

June 19, 1962

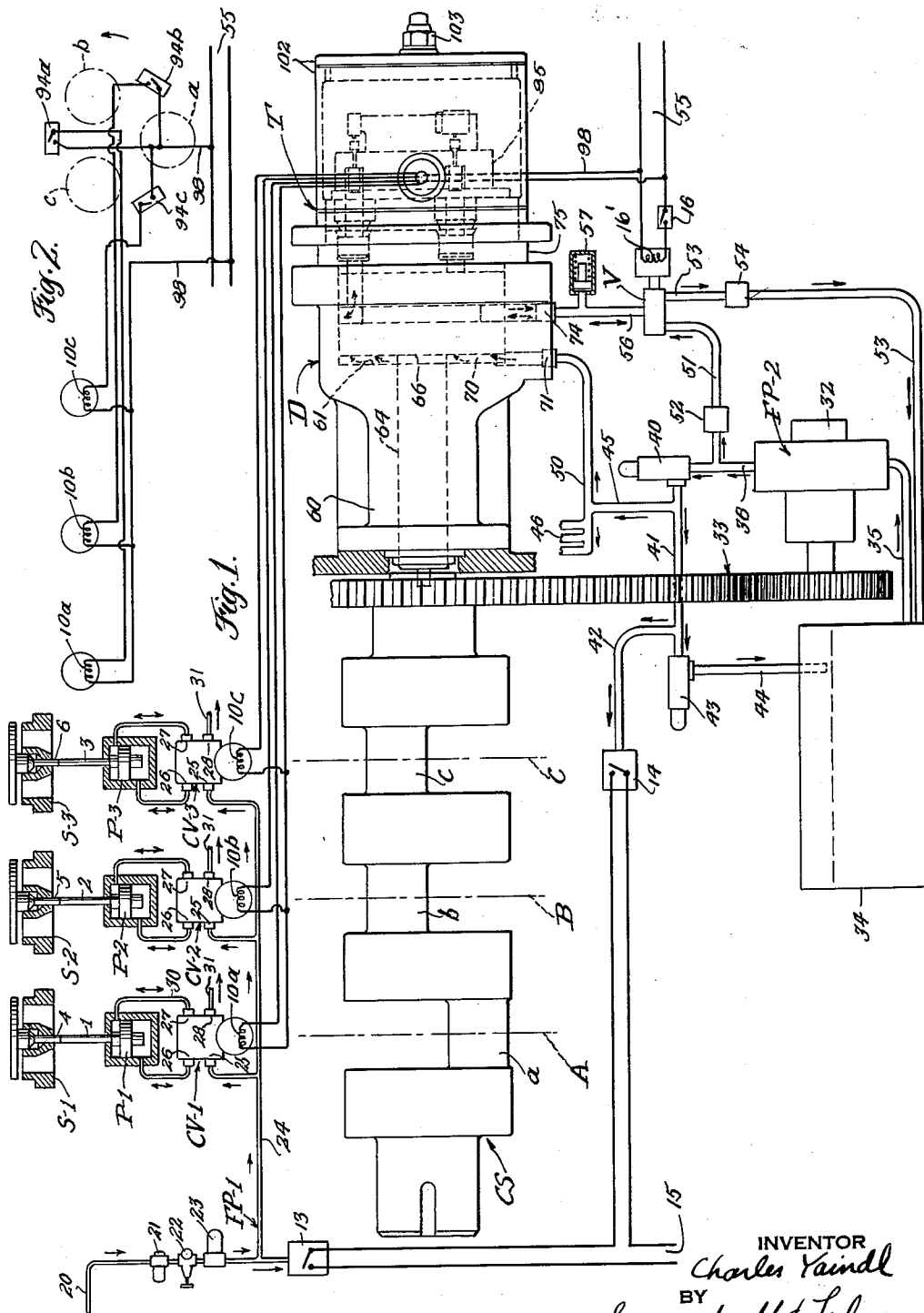
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3,039,393

CONTROL FOR FLUID PUMP

Filed Jan. 21, 1958

5 Sheets-Sheet 1



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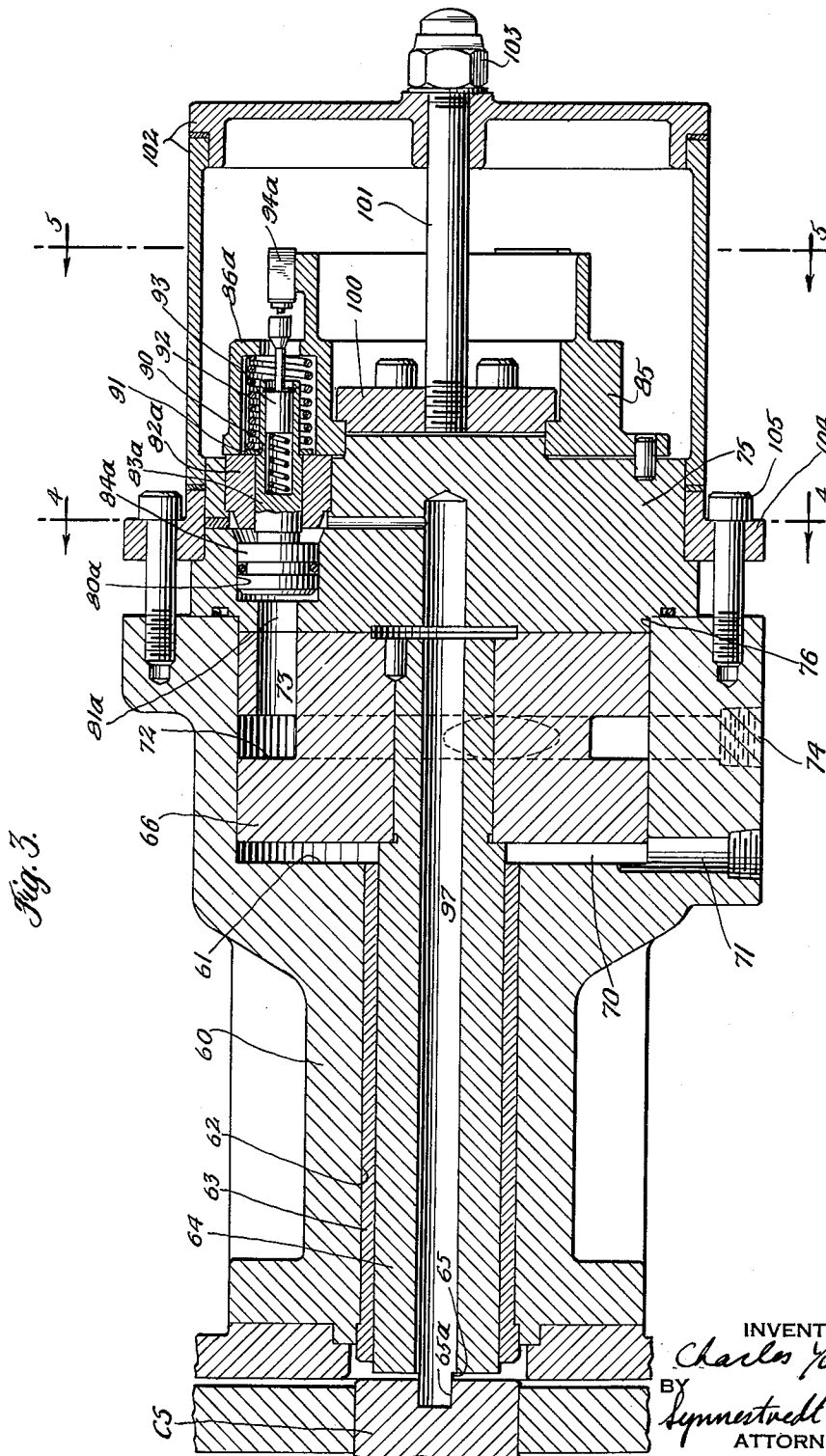
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5 Sheets-Sheet 2



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5 Sheets-Sheet 3



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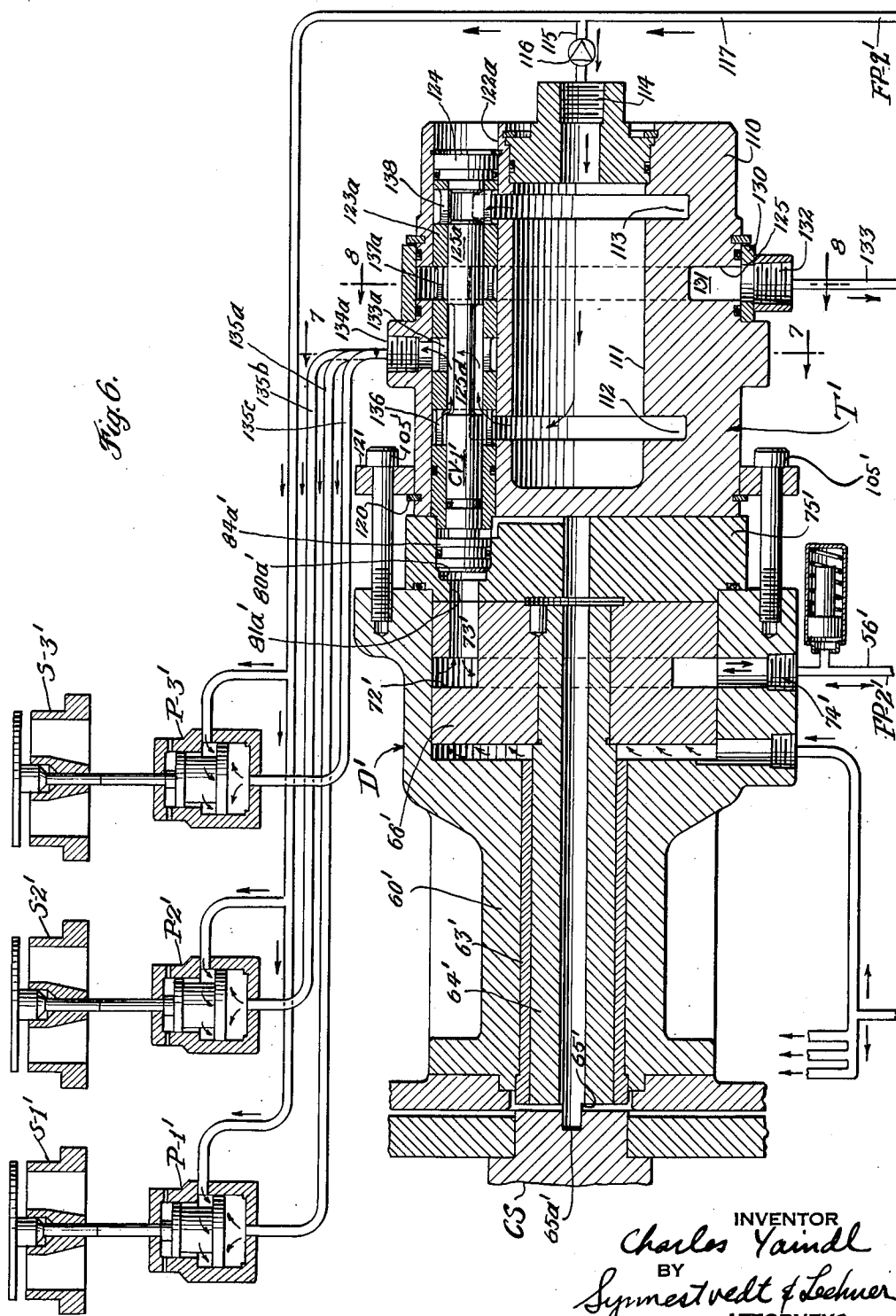
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CONTROL FOR FLUID PUMP

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5 Sheets-Sheet 4



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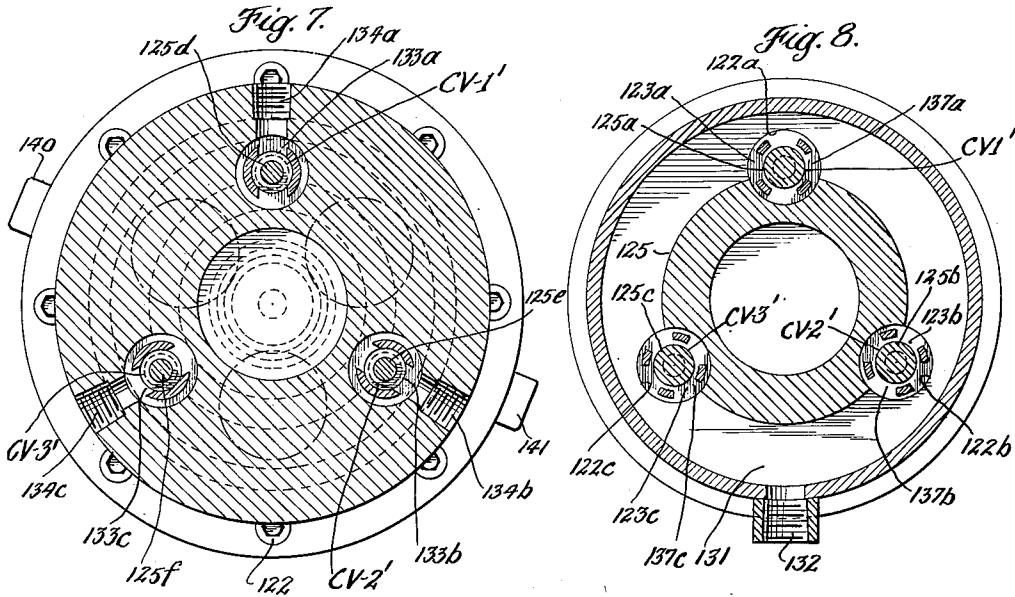
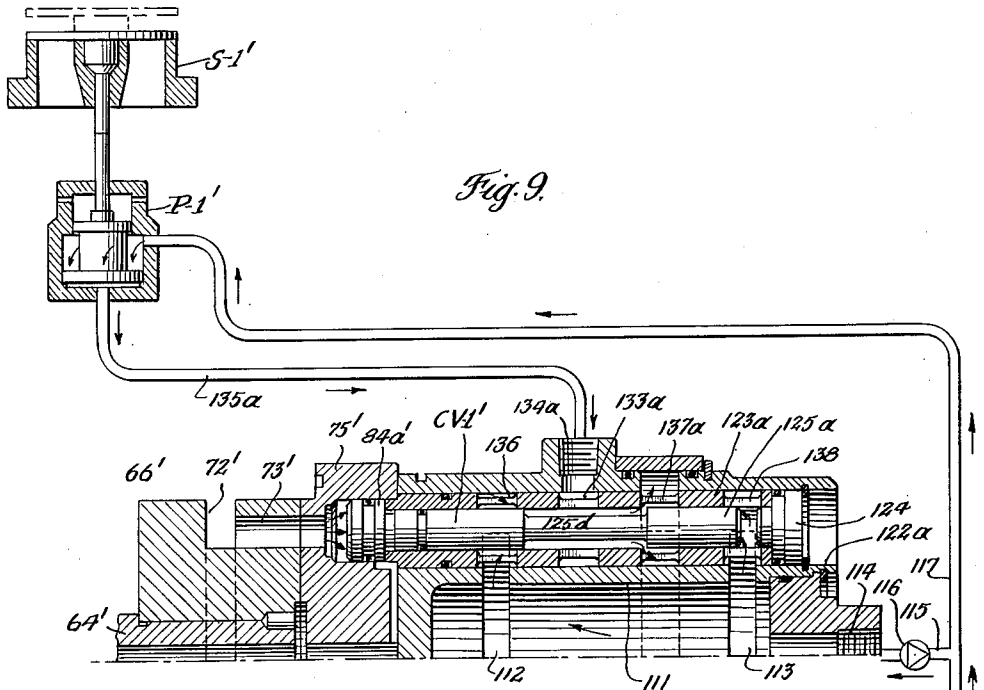
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CONTROL FOR FLUID PUMP

Filed Jan. 21, 1958

5 Sheets-Sheet 5



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3,039,393

CONTROL FOR FLUID PUMP

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Filed Jan. 21, 1958, Ser. No. 710,274

10 Claims. (Cl. 103—40)

This invention relates to reciprocating plunger type fluid pumps and, in particular, relates to improvements for mechanism for controlling the loading and unloading of the pump.

Pumps of the kind in question ordinarily include a plurality of plungers reciprocating in and out of chambers each having a fluid inlet connected to a suction manifold and a fluid outlet connected to a discharge manifold, there being valves in the inlet and outlet which open and close the chambers to the manifolds depending upon the position of the plunger. For example, on the discharge stroke, when the plunger is entering the chamber, the valve in the inlet is closed and the valve on the outlet is forced open so that fluid passes from the chamber to the discharge manifold, and when the plunger is moving out of the chamber or on the suction stroke, the valve on the outlet is closed by the head in the discharge manifold, while the valve in the inlet is sucked open so that the fluid can pass from the suction manifold to the chamber and then subsequently can be discharged on the discharge stroke.

In such a pump, the plungers are connected to a crankshaft which is operated by an electric motor and it is desirable that the motor, crankshaft and plungers remain operative regardless of whether the pump is loaded, i.e., pumping fluid, or unloaded, i.e., not pumping fluid.

Ordinarily, load or unload is accomplished by the control of the valve in the inlet which is commonly called a suction valve. This is done by fixedly holding the suction valve away from its seat so that on the suction stroke the plunger will merely draw the fluid in the suction manifold into the chamber and on the discharge stroke, force the fluid back into the suction manifold, the discharge valve remaining closed due to the head in the discharge manifold.

With that in mind then, the present invention contemplates mechanism for the automatic control of the suction valves of pumps of the kind in question. In particular, the invention contemplates control mechanism, the features of which alone and in combination constitute substantial improvements over prior art mechanism for controlling suction valves.

In one aspect, the invention contemplates control mechanism having a plurality of fluid operated double acting pistons to respectively operate the suction valves to cause the same to assume a load or unload condition, a plurality of control valves for the pistons which are adapted to transfer fluid as between a source and both sides of the double acting pistons together with a fluid operated timer distributor mechanism for actuating the control valves, the operation of the timer distributor being synchronized with the plunger reciprocation. In one arrangement of the invention, the fluid for operating the double acting pistons is taken from a source which is independent from the source of fluid for operating the timer distributor mechanism and in another arrangement the double acting pistons and the timer distributing mechanism are supplied from the same source.

The use of fluid operated double acting pistons as above mentioned has several advantages, for example, positive fluid pressure is used to actuate the pistons for either condition of suction valve operation; the use of bias or return springs for the pistons is eliminated; and direct mechani-

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cal linkage between the suction valves and the crankshaft is eliminated.

The fluid operated timer distributor mechanism has the advantage of enabling a change in the pump from load to unload condition or vice versa to be accomplished in a time which is the same as the stroke time of a plunger and of enabling change from load to unload condition or vice versa to take place in a time which is greater than the stroke time of a plunger, for example, requiring several strokes, and further having the advantage of permitting the change from load to unload or vice versa to be initiated toward the end of the discharge stroke, at the beginning of the suction stroke or at some point just after the beginning of the suction stroke, all of such variations being capable of being effected while the pump is under load or unload condition.

The manner in which the foregoing is accomplished will be apparent from the following description and drawings wherein:

FIGURE 1 is a schematic view of certain of the control mechanism of the invention shown in association with the crankshaft and suction valves of a pump, the relation of the components being shown for the unload condition of the suction valves, in this arrangement the fluid for the double acting pistons and the timer distributor being supplied from independent sources;

FIGURE 2 is a schematic view showing in particular the electrical connections between certain of the components of the mechanism of FIGURE 1;

FIGURE 3 is a longitudinal section of certain of the components of FIGURE 1 particularly showing distributor timer component, the view being taken along the lines 3—3 of FIGURE 4;

FIGURE 4 is a cross section taken on the lines 4—4 of FIGURE 3;

FIGURE 5 is a cross section taken on the lines 5—5 of FIGURE 3;

FIGURE 6 is a schematic view of certain of the control mechanism of the invention, the relationship of the components being shown for the unload condition of the suction valves and in this arrangement the fluid for the double acting pistons and the timer distributor being supplied from the same source;

FIGURE 7 is a cross section taken on the lines 7—7 of FIGURE 6;

FIGURE 8 is a cross section taken on the lines 8—8 of FIGURE 6; and

FIGURE 9 is a partial view of certain of the components of FIGURE 6 illustrating the same in position for the load condition of the suction valves.

The invention here will be described in connection with a triplex or three plunger pump, for example, a pump such as shown in the Shelly Patent 2,243,888, assigned to the same assignee as this application. Pumps of this nature are well known by those skilled in the art and, therefore, need not be described in detail herein. Suffice it to say that such pumps comprise in general a power section and pumping section, both being mounted on a frame with the power section having a crankshaft and drive motor together with connecting rods which couple the crankshaft with the plungers in the pumping section which operate as heretofore mentioned.

While the invention herein will be described in connection with a triplex or three plunger type pump, it will be understood that the invention is applicable where the pump may contain one or any number of plungers.

In FIGURE 1, the suction valves for the pump are designated as S-1, S-2 and S-3, and the crankshaft for the pump is designated by CS. The dot-and-dash lines on the crankshaft labeled A, B and C designate the connecting rods and pump plungers.

The invention contemplates that each of the suction

valves shall have a fluid operated double acting piston operating back and forth in a cylinder under the control and influence of fluid pressure. These elements in FIGURE 1 are designated by P-1, P-2 and P-3. As shown, the pistons have been moved to a position where each of the suction valves is lifted from its seat or is in the unload condition. When the pistons are moved downwardly, the piston rods 1, 2 and 3 come out of engagement with the valve stems 4, 5 and 6 so that the valves are free to seat and unseat depending upon the action of the plungers. This, of course, is the load condition.

The double acting pistons P-1, P-2 and P-3 are adapted to be moved to cause the suction valves to assume load and unload conditions by means of the control valves designated in FIGURE 1 as CV-1, CV-2 and CV-3. The control valves effect a transfer of fluid as between the double acting pistons and a source of fluid pressure generally designated by the letter FP-1. The control valves are actuated by solenoids, the coils of which are designated by the numerals 10a, 10b and 10c. When the solenoids are de-energized, the control valves effect a transfer of fluid between source FP-1 and the double acting pistons so that the same are moved into the unload position and when the solenoids are energized, the control valves effect a transfer of fluid so that the pistons assume the load condition.

When changing the pump from load to unload condition, it is desirable that the change for any one plunger be made when the same is substantially near the end of the discharge stroke or at the beginning of the suction stroke. For this purpose the invention contemplates a novel fluid actuated mechanism which in general comprises a timer means T, a distributor means D and a source of fluid pressure designated by FP-2 which, in this instance, is independent of the source FP-1. The distributor is connected to and operated in synchronism with the rotation of the crankshaft or with the reciprocating motion of the plungers. The distributor operates to transfer fluid as between the source FP-2 and the timer to cause the same appropriately to energize and de-energize the solenoids. The invention contemplates that the distributor and timer be relatively adjustable so that the change from load to unload conditions can be effected within certain limits, for example, extending near the end of the discharge stroke to slightly after the beginning of the suction stroke.

In FIGURE 6 I have designated the elements described above with corresponding primed letters and numerals, for example, the suction valves are designated as S-1', S-2' and S-3'; the double acting pistons by P-1', P-2' and P-3', with their control valves, one of which is shown at CV-1'. The timer mechanism is designated by T', the distributor mechanism by D' and the source of fluid pressure for the distributor and double acting pistons by FP-2', as in this arrangement the same source is used.

Referring again to FIGURE 1, I will refer to certain fail safe devices which are used in connection with the fluid pressure system for double acting pistons and the distributor. The numeral 13 designates a fluid pressure operated switch which is connected with the source FP-1 and the numeral 14 designates a pressure operated switch which is connected to the source FP-2. When the sources FP-1 and FP-2 are activated, both of these switches are closed. These switches are in series and are interconnected to the holding circuit for the controller of the motor driving the crankshaft CS via the power lines 15. Thus, if there is a failure of sources FP-1 or FP-2, to operate properly, one or the other or both of the switches are open and immediately stop the operation of the pump.

In connection with FIGURE 6, there is only a single source of fluid pressure FP-2' and, therefore, it is only necessary to use a single switch such as 14 in the pump motor holding circuit.

In general the operation of the elements of FIGURES 1 and 6 are as follows:

In FIGURE 1 a switch designated 16 controls a valve V. When the switch is in the normally open position, the valve V operates so that there is no fluid pressure transferred from the source FP-2 to the distributor D. At this time the solenoids 10a, etc., are de-energized, the effect of which is to arrange the pump in the unload condition. When it is desired to load the pump, the switch 16 is closed. This effects a transfer of fluid pressure from the source FP-2 to the distributor D which transfers fluid to the timing mechanism T which operates to energize the solenoids 10a, etc. The energizing of the solenoids effects a transfer of fluid between the source FP-1 and the pistons P-1, etc., so that the same cause the suction valves S-1, etc., to assume the load condition. When it is desired to unload the pump, the switch 16 is opened.

In FIGURE 6 a switch and valve similar to switch 16 and valve V are used. When the switch is in the opened condition there is no transfer of fluid pressure from the source FP-2' to the distributor. However, the control valves CV-1', etc., are arranged so that fluid is transferred to the pistons P-1', etc., in a manner to operate the same so that the suction valves S-1', etc., are in unload condition. When the switch 16 is closed, fluid is transferred to the distributor and thence to the timer which causes operation of the control valves to effect a transfer of fluid as between the source FP-2' and the double acting pistons P-1', etc., in a manner so that the pistons are moved to cause the suction valves to assume a load condition. When it is desired to unload the pump, the switch is opened.

Having described in general the components of the invention and the manner of operation, I will now go into a more detailed description.

In FIGURE 1 the source of fluid pressure FP-1 is preferably the air type and includes the air supply line 20, an air filter 21, an air pressure regulator 22, an air lubricator 23 together with a line 24 interconnected to each of the control valves CV-1, etc. Each of the control valves has ports 25, 26, 27 and 28, the port 25 in each valve being connected to the line 24. When the respective solenoids, 10a, etc., of the control valves are in de-energized condition, the valve interconnects ports 25 and 26 so that air is supplied to the lower side of the pistons and air exhausted from the upper side via the line 30, the interconnected ports 27 and 28 and exhaust line 31. When the solenoids of the valves are energized, the ports 25 and 27 are interconnected so that fluid is supplied to the top side of the pistons and the ports 26 and 28 are interconnected so that the lower side of the pistons is connected to exhaust. The line 24 is also connected to the switch 13 which is set so that if the air pressure in the line 24 drops below a certain minimum value, the switch will be open. This, of course, constitutes an interlock or a fail safety device as mentioned heretofore. The fluid pressure source FP-2 which is preferably hydraulic includes a pump 32 driven by gears 33 interconnected to the crankshaft CS. Fluid for the pump is supplied from the oil sump 34 via line 35. As mentioned heretofore, the source FP-2 supplies fluid to the distributor timer mechanism and the lines supplying this fluid are interconnected to the fail safe switch 14 which is arranged so that if the pressure drops below a certain minimum, the switch will open to stop the operation of the motor driving the crankshaft CS. This connection is explained following. It will be seen that discharge line 36 of the pump is connected to a regulating valve 40 which in turn is connected to lines 41 and 42, the line 42 being connected to the switch 14. The line 41 is connected to a regulating valve 43 having a return 44 to the sump 34. The line 41 from the valve 40 is also interconnected to a line 45 supplying fluid to certain pump lubrication lines 46, and line 50 supplies fluid

to the distributor D for reasons which will be explained shortly.

The manner in which fluid is supplied from the source FP-2 to the distributor timer mechanism will next be described. The discharge line 36 of the pump is connected to a line 51 provided with a variable throttle 52 which can be set so as to vary the rate of fluid flow through the line 51. The suction or return line 53, which is connected to the suction side of the pump, includes a variable throttle 54 which can be adjusted so as to vary the rate of fluid flow through the line 53. Both the lines 51 and the line 53 are interconnected to the valve V which is operated by a solenoid, the coil of which is indicated at 16'. This coil is in series with the switch 16 and both elements are connected to a source of power via the lines 55. When the switch 16 is open (unload condition of the pump), the solenoid is de-energized and the valve V is operated to interconnect the line 51 and line 53 so that fluid is transferred from the line 51 through the valve V and back to sump via the line 53. At this time any fluid in line 56 (which is connected to the distributor D) may flow through the valve V to sump line 53. When the switch is closed (load condition of pump), the solenoid is energized and the valve V is operated so as to interconnect the line 51 with the line 56.

The details of construction of the distributor timer mechanism and the manner in which the same is operated by the fluid pressure from line 56 or from source FP-2 will be described in connection with FIGURES 3, 4 and 5.

In FIGURE 3 a housing generally designated 60 has an internal bore forming a chamber 61 and a reduced bore 62 having a sleeve 63 supporting a shaft 64 which is connected to the crankshaft CS as by jaws 65 of the shaft 64 fitting a groove 65a in the crankshaft. Fixedly connected to the shaft 64 and disposed within the chamber 61 is a rotary distributing valve 66. It will be noted that the rotor 66 has an axial length which is shorter than the chamber 61 so that there is a space 70 open to a port 71 in the housing. This port 71 is interconnected to the line 50, as indicated in FIGURE 1. Fluid from the source FP-2 is transferred to the space 70 for a purpose as will be described hereinafter.

The rotor 66 has formed on the periphery thereof a groove 72 which is interconnected to an axially extending passage 73. The groove 72 is open to a port 74, which as seen in FIGURE 1, is connected to the line 56.

Disposed on the housing is a disk-like distributor head 75, a shoulder 76 of which extends slightly into the chamber 61. The head is provided with three bores 79a, 79b and 79c which, as indicated in FIGURE 4, are arranged concentrically with the axis of the rotor and spaced 120° apart. The innermost portion of each bore forms the channels 81a, 81b and 81c, all of which are adapted to register with the passage 73 in the rotor 66 as the same is rotated. The outermost part of each bore mounts bushings 82a, 82b and 82c which respectively slidably support the stems 83a, 83b and 83c of control pistons respectively connected thereto. These pistons, one of which is indicated at 84a in FIGURE 3, are disposed respectively in the intermediate sections 80a, 80b and 80c of the bores 79a, 79b and 79c, the intermediate sections forming chambers or cylinders for the pistons. Secured to the distributor head is a cap 85 having three hollow sections 86a, 86b and 86c (FIGURES 3 and 5), the piston stems 83a, 83b and 83c respectively extending to the hollow sections. As best seen in FIGURE 3, the stem 83a is provided with a shoulder 90 and around the stem is disposed a washer 91 and a return spring 92 is disposed between the washer and the hollow portion 86a. The spring is arranged so as to urge the piston 84a toward the left or as shown in the position of FIGURE 3. The stem 83a is bored and in the bore is mounted a spring loaded contactor 93a. The three pistons 84a, 84b and 84c are

similarly arranged, the contactor 93b and 93c being indicated in FIGURE 5.

The cap 85 mounts three switches 94a, 94b and 94c. In the position of the parts as shown in FIGURE 3, the pistons 84a, 84b and 84c and the respective contactors 93a, 93b and 93c are moved to the left so that each contactor is spaced away from its switch. When a piston is moved to the right, its contactor engages its switch so as to close the same.

The cap 85 is held fast on the distributor head 75 by a plate 100 and attached to the plate 100 is a stud 101 supporting a two part cover 102 held on the stud by the nut 103. The cover 102 abuts a securing ring 104 which is held fast on the housing 60 by the screws 105. When the screws 105 are pulled up tight, the ring holds the distributor head firm against the housing and when the nut 103 is pulled up tight, the cover 102 is held fast against the ring 104.

Referring back to FIGURE 3, the space 70 in the housing 60, fluid from the source FP-2 enters the space and acts to press the rotor 66 firm against the head 75. Also, leakage of this fluid about the rotor 66 serves as a lubricant and this leakage fluid is handled by the passage 97.

Referring to FIGURE 2, it will be seen that the switches 94a, 94b and 94c are interconnected to the solenoid coils 10a, 10b and 10c; each coil and its switch are series connected across the power supply lines 55 via the lines 98.

In general, the timer distributor mechanism operates as follows. The switch 16 is closed so that the valve V permits fluid from the source FP-2 to flow into the line 56 and thence into the groove 72, hence into the passage 73. The registry of the passage 73 with any one of the channels 81a, etc., will cause fluid to react against the control piston and move the same to the right. This movement of the piston will cause the actuator to contact its switch to close the same and hence supply power to one of the solenoids 10a, etc. When the switch 16 is open so that the groove 72 and line 56 are connected to sump via the line 53, registry of the passage 73 with any one of the channels 81a, etc., will relieve the fluid acting on the piston so that the piston will be moved to the left by the action of its return spring.

The channels 81a, 81b and 81c in the timer and the passage 73 in the distributor are arranged with respect to the crankshaft so that when the crank is in a rotary position whereby its connected plunger is at the end of the discharge stroke, the passage 73 will be in registry with the particular channel associated with the plunger. Thus when the portion of the crankshaft labeled a is in its lowermost position (as shown), the interconnected plunger is at the end of the discharge stroke and at this time the passage 73 is in registry with the channel 81a so that fluid can be supplied (assuming the pump to be load) to move the piston 84a whereby to close the switch and energize the solenoid 10a. When that part of the crankshaft labeled b is in its bottommost position, its associated plunger is also at the end of the discharge stroke and the passage 73 is lined up with the channel 81b so that the piston 84b will be actuated. When the portion of the crankshaft c is in its lowermost position, the passage 73 is in registry with the channel 81c so that the piston 84c will be actuated. As will be apparent, the unloading of the pump also takes place when the portions a, b and c of the crankshaft are in their lowermost positions.

Under the usual condition of pump operation, the fluid from FP-1 is kept energized so that the suction valves are kept in unload condition. When loading is called for, the switch 16 is closed and when the same is subsequently opened, the pump returns to no-load condition. The switch 16 may be manually or automatically operated.

One of the features of the invention is that the loading or unloading of the suction valves can be effected exactly at the time when a piston reaches the end of a discharge stroke or on either side thereof, i.e., when the pump plunger is almost at the end of a discharge stroke or has

already started the suction stroke. This is accomplished by means of varying the relative positions of the channels 81a, etc., with respect to the passage 73. As seen in FIGURE 5, the timer head 75 is provided with a pair of ears 106 and 107. Now, if the screws 105 are loosened and the ears 107 tapped lightly, the timer head 75 can be moved clockwise or counter-clockwise, hence change its relative position with respect to the passage 73 or the crankshaft CS. For example, assuming clockwise rotation of the crank, as viewed in FIGURE 4, when the portion a of the crank has reached the lowermost position, the associated plunger is at the end of the discharge stroke or at the beginning of the suction stroke. If the timer head has been previously moved clockwise, the crank must continue its motion (and its associated plunger will have started the suction stroke) before there is a registry between the passage 73 and the channel 81a. On the other hand, if the timer head had been moved counter-clockwise, then it will be seen that registry of the passage 73 and a channel 81a would take place just prior to the portion a reaching the lowermost position or when its plunger is near the end of its discharge stroke.

Another feature of the invention is that the loading or unloading of the pump can take place in a complete revolution of the crankshaft or can be arranged so that a plurality of revolutions are necessary for unloading or loading. This is done primarily through the agency of the throttles 52 and 54 either alone or preferably in conjunction with the springs 92. For example, in conditioning the pump for loading, if the throttle 52 is adjusted so that the fluid is metered through a very slow rate, it will be apparent that it will take a longer time to convey enough fluid into the groove 72 (for reaction against the control pistons 84a, etc.) than would be necessary if the throttle 52 were arranged so that there was unimpeded flow. In unloading, the throttle 54 is adjusted so that the transfer of fluid from the groove 72 (so as to relieve the force against the control pistons 84a, etc.) to the suction line 53 is at a slow rate so that it takes a longer period of time for the return springs 92 to overcome the force of the fluid and move the control pistons to the left so as to break contact with the switches. In conjunction with the varying of the throttles 52 and 54, it will be seen that by using return springs 92 of different strength, the time for the control pistons to move to engage and disengage the switches can be varied.

The accumulator 57 connected in the line 56 permits the build up of the force of the fluid in the groove 72 for acting on the control pistons to be at a gradual rate rather than stepped or with a sudden impact. The accumulator 57 operates similarly when the pump is unloaded, that is, in permitting the fluid force acting on the crankshaft to diminish gradually.

Referring to FIGURES 6-9, the construction of this arrangement will be explained. The parts of FIGURES 6-9 which correspond to those of FIGURES 1-5 are identified by the same numerals and letters but having a prime mark.

In the arrangements of FIGURES 6-9, the various control valves CV-1', etc., are formed integrally with the timer distributor mechanism and a single source of fluid pressure is used for the double acting pistons P-1', etc., and for operating the distributor D' and the timer T'.

In FIGURE 6 the line 56' is connected to the source FP-2' in the same manner as line 56 as explained in connection with FIGURE 1. The line 56' is also connected to the port 74' which is open to the channel 72' in a rotor 66', the channel being connected to the passage 73'. The timer head 75' has three bores which form three channels, one of which is indicated at 81a' and form the cylinders, one of which is indicated at 80a'. Each of the cylinders has a control piston, one of which is indicated at 84a'.

On the timer head 75' is mounted a housing 110 which

has a central bore 111 having annular ports 112 and 113 and an end port 114. The port 114 is connected to a line 115 provided with a check valve 116. Line 115 is connected to a line 117 which is connected to the discharge side of the pump of fluid pressure source FP-2'. The housing 110 holds the distributor head 75' fast against the housing 60', the housing 110 in turn being held fast to the housing 60' by way of the rings 120 and 121 pulled into engagement with the screws 105'.

The housing 110 is provided with three bores 122a, 122b and 122c which are in registry with the cylinders 80a', etc. Each of these bores has a bushing identified by 123a, 123b and 123c. As best seen in FIGURE 6, the shoulder end of each bushing extends into the corresponding cylinders 80a', etc. The outer end of each bore 122a, etc., is provided with a stop, one of which is indicated at 124 in FIGURE 6. Each of the bushings 123a slidably supports the spools 125a, 125b and 125c, each having a reduced section 125d, 125e and 125f. The spools are respectively connected to the control pistons 84a', 84b' and 84c'. The spools respectively form the control valves CV-1', CV-2' and CV-3'. On the periphery of the housing 110 is a slot 125 having a cover 130 which forms a chamber 131 having a port 132 connected to a line 133 in turn connected to the oil sump or suction side of the pump of the fluid pressure source FP-2'.

As indicated in FIGURES 6 and 7, the midsection of each of the bushings is apertured at 133a, 133b and 133c so as to be opened to a plurality of ports 134a, 134b and 134c which are in turn connected to a plurality of fluid lines 135a, 135b and 135c which run directly to the lower side of the pistons P-1', P-2' and P-3'.

The bushings are also apertured so as to be open to the slot 112, the aperture for the bushing 123a being indicated at 136. Each of the bushings is also apertured at 137a, 137b and 137c so as to be open to the chamber 131. The bushings are also apertured so as to be open to the slot 113, the apertures for the bushing 123a being indicated at 138.

The position of the parts as shown in FIGURE 6 is for the unload condition where the suction valves S-1', etc., are raised from their respective seats. For unload condition the line 56' is interconnected to the suction side of the source FP-2' so that any fluid in the slot 72' and passage 73' is free to go to sump. The line 117 is connected to the source FP-2' and transfers fluid to the upper side of the pistons P-1', P-2' and P-3'. Fluid from the line 117 moves through the check valve 116, through the port 114 into the port 113, through the aperture 138 and reacts on the right-hand end of each spool 125a, 125b and 125c to move the same to the left. Fluid also will flow through the port 112 and into apertures 136 and the position of each spool (see spool 125a) permits fluid to flow from the apertures 136 into the space provided by the reduced sections 125d, etc., of the spool, through the aperture 133a, etc., through the ports 134a, etc., and then into the lines 135a, 135b and 135c to the lower side of the piston P-1', etc. Substantially the same unit pressure is acting on both sides of the pistons, but the area on the lower side is much greater than that on the upper side; there will be a resultant force tending to move the piston upwardly to unseat the valve.

For load conditions line 56' and groove 72' are supplied with fluid from the source FP-2' and when the passage 73' comes in registry with the channels 81a', etc., the pistons 84a', etc., will be moved to the right. This will cut off the flow of fluid from the port 112 and interconnect the lines 135a, etc., with the chamber 131 which is connected to sump. The position of the spools to effect this transfer is shown in FIGURE 9. With the lower sides of the pistons P-1', etc., interconnected to sump, fluid from the line 117 reacting on the upper sides of the pistons will move the same downwardly and the piston rods disengage from the suction valve stems. The suction

valves are then free to seat and unseat as dictated by the positions of their respective plungers.

The distributor head may be adjusted so as to control the time when the loading or unloading takes place in a manner similar to that described above. This is accomplished by loosening the screws 105' and tapping the ears 140 or 141 as indicated in FIGURE 7.

The period of time for loading and unloading with respect to the revolutions of the crankshaft or the reciprocation of the pump plungers is accomplished by variable throttles (similar to throttles 52 and 54 connected to the line 56') and by the bias force on the spools, for example, by making the area of the end of the spool smaller so that more time is required for the fluid to move the spool to the left.

I claim:

1. In a reciprocating plunger type fluid pump having a suction valve for loading and unloading the pump, mechanism for causing the suction valve to assume a loading condition or, alternatively, to assume an unloading condition comprising: a fluid operated double acting piston connected to said suction valve and movable in opposite directions to either of two positions, one position causing the suction valve to assume a loading condition and the other position causing the suction valve to assume an unloading condition; working fluid supply means for the opposite sides of said double acting piston for effecting the movement thereof; control means connected to said double acting piston and to said working fluid supply means and including a control piston to control the working fluid on opposite sides of said double acting piston, the control piston being movable to a first position to cause transfer of said working fluid to and from said double acting piston to move the same to effect said unloading condition and movable to a second position to cause transfer of said working fluid to and from said double acting piston to move the same to effect said loading condition; means yieldably biasing said control piston to said first position; means for moving said control piston including a distributor valve connected to be moved in synchronism with the reciprocation of the plunger and at some predetermined position of the plunger to supply fluid to the control piston to move the same against said bias means from said first to said second position; and means to supply last said fluid to the distributor valve for loading condition and to cut off said supply for unloading condition.

2. A construction in accordance with claim 1 wherein the movement of said distributor valve is rotational.

3. In a reciprocating multi-plunger type fluid pump having, for each plunger, a suction valve for loading and unloading the pump, mechanism for causing each suction valve to assume a loading condition or, alternatively, to assume an unloading condition comprising: for each suction valve, a fluid operated double acting piston connected to a suction valve and movable in opposite directions to either of two positions, one position causing the suction valve to assume a loading condition and the other position causing the suction valve to assume an unloading condition; working fluid supply means for the opposite sides of each said double acting piston for effecting the respective movements thereof; control means connected to said working fluid supply and to each double acting piston and including, for each double acting piston, a control piston to control the working fluid on opposite sides thereof, the control piston being movable to a first position to cause transfer of said working fluid to and from said double acting piston to move the same to effect said unloading condition and movable to a second position to cause transfer of said working fluid to and from said double acting piston to move the same to effect said loading condition, the control piston being yieldably biased to said first position; means for moving said control pistons including a distributor valve connected to be moved in synchronism with the reciprocation of the plungers and

when each plunger is in a predetermined position, to supply fluid to a control piston to move the same from unload to load position; and means to supply last said fluid to said distributor valve for loading condition and to cut off said supply for unloading condition.

4. In a reciprocating multi-plunger type fluid pump having, for each plunger, a suction valve for loading and unloading the pump, mechanism for causing each suction valve to assume a loading condition or, alternatively, to assume an unloading condition comprising: for each suction valve, a fluid-operated, double acting piston connected to said suction valve and movable in opposite directions to either of two positions, one position causing the suction valve to assume a loading condition and the other position causing the suction valve to assume an unloading condition; and means to control the fluid on opposite sides of said double acting pistons to cause all of the same to assume one or the other of said positions including a source of fluid, a plurality of control valves, one for each double acting piston and each control valve operative to interconnect its double acting piston and the source, for supplying fluid to one or the other side of the double acting piston, a plurality of control pistons each mounted for reciprocating motion, there being one control piston for each said control valve, means biasing each said control piston in one direction, means connected between each said control piston and its control valve to effect operation of the valve with movement of the piston from the bias position, means to move said control pistons including a rotary valve rotated in synchronism with said plungers to sequentially transfer fluid from a source to the control pistons to move the same away from the bias position.

5. A construction in accordance with claim 4 wherein each said control piston operates its control valve when the corresponding plunger is at the beginning of the suction stroke.

6. A construction in accordance with claim 4 wherein said control pistons are angularly adjustable with respect to the rotary valve so that each valve can be operated when the corresponding plunger is in the discharge stroke or the suction stroke.

7. A construction in accordance with claim 4 further including means controlling the transfer of fluid between second said source and rotary valve so that a change from load to unload condition, or vice versa, is accomplished for each suction valve in less than a complete stroke of the corresponding piston.

8. A construction in accordance with claim 4 further including means controlling the transfer of fluid between second said source and said rotary valve so that a change from load to unload condition is accomplished for each suction valve in more than a complete stroke of the corresponding piston.

9. In a reciprocating multi-plunger type fluid pump having, for each plunger, a suction valve for loading and unloading the pump, mechanism for causing each suction valve to assume a loading condition, or alternatively, to assume an unloading condition comprising: for each suction valve, a fluid operated double acting piston movable in opposite directions to either of two positions, one position causing the suction valve to assume a loading condition and the other position causing the suction valve to assume an unloading condition; for each double acting piston, a control valve adapted to supply fluid to one side or the other of its double acting piston to cause the same to assume one or the other of said positions; a source of fluid connected to said control valves; for each control valve, a solenoid to control operation thereof, the solenoid, when de-energized, effecting said unloading condition and, when energized, effecting said loading condition; a plurality of switches, one for each solenoid and adapted to energize and de-energize the same; a crankshaft for use in reciprocating said plungers; a fluid pump driven in synchronism with said crankshaft; a rotary dis-

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tributor valve driven in synchronism with said crankshaft; fluid lines between said distributor valve and the discharge and suction sides of said pump including variable throttle means in the discharge and suction lines together with a selector valve alternatively operative to connect the distributor valve with the discharge line or the suction line; means to operate said selector valve; for each switch, a control piston movable in opposite directions to first and second positions whereby to actuate its switch; and spring means biasing said pistons to the respective first positions wherein the switches are actuated to de-energize the solenoids to effect transfer of fluid between said source and said double acting pistons to effect said unloading condition and the pistons being concentrically arranged about the axis of the distributor valve to receive fluid from said pump through said distributor valve whereby to be moved to said second position wherein the switches are actuated to energize the solenoids to effect transfer of fluid between said source and said double acting pistons to effect said loading condition, the distributor valve and the control pistons being arranged so that a control piston receives fluid when its corresponding plunger is substantially at the beginning of a suction stroke.

10. In a reciprocating multi-plunger type fluid pump having, for each plunger, a suction valve for loading and unloading the pump, mechanism for causing each suction valve to assume a loading condition, or alternatively, to assume an unloading condition comprising: for each suction valve, a fluid operated double acting piston movable in opposite directions to either of two positions, one position causing the suction valve to assume a loading condition and the other position causing the suction valve to assume an unloading condition; for each double acting piston, a control valve adapted to supply fluid to one side or the other of its double acting piston to cause the same to assume one or the other of said positions; a crankshaft for use in reciprocating said plungers; a fluid pump driven in synchronism with said crankshaft

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and connected to said control valves; a rotary distributor valve driven in synchronism with said crankshaft; fluid lines between said distributor valve and the discharge and suction sides of said pump including variable throttle means in the discharge and suction lines together with a selector valve alternatively operative to connect the distributor valve with the discharge line or the suction line; means to operate said selector valve; for each control valve, a control piston movable in opposite directions to first and second positions; and fluid means connected with said pump biasing said pistons to the respective first positions wherein the control valves are moved to effect transfer of fluid between said pump and said double acting pistons whereby to effect said unloading condition, the pistons being concentrically arranged about the axis of the distributor valve to receive fluid from said pump through said distributor valve whereby to be moved to said second position to effect transfer of fluid between said pump and said double acting pistons whereby to effect said loading condition, the distributor valve and the control pistons being arranged so that a control piston receives fluid when its corresponding plunger is substantially at the beginning of a suction stroke.

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