 the case 57 of which is shown as being arranged within the casing 1 and secured thereto.

The pump case 56 has a pump chamber 58 formed therein and containing two inter-

meshing gears 59 and 60 which are carried, respectively, by two shafts 61 and 62 journaled in the case 57.

The shaft 61 has a driving gear 63 fixed to its upper end in mesh with a ring gear 64 carried by a hollow hub 65 which is secured to the bottom of the driver 25.

The sum of the diameters of the gears 63 and 64 is equal to several times the distance which the driver 25 is moved in changing it from zero to full stroke position so that moving the gear 64 the relatively short distance necessary to change pump displacement does not materially affect the meshing of the gears.

The pump chamber 58 has a suction pipe 66 connected thereto at one side of the gears 59 and 60 and depending into the bottom of the casing 1 which constitutes a sump or reservoir 67 for the storage of driving liquid.

The pump chamber 58 at the other side of the gears 59 and 60 communicates with a discharge duct 68 which is formed in the cap of the case 57 and has one end of a discharge pipe 69 connected to one of its ends and its other end connected to a low pressure relief valve 70 which is also arranged in the case 57 and limits the pressure created by the gear pump 56.

The discharge pipe 69 has its other end connected to the inlet end of a check valve 71 which is attached to one end of the valve box 49 and communicates with the passageway 12, and a branch pipe 72 has one of its ends connected to the pipe 69 intermediate the ends thereof and its other end connected to the inlet end of a check valve 73 which is attached to the other end of the valve box 49 and communicates with the passageway 11.

The gear pump 56 draws liquid from the reservoir 67 and delivers a sufficient quantity thereof to the discharge pipe 69 to maintain therein a pressure determined by the resistance of the relief valve 70.

A part of the liquid delivered by the gear pump 56 is employed in keeping the hydraulic circuit flooded and thereby maintaining the liquid in the return side thereof at gear pump pressure, and another part thereof may be employed for other auxiliary purposes, such as operating valves or other control apparatus to which it is delivered through a pipe 74 having one end thereof connected to the pipe 69. Liquid delivered by the gear pump in excess of these requirements is exhausted through the relief valve 70.

The invention herein set forth is susceptible of various modifications without departing from the scope thereof as hereafter claimed.

The invention is hereby claimed as follows:

1. A variable displacement pump, comprising a casing, a pintle arranged within

said casing and fixed in a stationary position therein, a cylinder barrel journaled upon said pintle and having pistons fitted in its cylinders, two parallel guides carried by said casing and extending transversely of said pintle upon opposite sides thereof, a sliding head closely fitted between said guides to slide transversely of said pintle and restrained by said guides from movement transversely of said guides, a driving shaft carried by said head and movable therewith, a driver connected to said shaft for rotating said cylinder barrel and reciprocating said pistons, and means for moving said head along said guides to move the axis of said driver toward and from the axis of said pintle to thereby change pump displacement.

2. A variable displacement pump, comprising a casing, a pintle arranged within said casing and fixed in a stationary position therein, a cylinder barrel journaled upon said pintle and having pistons fitted in its cylinders, two parallel guides carried by said casing and extending transversely of said pintle upon opposite sides thereof, a sliding head closely fitted between said guides to slide transversely of said pintle and restrained by said guides from movement transversely of said guides, a driver carried by said head for rotating said cylinder barrel and reciprocating said pistons, a prime mover carried by said head to move therewith and having a shaft connected to said driver for rotating the same, and means for moving said head along said guides to move the axis of said driver toward and from the axis of said pintle to thereby change pump displacement.

3. A variable displacement pump, comprising a casing, a pintle arranged within said casing and fixed in a stationary position therein, a cylinder barrel journaled upon said pintle and having pistons fitted in its cylinders, two parallel guides carried by said casing and extending transversely of said pintle upon opposite sides thereof, a sliding head closely fitted between said guides to slide transversely of said pintle and restrained by said guides from movement transversely of said guides, an electric motor carried by said head to move therewith and having its shaft extending therethrough, a driver fixed to said shaft for rotating said cylinder barrel and reciprocating said pistons, and means for moving said head along said guides to move the axis of said driver toward and from the axis of said pintle to thereby change pump displacement.

4. A variable displacement pump, comprising a casing, a pintle arranged within said casing and fixed in a stationary position therein, a cylinder barrel journaled upon said pintle and having pistons fitted in its cylinders, two parallel guides carried by said casing and extending transversely of said pintle

upon opposite sides thereof, a sliding head closely fitted between said guides to slide transversely of said pintle and restrained by said guides from movement transversely of said guides, a driving shaft carried by said head and movable therewith, a driver connected to said shaft for rotating said cylinder barrel and reciprocating said pistons, means for moving said head along said guides to move the axis of said driver toward and from the axis of said pintle to thereby change pump displacement, a gear pump for supplying liquid to said variable pump, a gear carried by said driver and rotatable therewith, and another gear meshing with said gear and connected to said gear pump to drive the same and providing with the other gear a combined pitch diameter sufficient to enable said gears to remain in mesh upon said driver being shifted to vary the displacement of said variable pump between zero and maximum.

5. A variable displacement pump, comprising a casing, a pintle arranged within said casing and fixed in a stationary position, therein, a cylinder barrel journaled upon said pintle and having pistons fitted in its cylinders, two parallel guides carried by said casing and extending transversely of said pintle upon opposite sides thereof, a sliding head closely fitted between said guides to slide transversely of said pintle and restrained by said guides from movement transversely of said guides, an electric motor carried by said head to move therewith and having its shaft extending therethrough, a driver fixed to said shaft for rotating said cylinder barrel and reciprocating said pistons, and means for moving said head along said guides to move the axis of said driver toward and from the axis of said pintle to thereby change pump displacement, a gear pump for supplying liquid to said variable pump, a gear carried by said driver and rotatable therewith, and another gear meshing with said gear and connected to said gear pump to drive the same and providing with the other gear a combined pitch diameter sufficient to enable said gears to remain in mesh upon said driver being shifted to vary the displacement of said variable pump between zero and maximum.

6. A variable displacement pump, comprising a casing, a pintle arranged vertically in a stationary position within said casing, a cylinder barrel journaled upon said pintle and having pistons fitted in its cylinders, two parallel guides carried by said casing upon the top thereof and extending transversely of said pintle upon opposite sides thereof, a head arranged upon the top of said casing and fitted between said guides to slide transversely of said pintle and restrained by said guides from movement transversely of said guides, an electric motor carried by said head, a driver driven by said motor for rotating said cylinder barrel and reciprocating

said pistons, and means for moving said head along said guides to move the axis of said driver toward and from the axis of said pintle to thereby change pump displacement.

5 7. A variable displacement pump, comprising a casing, a pintle arranged vertically in a stationary position within said casing, a cylinder barrel journaled upon said pintle and having pistons fitted in its cylinders, two
10 parallel guides carried by said casing upon the top thereof and extending transversely of said pintle upon opposite sides thereof, a head arranged upon the top of said casing and fitted between said guides to slide transversely
15 of said pintle and restrained by said guides from movement transversely of said guides, an electric motor carried by said head in a vertical position and having its lower bearing bracket formed integral therewith, a driver
20 driven by said motor for rotating said cylinder barrel and reciprocating said pistons, and means for moving said head along said guides to move the axis of said driver toward and from the axis of said pintle to thereby change
25 pump displacement.

8. A variable displacement pump, comprising a casing having an opening in its top, a pintle arranged vertically in a stationary position within said casing, a cylinder barrel
30 journaled upon said pintle and having pistons fitted in its cylinders, a head arranged upon the top of said casing to close said opening and guided for transverse movement by the edges thereof, an electric motor carried
35 by said head, a driver driven by said motor for rotating said cylinder barrel and reciprocating said pistons, and means for moving said head transversely of said casing to move the axis of said driver toward and from the
40 axis of said pintle to thereby change pump displacement.

9. A variable displacement pump, comprising a casing, a pintle arranged vertically in a stationary position within said casing, a cylinder barrel journaled upon said pintle and
45 having pistons fitted in its cylinders, two parallel guides carried by said casing upon the top thereof and extending transversely of said pintle upon opposite sides thereof, a head arranged upon the top of said casing and fitted between said guides to slide transversely
50 of said pintle and restrained by said guides from movement transversely of said guides, an electric motor carried by said head in a vertical position and having its lower bearing bracket formed integral therewith, a driver
55 fixed upon the shaft of said motor for rotating said cylinder barrel and reciprocating said pistons, and means for moving said head along said guides to move the axis of said driver toward and from the axis of said pintle to thereby change pump displacement.

10. A variable displacement pump, comprising a casing, a pintle arranged vertically
65 in a stationary position within said casing, a

cylinder barrel journaled upon said pintle and having pistons fitted in its cylinders, two parallel guides carried by said casing upon the top thereof and extending transversely
70 of said pintle upon opposite sides thereof, a head arranged upon the top of said casing fitted between said guides to slide transversely of said pintle and restrained by said guides from movement transversely of said guides,
75 an electric motor carried by said head in a vertical position and having its lower bearing bracket formed integral therewith, a driver fixed upon the shaft of said motor for rotating said cylinder barrel and reciprocating
80 said pistons, and means for moving said head along said guides to move the axis of said driver toward and from the axis of said pintle to thereby change pump displacement, a gear pump for supplying liquid to said variable pump, a gear carried by said driver and
85 rotatable therewith, and another gear meshing with said gear and connected to said gear pump to drive the same and providing with the other gear a combined pitch diameter sufficient to enable said gears to remain in mesh
90 upon said driver being shifted to vary the displacement of said variable pump between zero and maximum.

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