Jan. 16, 1940. A. E. HAMBLY 2,186,970

PUMPING APPARATUS

Filed July 18, 1938 3 Sheets-Sheet 1

Fig. 1

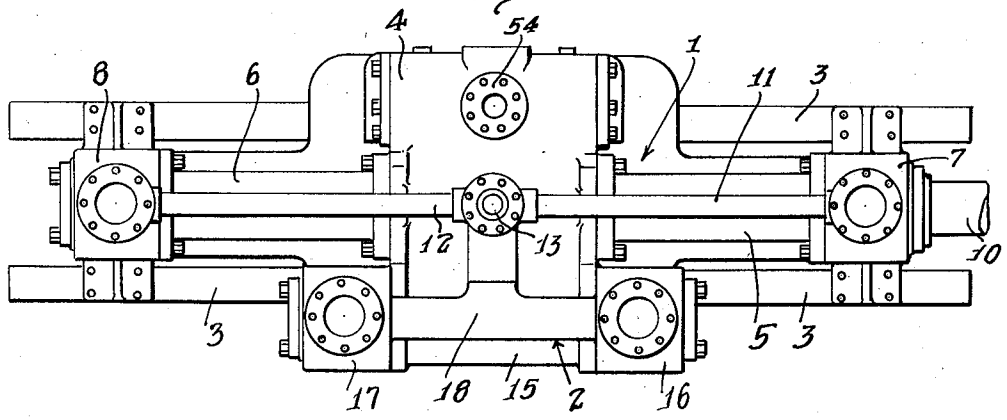


Fig. 2

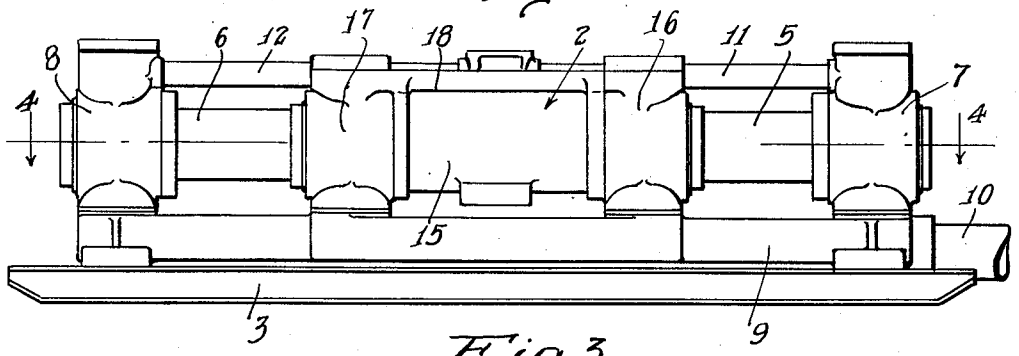
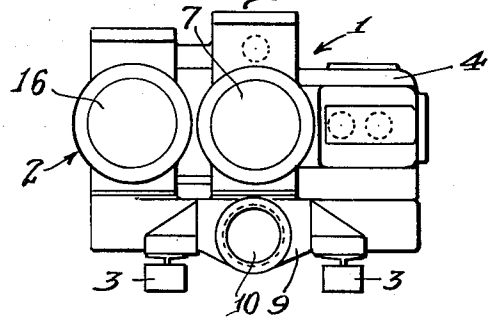


Fig. 3



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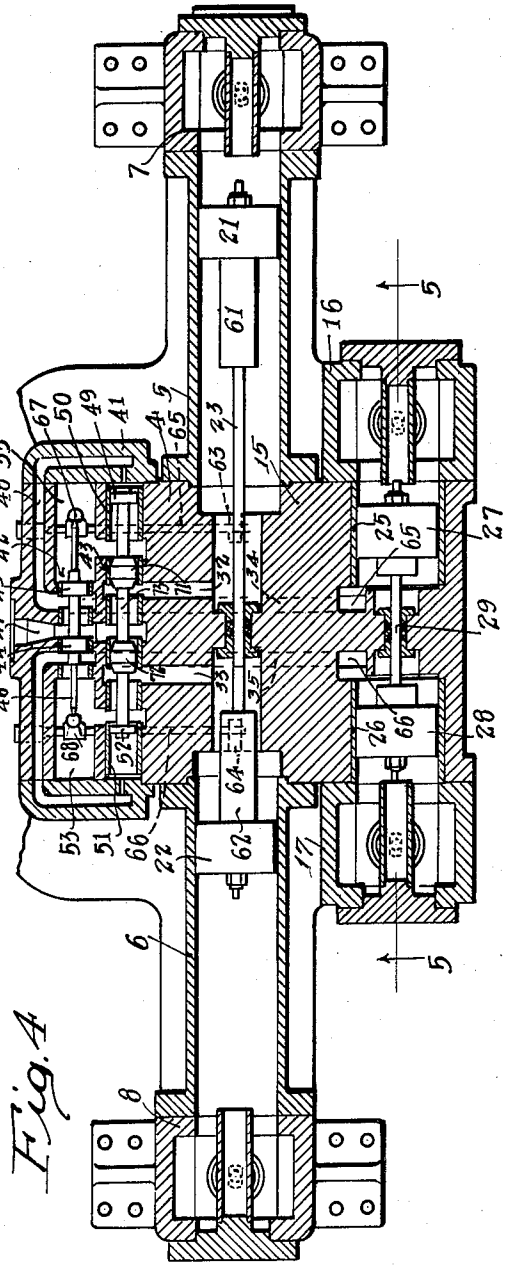


Fig. 4

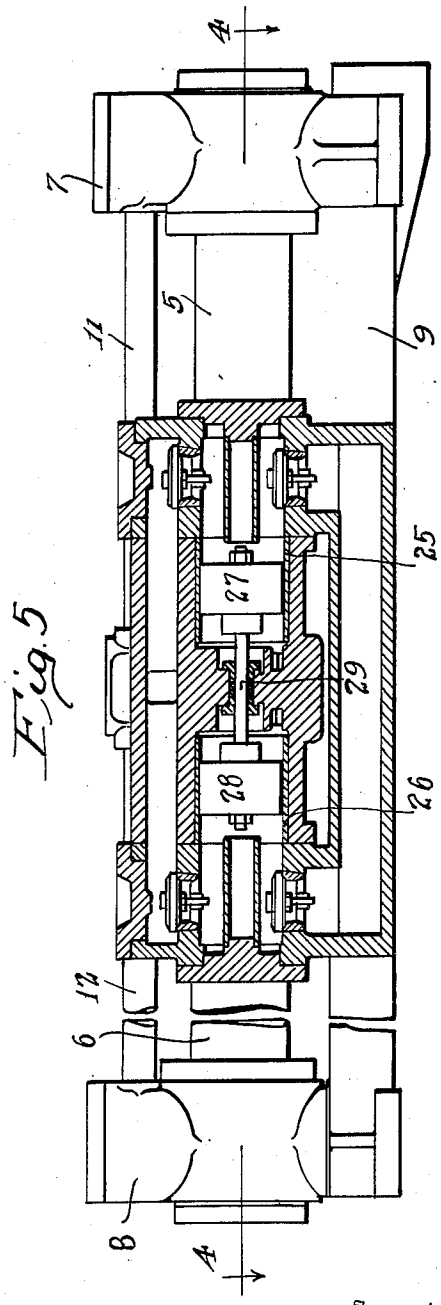


Fig. 5

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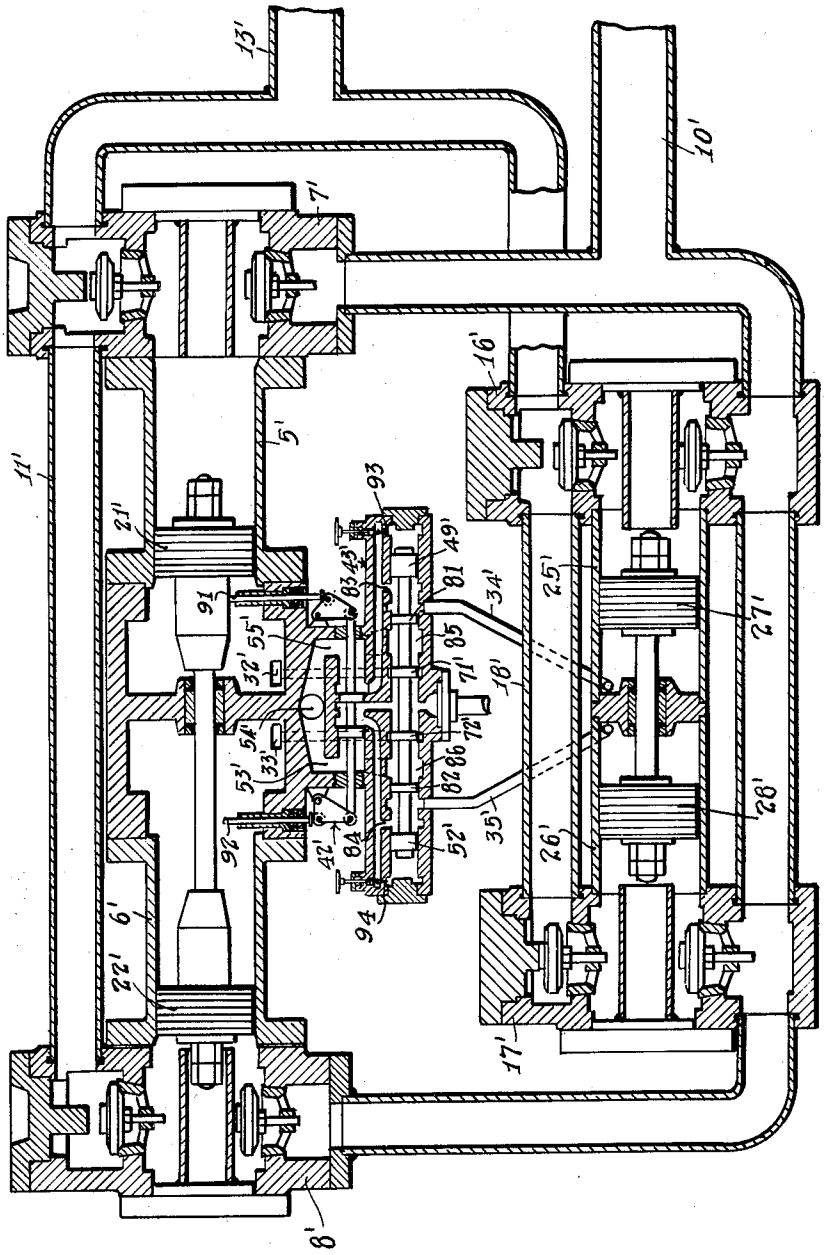
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Fig. 6



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UNITED STATES PATENT OFFICE

2,186,970

PUMPING APPARATUS

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Application July 18, 1938, Serial No. 219,800

10 Claims. (Cl. 103—52)

This invention relates to hydraulically-actuated piston pumps, and particularly to a duplex hydraulic pump having a long stroke piston and a short stroke piston.

In the copending application of Waldemar F. Mayer, for Duplex hydraulic pump, Ser. No. 219,802, filed July 18, 1938, there is disclosed a duplex, double-acting hydraulic piston pump wherein the motive liquid is applied successively to one side of each of a plurality of pistons to cause reciprocation thereof in their respective cylinders The pistons are mechanically connected in pairs whereby the pumping stroke of one piston effects the suction stroke of the other piston connected thereto. The supply of motive liquid alternately to each of the pistons of each pair is controlled by the movement of the other pair of pistons, one pair being idle during the major portion of the stroke of the other pair. In order to reduce the idle periods as far as possible, the stroke of one pair of pistons is made relatively short, of only sufficient length to continue the pumping action during the reversal of the other, relatively long stroke piston.

A principal object of this invention is to provide a pump of the general character described above, in which the reversals of both pairs of pistons is effected by the movements of the long stroke pistons.

A further object is to provide in such a pump an arrangement whereby motive liquid is supplied to the short stroke pistons only during reversal of the long stroke pistons.

Other objects will be apparent from the following description, taken in conjunction with the accompanying drawings, wherein two embodiments of the invention are illustrated.

In the drawings:

Fig. 1 is a plan view of a pump constructed in accordance with this invention;

Fig. 2 is a side elevation thereof;

Fig. 3 is an end view thereof, as seen from the right of Fig. 1;

Fig. 4 is a horizontal section through the pump, taken on line 4—4 of Fig. 2;

Fig. 5 is a longitudinal vertical section through the short stroke unit, taken on line 5—5 of Fig. 4; and

Fig. 6 is a schematic assembly view illustrating a modified valve arrangement.

Referring to the drawings, the pump comprises generally a long stroke unit 1 and a short stroke unit 2 mounted on a base 3. A central body 4 houses the valve assembly and the motive liquid distributing passages. Secured to opposite sides of the central body are main cylinders 5 and 6. Valve chambers 7 and 8 are secured to the outer ends of the cylinders, and house suction and discharge valves for pump liquid. A suction header 9 extends longitudinally beneath the main cylinders, and has connection at one end, as at 10, with a source of liquid to be pumped. The suction side of each of the valve chambers 7 and 8 communicates with the header 10. Discharge conduits 11 and 12 extend from the discharge side of the valve chambers to a common outlet 13.

The cylinders of the short stroke unit 2 are formed in a lateral extension 15 of the central body 4, and valve chambers 16 and 17 similar to those on the main cylinders are secured to opposite ends of the auxiliary cylinders. These valve chambers are also in valved communication with the suction header 9 and with the common discharge outlet 13, the latter connection being by means of a T-shaped connection 18 formed integral with the central body.

Referring now to Figs. 4 and 5, a pair of pistons 21 and 22 are reciprocable in cylinders 5 and 6 respectively, and are connected to opposite ends of a piston rod 23 extending through a partition in the central body in fluid-tight relation thereto. As previously stated, the cylinders of the short-stroke unit, or auxiliary cylinders as they will be referred to hereinafter, are formed in the central body 4, and are designated 25 and 26. Auxiliary pistons 27 and 28 are reciprocable in the cylinders 25 and 26, and are connected by a piston rod 29. The auxiliary cylinders and pistons are of the same diameter as the main pistons so as to have the same displacement for a given piston speed, but the stroke of the former is much shorter, being only sufficient to permit one of the auxiliary pistons to pump during the reversal of the main pistons.

Extending transversely of the central body are four fluid passageways 32, 33, 34, and 35 communicating at one end with the inner ends of the cylinders 5, 6, 25, and 26, respectively. Motive liquid is alternately admitted to passageways 32 and 33 to reciprocate the pistons 21, 22, the spent liquid being exhausted through the same passageways during the return strokes.

During reversal of the main pistons motive liquid is admitted to one of the auxiliary cylinders through one passageway 34 or 35 and spent liquid is discharged through the other.

The valve mechanism for controlling the flow of motive liquid through the passageways 32, 33, 34, and 35 is enclosed in a valve housing 41 secured to the central body. Reciprocable in parallel bores in the housing are a pilot valve 42 and a hy-

draulically-actuated main valve 43. The pilot valve comprises a pair of sliding valves 44 and 45 secured to a common valve stem 46 and shiftable thereby between two positions. When in the position shown in Fig. 4, motive liquid under pressure is admitted from an inlet 47 to passageway 34 leading to auxiliary cylinder 25, and also to a passageway 48 leading to the outer face of a shuttle piston 49 secured to the main valve 43 and reciprocable in shuttle cylinder 50, whereby the latter is moved to the left. At the same time, liquid is exhausted from auxiliary cylinder 26 and from the left-hand shuttle cylinder 51, to release the pressure from shuttle piston 52, to a discharge chamber 53 whence it is conducted back to the source of motive liquid through an outlet 54 (Fig. 1). The valve 44 separates the pressure liquid inlet 47 from the discharge chamber 53, and the valve 45 separates the inlet from the right-hand discharge chamber 55. When the pilot valve is shifted to the left all of the above conditions are reversed.

The pilot valve is alternately shifted from one side to the other as the main pistons 21 and 22 approach the end of their stroke. Sleeves 61 and 62 are secured to the inner sides of the pistons, and engage actuating fingers 63 and 64 as they approach the inner end of their stroke. The fingers are secured respectively to the inner ends of rocker shafts 65 and 66 journaled in the central body and the valve housing. The outer ends of the pilot valve stem 46 are operatively connected to the rocker shafts by levers 67, 68, whereby oscillation of the shafts causes reciprocation of the pilot valve.

The main valve 43 comprises a pair of sliding valves 71 and 72 secured to a common valve stem 73 to the outer ends of which the shuttle pistons 49 and 52 are secured. In the position shown in Fig. 4, the valve 71 admits motive liquid under pressure from the inlet 47 to passageway 32 leading to cylinder 5, while valve 72 exhausts spent motive liquid from cylinder 6 to the discharge passage 53. As depicted in Fig. 4, the main valve is being moved to the left by pressure liquid admitted through passageway 48 and acting on shuttle piston 49. When the valves 71 and 72 have moved to the left of passageways 32 and 33, respectively, motive liquid will then be admitted to passageway 33 and cylinder 6 to cause the main pistons 21 and 22 to move to the left. Spent motive liquid in cylinder 5 will then be forced by piston 21 out through passageway 32 to the discharge chamber 55.

It will be understood that after the auxiliary pistons have completed their stroke they will remain at rest during the stroke of the main pistons, and during the next reversal of the latter the auxiliary pistons will move in the opposite direction.

It is believed that the operation of this form of the invention will be apparent from the foregoing description.

Referring now to the modification shown in Fig. 6, it will be understood that the pumping units have been illustrated schematically to facilitate comprehension of the novel features, and that structurally the pump may be embodied in a design similar to that of Figs. 1 to 4. The only difference between this modification and the form described above is with respect to the valve mechanism. Whereas in the first form motive liquid is admitted to the auxiliary cylinders directly from the pilot valve, in the modificatitn to be described the admission of motive liquid to the auxiliary cylinders is controlled by shuttle valves formed on the main valve stem.

In the following brief description of the pump as a whole, primed reference characters are used to designate those elements which are similar to corresponding elements in the form previously described. The main pistons 21' and 22' are reciprocable in cylinders 5' and 6' to the outer ends of which are secured valve chambers 7' and 8'. Similarly, auxiliary pistons 27' and 28' are reciprocable in cylinders 25' and 26' to which are secured valve chambers 16' and 17'. A pump liquid suction inlet 10' has connection with the suction side of each of the four valve chambers, while the discharge sides of the chambers are connected to a common discharge outlet 13' through the discharge conduits 11' and 18'.

Motive liquid is admitted to and discharged from both the main cylinders and the auxiliary cylinders in the same sequence as in the previously described form, under the control of a pilot valve 42' and a main valve 43'. Fluid passageways 32' and 33' lead from the main valve to the main cylinders 5' and 6', and passageways 34' and 35' lead to the auxiliary cylinders 25' and 26' from the main valve, instead of from the pilot valve as in the first form. In this form the pilot valve controls only the alternate application of motive liquid under pressure to the shuttle pistons 49' and 52' at opposite ends of the main valve 43'.

In addition to the main valve members 71' and 72', corresponding functionally to valves 71 and 72 of Fig. 4, an additional pair of shuttle valves 81 and 82 is provided to control the flow of motive liquid to and from the auxiliary cylinders. Branching from the passageways 48' and 58' leading from the pilot valve to the shuttle pistons 49' and 52' are a pair of branch ports 83 and 84. Discharge ports 85 and 86 lead from the main valve bore to the discharge chambers 53' and 55'.

The relative spacing of the shuttle valves 71', 72', 81 and 82 and of the shuttle pistons 49' and 52' with respect to the ports 32', 33', 34', 35', 83, 84, 85, and 86 is such that during the stroke of the main pistons to the right, the main valve 43' is at the extreme right and the shuttle piston 52' closes port 84 and valve 82 is disposed centrally of the wide port 86, whereby pressure liquid is excluded from the auxiliary cylinder 26' and the latter is open to the discharge chamber 53'. Also, valve 81 is disposed to the right of port 34', between the latter and branch port 83, whereby cylinder 25' is also open to the discharge chamber through port 85. When the main piston is moving from right to left, the main valve is at the extreme left and the same conditions prevail, but reversed with respect to a central transverse plane.

During the movement of the main valve 43' from the extreme lefthand position to the right, the shuttle valve 82 moves to the right of port 35' to admit pressure fluid to cylinder 26' simultaneously with closing of port 33' leading to the main cylinder 6'. The righthand shuttle piston uncovers port 83, to allow cylinder 25' to exhaust to the discharge chamber. The auxiliary piston 28' thus continues the discharge of pump liquid while the main shuttle valves 71' and 72' are reversing. This condition is illustrated in Fig. 6.

On continued movement of the main valve to the right to a point where port 32' is opened to the pressure fluid and port 33' is open to the

discharge chamber, the shuttle piston 52' gradually closed the branch port 84, thus cutting off the supply of pressure fluid to cylinder 26'. Shuttle valve 81 also gradually closes port 34', producing a snubbing effect on piston 27' by gradually throttling the discharge of spent motive liquid from in front of the piston. During the final phase of movement of the main valve, shuttle valve 81 moves to the right of port 34 and shuttle valve 82 moves into the central portion of the wide port 86', whereby both auxiliary cylinders are opened to the discharge chamber and the pressure across the auxiliary pistons is balanced during the period of rest.

It will be observed that the mechanical connection between the main pistons and the pilot valve differs somewhat from that shown in Fig. 4, comprising in this instance plungers 91 and 92 in lieu of the rocker shafts 65 and 66 of Fig. 4. This actuating means is substantially identical with that shown in Fig. 1 of the copending application of Aladar Hollander and Waldemar F. Mayer, Ser. No. 197,140, filed March 21, 1938, and further description thereof is deemed unnecessary.

In this form of the invention adjustable needle valves 93 and 94 are provided for regulating the flow of pressure fluid to the shuttle pistons, whereby the time interval of reversal of the main valve may be suitably repulated.

Having described two preferred embodiments of the invention, I do not wish to be restricted to the details thereof, since the invention may be embodies in other specific forms.

I claim:

1. A duplex pump comprising a pair of fluid-actuated reciprocating pump units, each comprising a pair of cylinders and a pair of interconnected pistons in said cylinders, each pair of pistons having two oppositely directed faces constituting motor elements exposed to motive fluid in motive-fluid ends of said cylinders, and two oppositely directed faces constituting pumping elements and exposed to pump liquid in pump-liquid ends of said cylinders, the pump-liquid ends of said cylinders having valye inlets and outlets connected to common suction and discharge conduits respectively, whereby the pumping faces of said pistons draw in and discharge pump liquid in response to reciprocation of said pistons, separate motive-fluid valve means for each unit operable to admit motive fluid to either motive fluid cylinder end of that unit and exhaust motive fluid from the other motive fluid cylinder end to move the pistons of that unit in either direction, the two valve means associated with said two units being interconnected to produce alternate actuation of the units in synchronism, but out of phase with each other, and valve-actuating means operated by the piston means of only one of said units at predetermined points in the pumping cycle of said one unit.

2. A duplex pump comprising a pair of fluid-actuated reciprocating pump units, each comprising a pair of cylinders and a pair of interconnected pistons in said cylinders, each pair of pistons having two oppositely directed faces constituting motor elements exposed to motive fluid in motive-fluid ends of said cylinders, and two oppositely directed faces constituting pumping elements and exposed to pump liquid in pump-liquid ends of said cylinders, the pump-liquid ends of said cylinders having valve inlets and outlets connected to common suction and discharge conduits respectively, whereby the pumping faces of said pistons draw in and discharge pump liquid in response to reciprocation of said pistons, separate motive-fluid valve means for each unit operable to admit motive fluid to either motive fluid cylinder end of that unit and exhaust motive fluid from the other motive fluid cylinder end to move the pistons of that unit in either direction, the two valve means associated with said two units being interconnected to produce alternate actuation of the units in synchronism, but out of phase with each other, and valve-actuating means operated by the piston means of only one of said units at predetermined points in the pumping cycle of said one unit, said one unit having a relatively long stroke and the other unit having a relatively short stroke.

3. A pump as defined in claim 2, in which the motive fluid valve means of the short stroke pump is actuated to admint motive fluid thereto only during reversal of the long stroke pump.

4. A pump as defined in claim 2, in which the motive fluid valve means comprises a pilot valve actuated by predetermined movements of the piston means of the long stroke pump, and a hydraulically actuated main valve controlled by said pilot valve, said main valve controlling the flow of motive fluid alternately to the pumps.

5. A pump as defined in claim 2, in which said motive fluid valve means comprises a pilot valve actuated by predetermined movements of the piston means of said long stroke pump, motive fluid inlets to said short stroke pump controlled by said pilot valve, a hydraulically actuated main valve controlled by said pilot valve, and motive fluid inlets to said long stroke pump controlled by said main valve.

6. A duplex hydraulic pump as in claim 1, in which the motive fluid valve means comprises a hydraulically actuated reversing valve for controlling the flow of motive fluid to and from one of the units, a pilot valve actuated by the piston means of said one unit for controlling the actuation of said reversing valve, said pilot valve also controlling the flow of motive fluid to and from the other unit.

7. A duplex hydraulic pump as in claim 1, in which the motive fluid valve means and its actuating means comprises a pilot valve, trip mechanism actuated by the pistons of one of said units at the end of each stroke thereof for reversing said pilot valve, a fluid-operated reversing valve for controlling the flow of motive fluid to and from said one unit, fluid connections from said pilot valve to said reversing valve whereby reversal of said pilot valve effects reversal of said reversing valve, and fluid connections from said pilot valve to the other of said units, said last-named fluid connections being so related to said first-named fluid-connection that the flow of motive fluid to and from said other unit is reversed simultaneously with reversal of said reversing valve.

8. A duplex hydraulic pump as in claim 1, in which the motive fluid valve means comprises a fluid-actuated reversing valve, a pilot valve actuated by the piston means of one of said units at the end of each stroke thereof for reversing said reversing valve, motive fluid supply and exhaust connections from said reversing valve to the motive fluid cylinder ends of each of said units, said reversing valve being constructed and arranged to close the motive fluid connections to said one unit, and to open the motive fluid connections to the other of said units during reversal of the valve, and to open said first-named con-

nections and close said last-named connections upon reversal of said valve.

9. A duplex hydraulic pump as in claim 1, in which said motive fluid valve means comprises a fluid-actuated reciprocating main valve controlling the admission and exhaust of motive fluid to one of said units, a shuttle piston connected to each end of said main valve and reciprocable in a shuttle cylinder, a pilot valve, a motive fluid inlet to said pilot valve, fluid connections from said pilot valve to said shuttle cylinders, trip mechanism actuated by the pistons of said unit at the end of each stroke thereof for reversing said pilot valve to alternately admit motive fluid to said shuttle cylinders to reverse said main valve, and motive fluid supply and exhaust connections from said main valve to said other unit, said main valve being constructed and arranged to open said last-named connections during reversal thereof.

10. A duplex hydraulic pump as in claim 1 in which the motive fluid valve means and its actuating means comprises a pilot valve, trip mechanism actuated by the pistons of one of said units at the end of each stroke thereof for reversing said pilot valve, a fluid-operated reversing valve for controlling the flow of motive fluid to and from said one unit, fluid connections from said pilot valve to said reversing valve whereby reversal of said pilot valve effects reversal of said reversing valve, and fluid connections from said pilot valve to the other of said units, said last-named fluid connections being so related to said first-named fluid-connection that the flow of motive fluid to and from said other unit is reversed simultaneously with reversal of said reversing valve, and including a regulating valve in each fluid connection from the pilot valve to the shuttle cylinders for controllably varying the speed of reversal of said main valve.

ALLEN E. HAMBLY.