

April 19, 1949.

R. H. SHEPARD
HYDRAULIC PUMP

2,467,916

Filed Sept. 6, 1946

6 Sheets-Sheet 1

Fig. 1

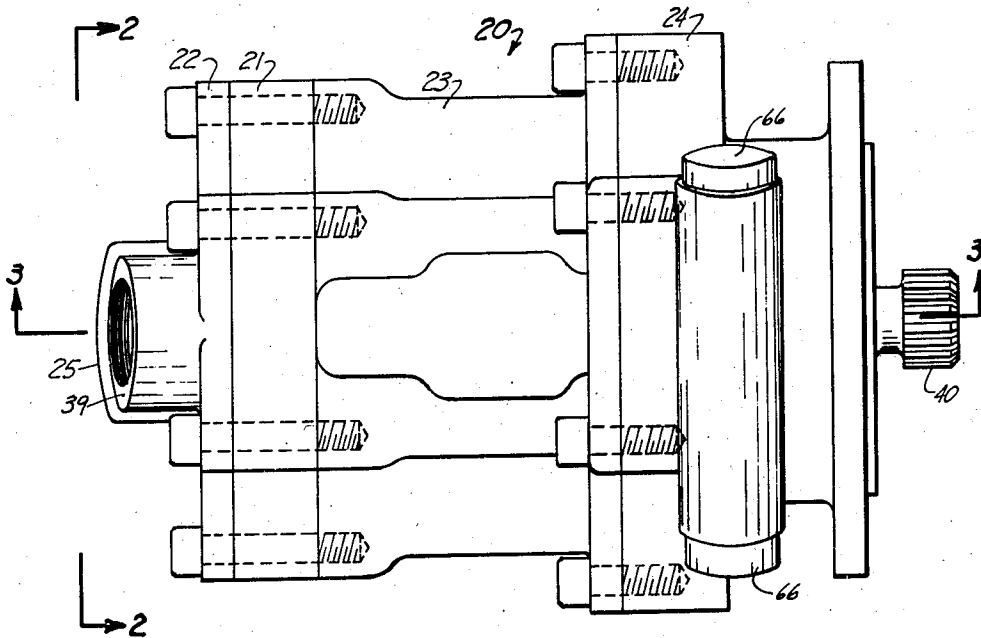
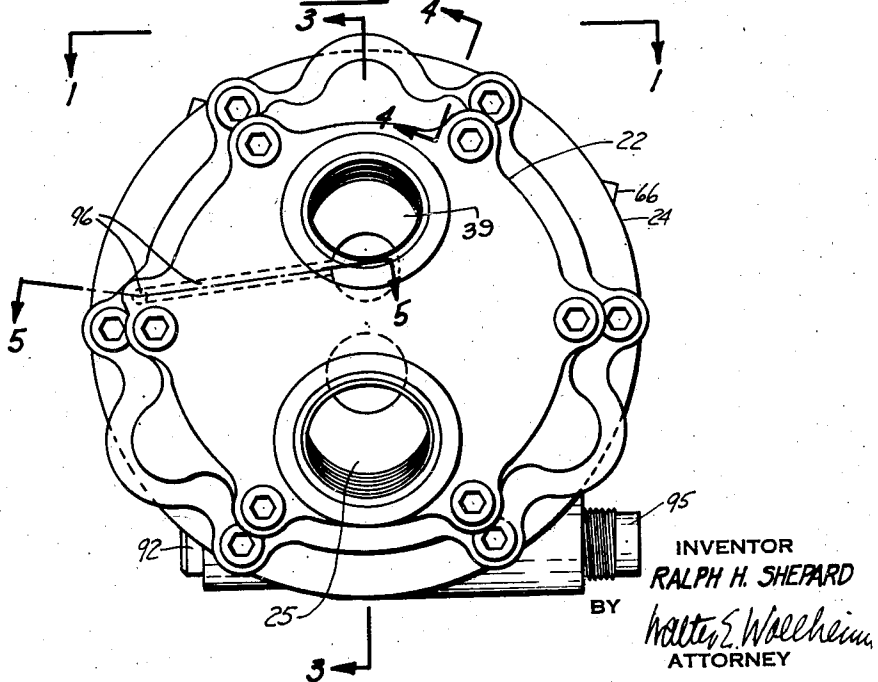


Fig. 2



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6 Sheets-Sheet 2

Fig. 3

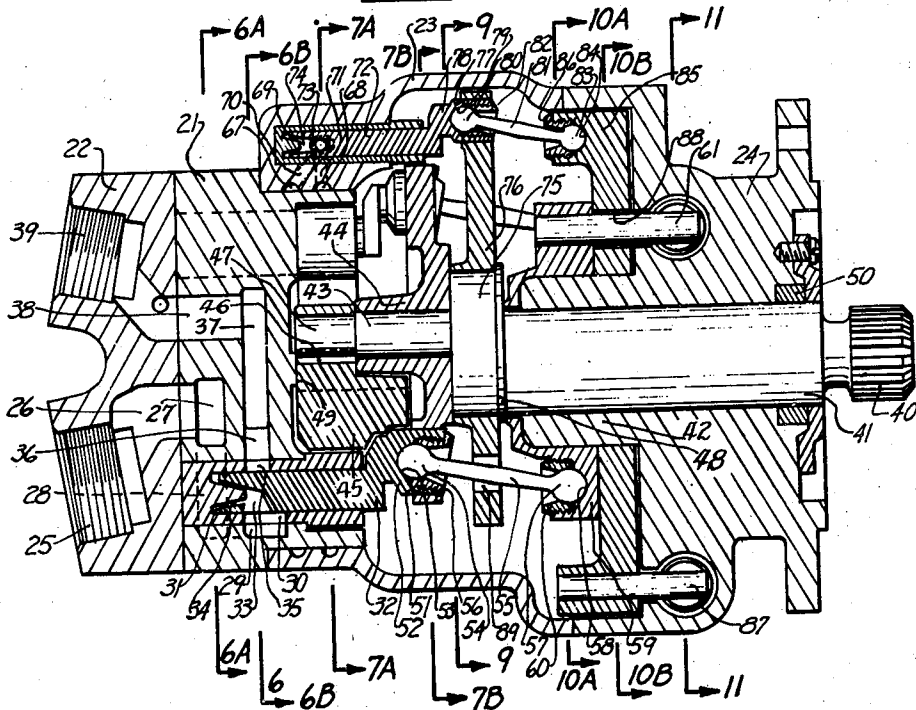


Fig. 4

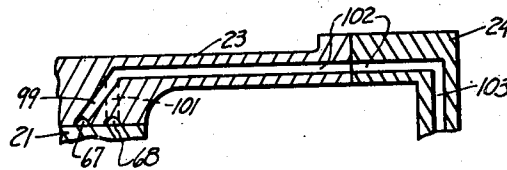
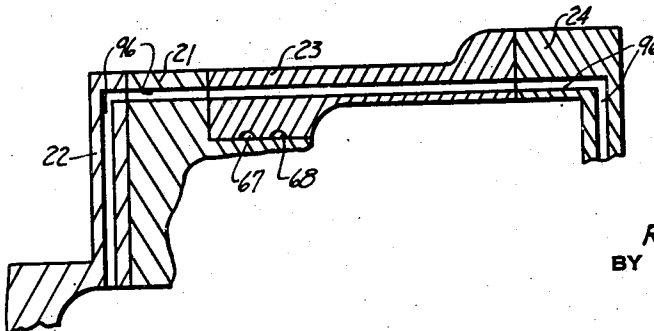


Fig. 5



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6 Sheets-Sheet 3

Fig. 6

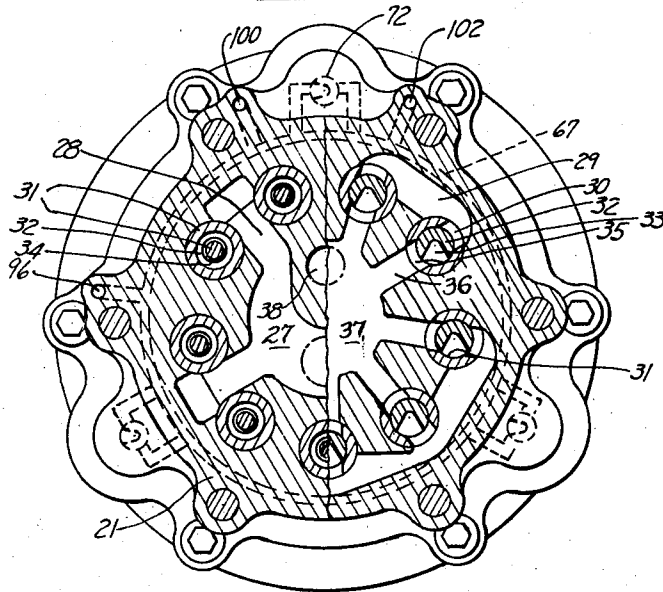


Fig. 7

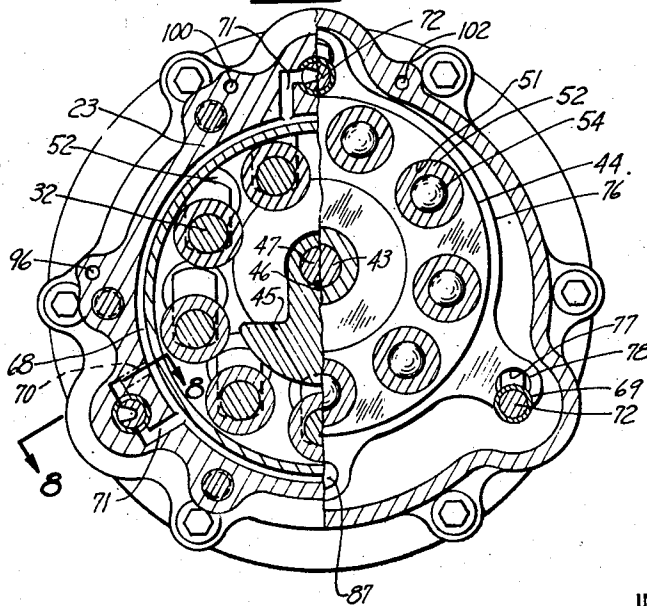
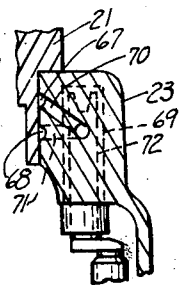


Fig. 8



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Fig. 9

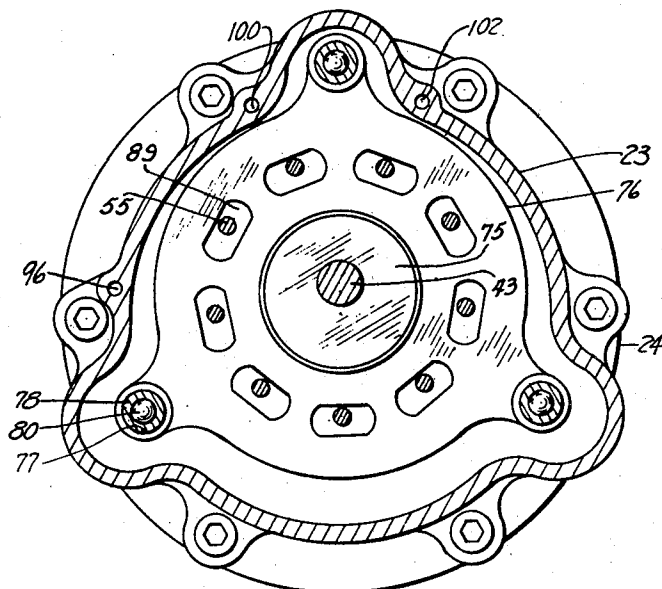
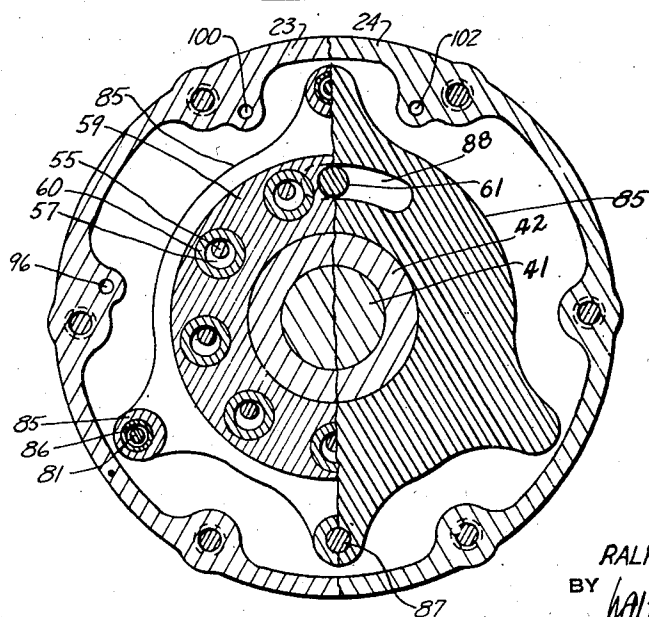


Fig. 10



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Fig. 11

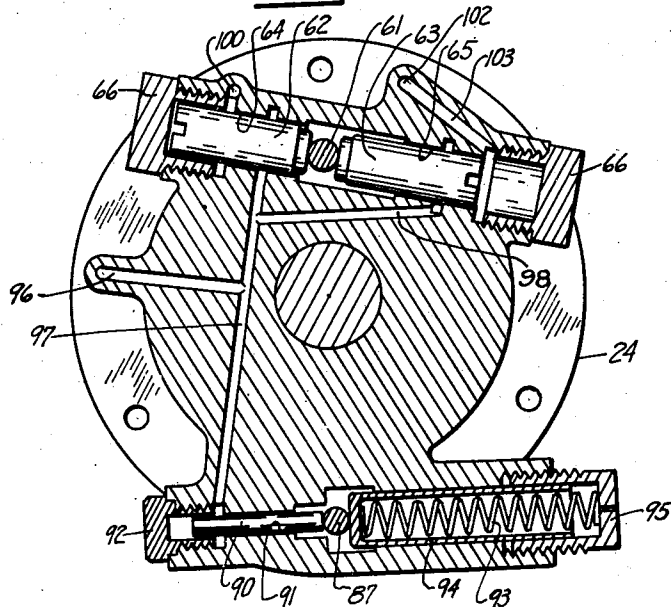


Fig. 12

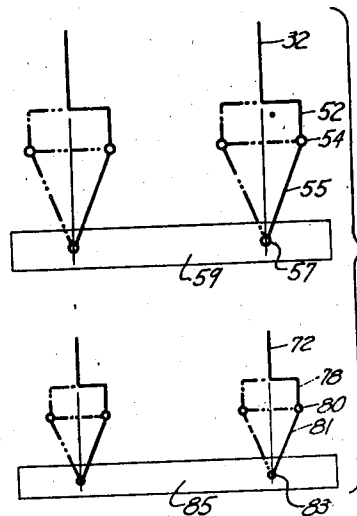
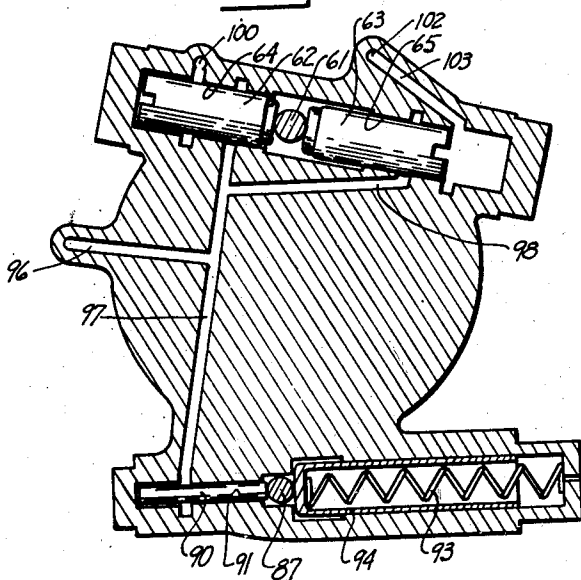


Fig. 13



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Fig. 14

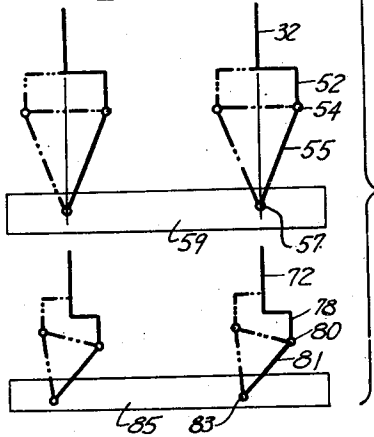


Fig. 16

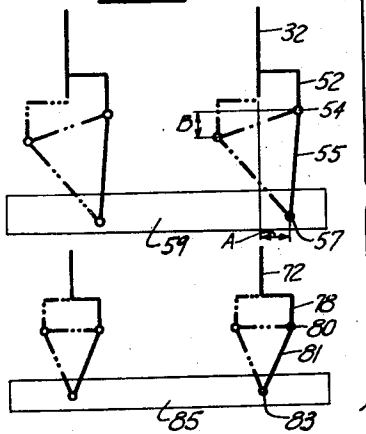


Fig. 18

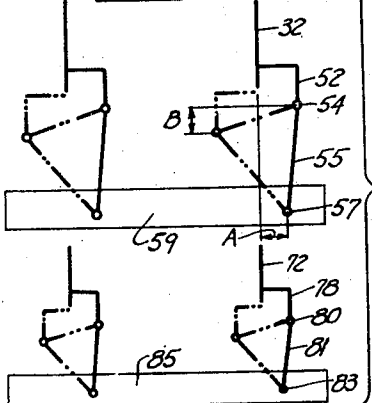


Fig. 15

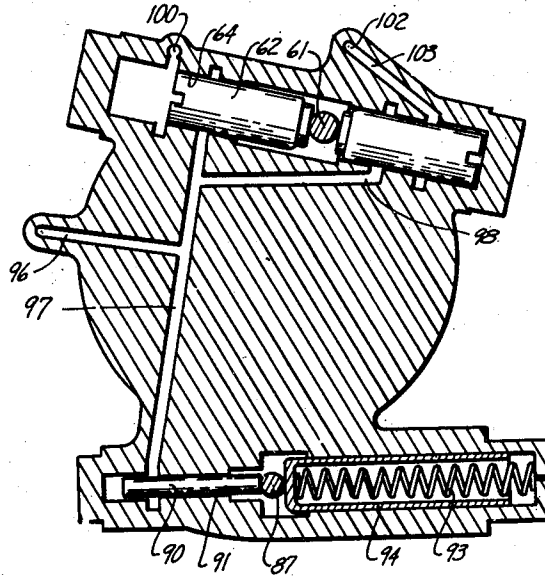
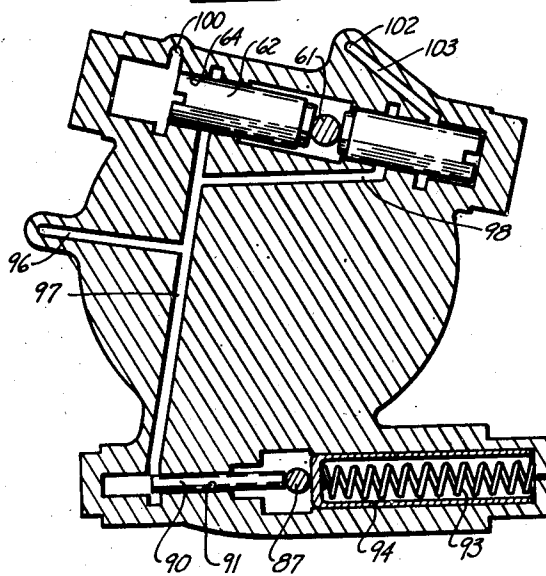


Fig. 17



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UNITED STATES PATENT OFFICE

2,467,916

HYDRAULIC PUMP

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Application September 6, 1946, Serial No. 695,125

11 Claims. (Cl. 103-4)

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This invention relates to hydraulic pumps of the type described in Folke Patent No. 2,369,345 issued on February 13, 1945, and has for its object certain improvements in such pumps.

The pump illustrated in the patent comprises a plurality of cylinders each fitted with a rotary and reciprocatory piston, each piston having an eccentric pivot universally coupled to a fixed pivot laterally displaced with reference to the piston axis, whereby rotation of the piston results in its reciprocation, the amplitude of which is a factor of the lateral displacement of the fixed pivot. Manual means are provided for adjusting the lateral displacement of each fixed pivot.

Application for patent, Serial No. 624,552 now Patent No. 2,430,394, granted Nov. 4, 1947, of which I am one of the joint inventors, discloses certain improvements in the patented pump. In accordance with the invention of that application all of the fixed pivots are mounted on a common movable member so that a single adjustment suffices for all, and means are provided, controlled by the discharge pressure of the pump, for automatically adjusting the lateral displacement of the fixed pivot or pivots to vary the piston stroke and thereby maintain a constant discharge pressure.

This present invention is a carrying forward of the improvements disclosed in application for patent, Serial No. 624,552. Thus, I have here provided in the pump a source of secondary fluid pressure for adjusting the lateral displacement of the fixed pivots to vary the piston strokes which in turn is controlled by the discharge pressure of the pump, and also optional means to make up automatically any loss in the pressure fluid from the fluid handled by the pump. The source of this secondary fluid pressure is preferably a secondary or regulating pump, similar in construction and operation to the primary pump except that it is reversible, the pressure of which adjusts the common movable member on which the primary fixed pivots are mounted, the piston stroke of the secondary pump being itself adjustable in response to the discharge pressure of the primary pump. The adjusting fluid operates against a working pressure only when required to change the adjustment. Other novel features will become apparent in the following specification.

In the drawings which illustrate a preferred embodiment of the invention,

Fig. 1 is a plan view of the pump assembly;

Fig. 2 is a left hand side view of the same showing in dotted lines certain passages important in the mechanism;

Fig. 3 is a longitudinal sectional view of the same along the plane of line 3-3 in Fig. 1;

Fig. 4 is a fragmentary sectional view along the plane of line 4-4 in Fig. 2;

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Fig. 5 is a fragmentary sectional view along the planes of line 5-5 in Fig. 2;

Fig. 6 is a cross sectional view, its left half along the plane of line 6a-6a in Fig. 3, and its right half along the plane of line 6b-6b in Fig. 3;

Fig. 7 is a cross sectional view, its left half along the plane of line 7a-7a in Fig. 3, and its right half along the plane of line 7b-7b in Fig. 3;

Fig. 8 is a fragmentary sectional view along the plane of line 8-8 in Fig. 7;

Fig. 9 is a cross sectional view along the plane of line 9-9 in Fig. 3;

Fig. 10 is a cross sectional view, its left half along the plane of line 10a-10a in Fig. 3, and its right half along the plane of line 10b-10b in Fig. 3;

Fig. 11 is a cross sectional view along the plane of line 11-11 in Fig. 3;

Fig. 12 is a diagrammatic view of the primary and secondary pump pistons in no-stroke or minimum positions, as shown in Fig. 11;

Fig. 13 is a cross sectional view, partly diagrammatic, similar to Fig. 11, but showing the mechanism in the initial position which it assumes when the discharge pressure of the pump is decreased;

Fig. 14 is a diagrammatic view of the mechanism conforming to Fig. 13;

Fig. 15 is a cross sectional view, partly diagrammatic, similar to Fig. 13, but showing the mechanism with the primary pump pistons operating at full stroke to reestablish the full discharge pressure, and the secondary pump pistons returned to no-stroke position;

Fig. 16 is a diagrammatic view of the mechanism conforming to Fig. 15;

Fig. 17 is a cross sectional view similar to Fig. 15, but showing the mechanism with the primary pump pistons still at full stroke and the secondary pump pistons operating so as to cause the former to reduce their strokes to prevent excessive discharge pressure; and

Fig. 18 is a diagrammatic view of the mechanism conforming to Fig. 17.

Like characters of reference denote similar parts throughout the various views and the following specification.

The primary pump illustrated is housed within a casing 20 comprising a pump cylinder block 21, a manifold 22, a body 23 and a base 24. The manifold 22 is provided with an inlet 25 supplying liquid through inlet passage 26, and passages 27, 28, 29 and 30 in the pump cylinder block 21 to annularly disposed cylinders 31, each fitted with a piston 32. Each piston 32 has an elongated transverse duct 33 connected with a longitudinal duct 34 in communication with the end of its cylinder and each is rotated and reciprocated in its cylinder in the manner described in U. S. Patent No. 2,369,345 and also as described later

in this specification, causing duct 33 to communicate alternately with inlet passage 30 and a discharge passage 35 which, through passages 36, 37 and 38 communicates with an outlet 39 in the manifold.

A suitable drive connection 40 rotates a crank shaft 41 supported in a bearing sleeve 42 forming part of the base 24. The crank shaft 41 is provided with a crank pin 43 on which a disk 44 is mounted. A counterbalance weight 45 is secured by means of a key 46 to an extension 47 of the crank pin 43. The crank shaft 41 is held in longitudinal alignment by means of a shoulder 48 on crank shaft 41 and a thrust face 49.

The crank shaft 41 is provided at its outer end with an oil seal 50 to prevent leakage of fluid around the end of the shaft.

By referring to Fig. 3, it will be noted that the disk 44 is provided with a number of spaced circular openings 51 which serve as bearings for off-set extensions or crank pins 52 of the pistons 32. The crank pins 52 are eccentrically located with respect to the pistons 32, and the eccentricity with respect to the pistons 32 is the same as the eccentricity of the crank pin 43 with respect to the crank shaft 41. Rotation of the crank shaft 41 therefore results in corresponding rotation of the pistons 32.

The outer end of crank pin 52 of each piston 32 is provided with a socket 53 which receives one ball 54 of a ball link 55 and serves as a pivot therefor. The ball 54 is movably secured in the socket 53 by means of a retainer 56. The retainer 56 is locked in place by suitable means (not shown). The ball link 55 is provided at its other end with a ball 57 likewise secured in a socket 58 of a regulating disk 59 by means of a retainer 60, the socket 58 serving as a fixed pivot for the link 55. The regulating disk 59 is rotatably supported on the bearing sleeve 42 and is provided with a pin 61.

Reference to Fig. 11 shows in the base 24, at substantially right angles to the longitudinal axis of the pump, plungers 62 and 63 slidably fitted within cylinders 64 and 65, respectively. Caps 66 serve to close cylinders 64 and 65. Pin 61 projects into the base 24 so as to be disposed between opposite inner ends of aligned plungers 62 and 63.

67 and 68 are semi-circular grooves in the inner bore of body 23 forming annular ducts between the body 23 and pump cylinder block 21. 69 are the cylinders of the secondary pump, annularly disposed in the body 23 and of somewhat smaller diameter than cylinders 31 in block 21. Each cylinder 69 communicates with duct 67 by an oblique passage 70 and by a straight passage 71 with duct 68. The passages 70 and 71 terminate in each cylinder at opposite walls and in the same plane. Each cylinder 69 is fitted with a piston 72 having an elongated transverse duct 73 connected with a longitudinal duct 74 in communication with the end of its cylinder and each is rotated and reciprocated as described later causing duct 73 to communicate alternately with passages 70 and 71 and their connecting grooves 67 and 68.

Crank shaft 41 is provided with an eccentric 75 intermediate its shoulder 48 and crank pin 43. A disk 76 is mounted on eccentric 75 and is provided with a number of spaced circular openings 77 which serve as bearings for offset extensions or crank pins 78 of the pistons 72. The crank pins 78 are eccentrically located with re-

spect to the pistons 72, and the eccentricity with respect to the pistons 72 is the same as the eccentricity of eccentric 75. Rotation of the crank shaft 41, and particularly the eccentric 75, therefore results in corresponding rotation of the pistons 72.

The outer end of crank pin 78 of each piston 72 is provided with a socket 79 which receives one ball 80 of a ball link 81 and serves as a pivot therefor. The ball 80 is movably secured in the socket 79 by means of a retainer 82. The ball link 81 is provided at its other end with a ball 83 likewise secured in a socket 84 of an adjusting disk 85 by means of a retainer 86, the socket 84 serving as a fixed pivot for the link 81. The adjusting disk 85 is rotatably supported on the base 24 and bearing sleeve 42 and is provided with a pin 87. Disk 85 is further provided with an arcuate slot 88 to clear pin 61 which projects through it in its various positions. Disk 76 has a number of similar slots 89 to clear ball links 55 projecting through it.

In the base 24, in substantially the same horizontal plane as plungers 62 and 63 but at the opposite side of the crank shaft 41, is a small piston 90 slidably disposed within a cylinder 91. A cap 92 closes an open end of the cylinder 91. Pin 87 is held in contact with an inner end of piston 90 by a spring 93 and a spring container or follower 94, preferably coaxially disposed with piston 90. A cap 95 serves as a stop for spring 93 and, being adjustable, regulates the tension of the spring, which in turn determines the discharge pressure, as I shall explain presently.

A duct 96 from the outlet in the manifold 22 runs through cylinder block 21, body 23 and into base 24 to a transverse duct 97, one end of which communicates with the outer end of cylinder 91, while its other end communicates with the side wall of cylinder 64 and a branch 98 of duct 97 communicates with the side wall of cylinder 65. Annular groove 67 by way of an oblique duct 99 and longitudinal duct 100 communicates with the outer end of cylinder 64, while annular groove 68 by way of a straight duct 101 and longitudinal duct 102 and transverse duct 103 communicates with the outer end of cylinder 65.

Referring now to Fig. 12, it will be noted that when the regulating disk 59 is turned into a position where the ball terminal 57 of the link 55 is in line with the center of piston 32, the rotation of the piston 32 as imparted to it by the disk 59, does not result in any reciprocating movement of the piston. On the other hand, referring to Fig. 16, it will be noted that when the disk 59 has been rotated a certain angle so that ball terminal 57 of the link 55 which serves as a universal coupling has been displaced a distance A from the center line of the piston 32, the piston will be reciprocated while it is being rotated. The amplitude of the reciprocation B is a function of the distance A. By turning the regulating disk 59, it will be seen therefore that the distance A may be varied to any desired amount and the stroke B of the pistons may also be regulated to any desired amount between zero and maximum.

The regulating disk 59 is turned by pressure exerted by plungers 62 and 63 against pin 61, as will be explained later.

Pistons 72 are rotated and reciprocated by eccentric 75, disk 76, ball link 81 in cooperation with adjusting disk 85, in a manner substantially the same as previously explained in reference to pistons 32, the disk 85 being turned by pressure

exerted by piston 90 and spring 93, as will be explained presently.

In assembling the pump, fluid is admitted into grooves 67 and 68, ducts 99, 100, 101, 102, 103, cylinders 64 and 65 which form substantially a closed system. If preferred, additional caps 66 may be provided to inject a fluid into this system after assembling and prevent air from being trapped in the system.

In Fig. 11, and in the diagram of Fig. 12, the pump is shown with both the primary pistons 32 and the secondary pistons 72 at no-stroke position when there is no consumption of fluid in the hydraulic line and the desired normal operating pressure is prevalent. In this position the operating pressure admitted through ducts 96 and 97 against one end of piston 90 is balanced by the force of spring 93 and pin 87 is in a no-stroke position, as shown in Fig. 12. Inasmuch as pin 87 is in a no-stroke position and pistons 72 do not operate, no fluid is pumped into or withdrawn from cylinders 64 and 65, and plungers 62 and 63 remain in whatever position they may be which, as illustrated, is that in which the pin 61 is also in a no-stroke position. Lateral displacement of the fixed pivots of either pump is necessary to its pumping action. When either the primary or secondary pistons are in no-stroke position, the lateral displacement of their fixed pivots is zero.

If the pressure in the hydraulic line should drop due to operating certain mechanisms, the pressure in ducts 96 and 97, which are in direct communication with the outlet of the pump in the manifold, decreases correspondingly. The greater force of the spring 93 then moves pin 87 toward the left, as indicated in Fig. 13, which causes the adjusting disk 85 to turn, the pistons 72 to reciprocate as well as rotate and to transfer fluid from the outer end of the cylinder 65 to the outer end of the cylinder 64, thereby causing the pin 61 to assume the position indicated in Fig. 15. The pin 61 has then turned regulating disk 59 and caused pistons 32 to reciprocate until the desired pressure has been reestablished. As soon as the pressure has been reestablished, this pressure overcomes the force of spring 93 and thus returns pin 87 of adjusting disk 85 to the no-stroke position shown in Figs. 15 and 16. In case the operating pressure in the hydraulic line is increased over the normal pressure owing to continuous pumping action and no operation of mechanisms, the increase in pressure forces pin 87 to the right against the force of the spring 93 as shown in Figs. 17 and 18 which causes the fluid from the outer end of plunger 62 to be transferred to the outer end of plunger 63 until the conditions are equalized and the primary and secondary pistons again assume no-stroke positions.

Attention is particularly drawn to the fact that the pistons 72 and their cooperating ducts 70 and 71 are so disposed that the pistons will pump in either direction so that the flow of fluid in the closed system is reversible. Suppose, for example, under the conditions of Fig. 14, one of the pistons 72 is rotating from the position indicated by broken lines to that indicated by solid lines. During this period the piston is being withdrawn from its cylinder 69. If the ducts 73 and 74 in this piston communicate with ducts 71, 68, 102 and 103 in the body and base at this time, fluid will be withdrawn through the latter and from the outer end of piston 63. Now suppose the conditions are changed so the pivot

83 is shifted to the opposite side of its no-stroke position, as in Fig. 18, and a piston 72 is again rotating in the same direction from the position shown by broken lines to that shown by solid lines. During this period the piston is now being driven into its cylinder 69 and, if the ducts 73 and 74 in the piston communicate with ducts 71, 68, 102 and 103 as before, fluid will be forced through the body and base ducts against the outer end of piston 63. Thus, by shifting the pivot 83 to the other side of its no-stroke position, the longitudinal movement of the piston is reversed during a given period of its rotation. In this manner, suction strokes are changed to delivery strokes and vice versa, and fluid flows through the closed system in the opposite direction.

Any slight loss of the fluid in the closed system will automatically be made up by slight leakage from ducts 97 and 98 past plungers 62 and 63 in cylinders 64 and 65, respectively, provided the same fluid is used in the pump and the closed system.

It is clearly evident that the secondary pistons 72 do not operate continuously against pressure, but operate only when necessary to transfer fluid in the closed system to adjust the strokes of the pumping pistons 32; furthermore, the pressure in the closed system need not be the same or as high as the pressure in the hydraulic line but need only be sufficient to operate this transfer.

While I have shown ducts 96 and 97, in communication with the outlet of the pump, permit fluctuations in pressure to be imparted to the piston 90 and so adjust by pin 87 the position of the disk 85, these ducts may be omitted and other means, entirely independent of the pump pressure, may be used for this purpose, such as thermostatic means, or other means responsive to operating variations.

The positions of the pins 87 and 61 and their associated parts are shown in their extreme positions in Figs. 13 through 18, but this is for illustrative purposes only. Actually, the movements would be much smaller. Thus, the moment the discharge pressure falls, spring 93 shifts the pin 87, which immediately causes the secondary pump to shift pin 61, which in turn starts the primary pump to bring back the discharge pressure to the predetermined point. But this pressure will overshoot the mark if the primary pump continues to operate, and this in its turn shifts pin 87, compresses spring 93 and moves the fixed pivots of the secondary pump to the other side of alignment with their piston axes, thereby reversing the action of the secondary pump, which tends to return pin 61 to its no-stroke position.

When a pump of this character is used to maintain a constant pressure in a system from which various mechanisms are operated, the no-stroke position is the norm to which both primary and secondary pistons are automatically returned. However, if the pump were constantly delivering fluid at a constant pressure, the norm for the primary pistons would be some other position and the length of stroke of the primary pistons would vary above and below that necessary to maintain the given discharge pressure, never reaching the no-stroke position.

Many changes in the form, proportion, combination of parts and minor details of construction may be resorted to without departing from the principles or sacrificing any of the advantages of the invention, as defined in the appended claims.

What I claim as new, is:

1. A pump comprising a cylinder having inlet and discharge passages, a rotary and reciprocatory piston in the cylinder having means for alternately placing the inlet and discharge passages in communication with the cylinder as the piston rotates, an eccentric pivot carried by the piston, a fixed pivot laterally displaced with reference to the piston axis, a universal coupling between the pivots, means for rotating and thereby reciprocating the piston, a source of secondary fluid pressure for adjusting the lateral displacement of the fixed pivot to regulate the stroke of the piston, and means controlled by the discharge pressure of the pump for controlling the secondary fluid pressure.

2. A pump comprising a cylinder having inlet and discharge passages, a rotary and reciprocatory piston in the cylinder having means for alternately placing the inlet and discharge passages in communication with the cylinder as the piston rotates, an eccentric pivot carried by the piston, a fixed pivot laterally displaced with reference to the piston axis, a universal coupling between the pivots, means for rotating and thereby reciprocating the piston, a source of secondary fluid pressure for automatically adjusting the lateral displacement of the fixed pivot to regulate the stroke of the piston, and means controlled by the discharge pressure of the pump for automatically controlling the secondary fluid pressure.

3. A pump comprising a cylinder having inlet and discharge passages, a rotary and reciprocatory piston in the cylinder having means for alternately placing the inlet and discharge passages in communication with the cylinder as the piston rotates, an eccentric pivot carried by the piston, a fixed pivot laterally displaced with reference to the piston axis, a universal coupling between the pivots, means for rotating and thereby reciprocating the piston, a source of secondary fluid pressure for adjusting the lateral displacement of the fixed pivot to regulate the stroke of the piston, means controlled by the discharge pressure of the pump for controlling the secondary fluid pressure, and means for making up any loss in the secondary pressure fluid from the fluid handled by the pump.

4. A pump comprising a cylinder having inlet and discharge passages, a rotary and reciprocatory piston in the cylinder having means for alternately placing the inlet and discharge passages in communication with the cylinder as the piston rotates, an eccentric pivot carried by the piston, a fixed pivot laterally displaced with reference to the piston axis, a universal coupling between the pivots, means for rotating and thereby reciprocating the piston, a secondary pump for creating a fluid pressure for adjusting the lateral displacement of the fixed pivot to regulate the stroke of the piston, and means controlled by the discharge pressure of the primary pump for regulating the discharge of the secondary pump.

5. A pump comprising a cylinder having inlet and discharge passages, a rotary and reciprocatory piston in the cylinder having means for alternately placing the inlet and discharge passages in communication with the cylinder as the piston rotates, an eccentric pivot carried by the piston, a fixed pivot laterally displaced with reference to the piston axis, a universal coupling between the pivots, means for rotating and thereby reciprocating the piston, a reversible secondary pump for creating a fluid pressure for adjusting the lateral displacement of the fixed

pivot to regulate the stroke of the piston, and means controlled by the discharge pressure of the primary pump for regulating the discharge of the secondary pump.

6. A pump comprising a cylinder having inlet and discharge passages, a rotary and reciprocatory piston in the cylinder having means for alternately placing the inlet and discharge passages in communication with the cylinder as the piston rotates, an eccentric pivot carried by the piston, a fixed pivot laterally displaced with reference to the piston axis, a universal coupling between the pivots, means for rotating and thereby reciprocating the piston, a secondary pump for creating a fluid pressure, the secondary pump comprising a cylinder having inlet and discharge passages, a rotary and reciprocatory piston in the cylinder having means for alternately placing the inlet and discharge passages in communication with the cylinder as the piston rotates, an eccentric pivot carried by the piston, a fixed pivot laterally displaced with reference to the piston axis, a universal coupling between the pivots, and means for rotating and thereby reciprocating the piston, means controlled by the discharge pressure of the primary pump for adjusting the lateral displacement of the fixed pivot of the secondary pump to regulate the stroke of its piston and thus determine the fluid pressure created, and means controlled by the pressure of the secondary pump for adjusting the lateral displacement of the fixed pivot of the primary pump to regulate the stroke of the piston of the primary pump.

7. A pump comprising a cylinder having inlet and discharge passages, a rotary and reciprocatory piston in the cylinder having means for alternately placing the inlet and discharge passages in communication with the cylinder as the piston rotates, an eccentric pivot carried by the piston, a fixed pivot laterally displaced with reference to the piston axis, a universal coupling between the pivots, means for rotating and thereby reciprocating the piston, a reversible secondary pump for creating a fluid pressure, the secondary pump comprising a cylinder having inlet and discharge passages, a rotary and reciprocatory piston in the cylinder having means for alternately placing the inlet and discharge passages in communication with the cylinder as the piston rotates, an eccentric pivot carried by the piston, a fixed pivot laterally displaced with reference to the piston axis, a universal coupling between the pivots, and means for rotating and thereby reciprocating the piston, means controlled by the discharge pressure of the primary pump for adjusting the lateral displacement of the fixed pivot of the secondary pump to either side of alignment with its piston axis and thus regulate the stroke of its piston and determine the amount and direction of the fluid pressure created, and means controlled by the pressure of the secondary pump for adjusting the lateral displacement of the fixed pivot of the primary pump to regulate the stroke of the piston of the primary pump.

8. A pump comprising a casing having an inlet and an outlet, a plurality of cylinders, each cylinder having an inlet passage in communication with the inlet and a discharge passage in communication with the outlet, a rotary and reciprocatory piston in each cylinder having means for alternately placing said inlet passage and said discharge passage in communication with the cylinder as the piston rotates, an eccentric pivot car-

ried by each piston, a fixed pivot for each piston laterally displaced with reference to the piston axis, a universal coupling between each fixed and eccentric pivot, means for rotating and thereby reciprocating the pistons, a source of secondary fluid pressure for simultaneously adjusting the lateral displacement of all the fixed pivots to regulate the stroke of the pistons, and means controlled by the discharge pressure of the pump for controlling the secondary fluid pressure.

9. A pump comprising a casing having an inlet and an outlet, a plurality of cylinders, each cylinder having an inlet passage in communication with the inlet and a discharge passage in communication with the outlet, a rotary and reciprocatory piston in each cylinder having means for alternately placing said inlet passage and said discharge passage in communication with the cylinder as the piston rotates, an eccentric pivot carried by each piston, a fixed pivot for each piston laterally displaced with reference to the piston axis, a universal coupling between each fixed and eccentric pivot, means for rotating and thereby reciprocating the pistons, a secondary pump for creating a fluid pressure for simultaneously adjusting the lateral displacement of all the fixed pivots to regulate the stroke of the pistons, and means controlled by the discharge pressure of the primary pump for regulating the operation of the secondary pump.

10. A pump comprising a casing having an inlet and an outlet, a plurality of annularly arranged cylinders, each cylinder having an inlet passage in communication with the inlet and a discharge passage in communication with the outlet, a rotary and reciprocatory piston in each cylinder having means for alternately placing the inlet and discharge passages in communication with the cylinder as the piston rotates, an eccentric pivot carried by each piston, a rotary disk, a plurality of annularly arranged fixed pivots on the disk corresponding in number to the cylinders, a universal coupling between each eccentric pivot and a fixed pivot, means for rotating and thereby reciprocating the pistons, a secondary pump for creating a fluid pressure, the secondary pump comprising a plurality of annularly arranged cylinders, each cylinder having inlet, and discharge passages, a rotary and reciprocatory piston in each cylinder having means for alternately placing the inlet and discharge passages in communication with the cylinder as the piston rotates, an eccentric pivot carried by each piston, a rotary disk, a plurality of annularly arranged fixed pivots on the disk corresponding in number to the cylinders, a universal coupling between each eccentric pivot and a fixed pivot, and means for rotating and thus reciprocating the pistons, means controlled by the discharge pressure of the

primary pump for automatically turning the disk of the secondary pump to adjust the lateral displacement of the fixed pivots of the secondary pump with reference to their corresponding piston axes and thus regulate the stroke of its pistons and determine the fluid pressure created, and means controlled by the pressure of the secondary pump for turning the disk of the primary pump to adjust the lateral displacement of the fixed pivots of the primary pump with reference to their corresponding piston axes and thus regulate the stroke of the pistons and maintain a constant discharge pressure.

11. A pump comprising a casing having an inlet and an outlet, a plurality of annularly arranged cylinders, each cylinder having an inlet passage in communication with the inlet and a discharge passage in communication with the outlet, a rotary and reciprocatory piston in each cylinder having means for alternately placing the inlet and discharge passages in communication with the cylinder as the piston rotates, an eccentric pivot carried by each piston, a rotary disk, a plurality of annularly arranged fixed pivots on the disk corresponding in number to the cylinders, a universal coupling between each eccentric pivot and a fixed pivot, means for rotating and thereby reciprocating the pistons, a reversible secondary pump for creating a fluid pressure, the secondary pump comprising a plurality of annularly arranged cylinders, each cylinder having inlet, and discharge passages, a rotary and reciprocatory piston in each cylinder having means for alternately placing the inlet and discharge passages in communication with the cylinder as the piston rotates, an eccentric pivot carried by each piston, a rotary disk, a plurality of annularly arranged fixed pivots on the disk corresponding in number to the cylinders, a universal coupling between each eccentric pivot and a fixed pivot, and means for rotating and thus reciprocating the pistons, means controlled by the discharge pressure of the primary pump for automatically turning the disk of the secondary pump to adjust the lateral displacement of the fixed pivots of the secondary pump to either side of alignment with their corresponding piston axes and thus regulate the stroke of its pistons and determine the amount and direction of the fluid pressure created, and means controlled by the pressure of the secondary pump for turning the disk of the primary pump to adjust the lateral displacement of the fixed pivots of the primary pump with reference to their corresponding piston axes and thus regulate the stroke of the pistons and maintain a constant discharge pressure.

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No references cited.