

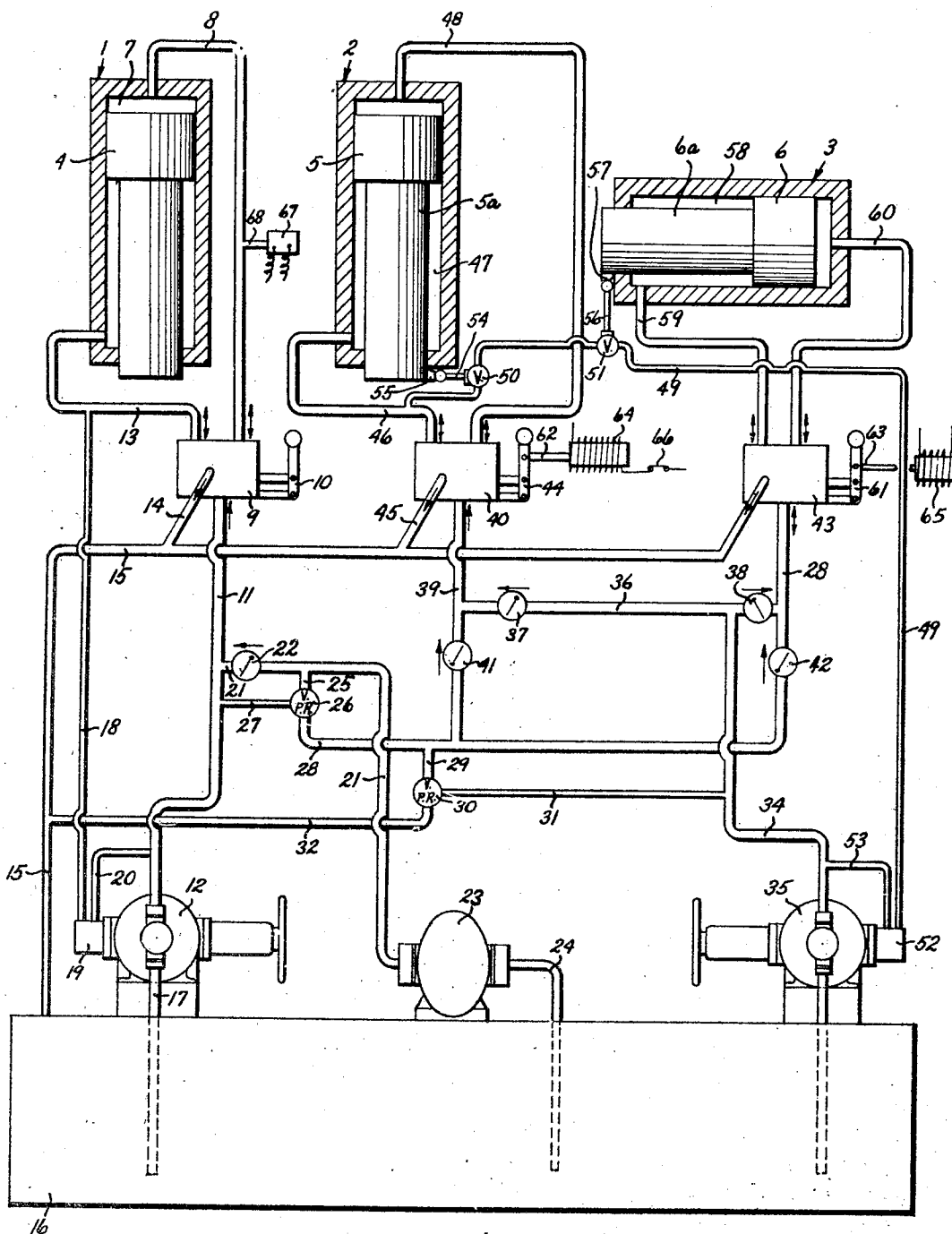
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MULTIPLE CYLINDER PRESS

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MULTIPLE CYLINDER PRESS

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This invention relates to hydraulic machinery, and in particular to hydraulic presses having a plurality of hydraulically operable cylinder-piston-assemblies.

It is an object of the invention to provide a press of the above character, in which the hydraulically operable cylinder-piston-assemblies are adapted to be actuated in a predetermined sequence.

It is another object of the invention to provide a press with a plurality of hydraulically operable cylinder-piston-assemblies cooperating with a plurality of pumps, in which the delivery of said pumps is temporarily supplemented by the delivery of additional pumping means.

A further object of the invention consists in the provision of a hydraulic system comprising a plurality of cylinder-piston-assemblies, in which main pumping means operable independently of each other are adapted to supply pressure fluid to said cylinder-piston-assemblies in a desired sequence, and in which additional pumping means supplements the delivery of said main pumping means responsive to a predetermined pressure condition in that cylinder-piston-assembly in which the main pumping means delivers.

It is still another object of the invention to provide a hydraulic system comprising a plurality of cylinder-piston-assemblies, in which a constant delivery pump selectively cooperates with one or a plurality of variable delivery pumps for effecting a fast traverse movement of the respective cylinder-piston-assembly.

These and other objects and advantages of the invention will appear more clearly from the following specification in connection with the accompanying drawing diagrammatically showing an assembly of the hydraulic system according to the invention.

General arrangement

The hydraulic system according to the present invention comprises a plurality of cylinder-piston-assemblies, each of which is adapted to be supplied with pressure fluid by a plurality of pressure fluid sources, one of which is delivering pressure fluid to the respective cylinder-piston-assembly during the entire working stroke thereof, while another fluid source merely temporarily supplements delivery of said first mentioned fluid source to effect a fast traverse movement of said cylinder-piston-assembly. According to a more specific embodiment of the invention, the fluid source which only temporarily

supplements the delivery of another fluid source to a cylinder-piston-assembly is controlled so as to be selectively by-passed or to supplement the delivery of a further fluid source supplying pressure fluid to a further cylinder-piston-assembly.

Structural arrangement

Referring to the drawing in detail, 1, 2 and 3 are cylinders having reciprocally mounted therein a double-acting piston 4, 5 and 6 respectively. While the cylinders 1 and 2 are arranged vertically, the cylinder 3 is arranged horizontally, however it is of course understood that the position of the cylinders 1, 2 and 3 may vary in accordance with the purposes for which they are used. Communicating with the upper portion of the cylinder bore 7 of the cylinder 1 is a conduit 8 leading to a four-way valve 9 which is operable by means of a lever system 10 which may be actuated manually or in any other way, for instance electrically. Operation of the lever system 10 in one direction is adapted to effect communication between the conduit 8 and the conduit 11 leading to the pressure side of the variable delivery pump 12 in which case the conduit 13, communicating with the lower portion of the cylinder bore 7, communicates with the conduit 14 branching off from the conduit 15 which latter leads to the fluid tank 16. The fluid tank 16 communicates through conduit 17 with the suction side of the pump 12. Movement of the lever system 10 in the other direction effects communication between the conduits 11 and 13 while the conduit 8 is placed into communication with the conduit 14. Branching off from the conduit 13 is a pilot line 18 leading to the servomotor 19 associated with the pump 12. Similarly, pilot line 20 also leading to the servomotor 19 is connected with the conduit 11. Such servomotors in cooperation with pilot lines are well known in the art and for a more detailed description thereof reference may be had to U. S. Patent No. 2,039,893 to Ernst describing a servomotor in which the flow control member is operable by a push rod with different piston areas, each of which may be effective when pressure is conveyed to the pilot line leading to the respective piston area. Servomotors of this kind are adapted in response to different pressures to shift the variable delivery pump to neutral position depending on whether pilot pressure is conveyed to one or the other pilot line.

Branching off from the conduit 11 is a conduit 21 comprising a check valve 22 and leading to the

pressure side of a constant delivery pump, for instance a gear pump 23, the suction side of which communicates through conduit 24 with the fluid tank 16. Communicating with the conduit 21 is a conduit 25 connected with an unloading valve 26 which, responsive to a predetermined pressure in the conduit 27 communicating with the conduit 11, is adapted to effect communication between the conduit 25 and the conduit 28. The conduit 28 communicates with a conduit 29 which in its turn is connected with an unloading valve 30. This unloading valve is adapted, in response to a predetermined pressure in the line 31, to effect communication between the conduit 29 and the conduit 32 communicating with the line 15, which latter leads to the fluid tank 16.

The line 31 is connected with a conduit 34 communicating on one hand with the pressure side of the variable delivery pump 35 and on the other hand with a conduit 36 comprising check valves 37 and 38. The check valve 37, when open, effects communication between the conduit 36 and the conduit 39, which latter leads to the four-way valve 40 and comprises a check valve 41. The check valve 38, when open, effects communication between the conduit 36 and the conduit 28 which comprises the check valve 42 and leads to the four-way valve 43. The four-way valve 40 is in its construction similar to the four-way valve 9 and is operable by the lever system 44. The conduit 45 is adapted to effect communication between the four-way valve 40 and the fluid tank 16 by means of the conduit 15. Also connected with the four-way valve 40 is a conduit 46 leading to the lower portion of the cylinder bore 47 of the cylinder 2, while the conduit 48, also connected with the four-way valve 40, leads to the upper portion of the cylinder bore 47. Branching off from the conduit 46 is a pilot line 49 which comprises a pilot valve 50 and a pilot valve 51 and is connected with the servomotor 52 pertaining to the variable delivery pump 35. A further pilot line 53 branching off from the conduit 34 likewise leads to the servomotor 52. The servomotor 52 of the pump 35 corresponds in its construction to the servomotor 19 of the pump 12.

The pilot valve 50 is provided with an arm 54 and is adapted to be opened by engagement of the cam 55 carried by the piston shaft 5a with the arm 54. Similarly, the pilot valve 51 is provided with an arm 56 adapted to be opened by engagement of the cam 57 carried by the piston shaft 6a. The left side of the cylinder bore 58, in which the piston 6 is reciprocable, communicates with a conduit 59 leading to the four-way valve 43. The right side of the cylinder bore 58 is adapted, by means of the conduit 60, to effect communication between the four-way valve 43 and the cylinder bore 58. The lever system 44 pertaining to the four-way valve 40 and the lever system 61 pertaining to the four-way valve 43 is connected with a rod 62 and 63 respectively, each of which carries an armature respectively cooperating with a solenoid 64 and 65. The solenoids 64 and 65 are arranged in the same circuit which may be interrupted by opening of the normally closed switch 66. The circuit comprising the solenoids 64 and 65 may be closed by the pressure responsive device 67 in response to a predetermined pressure in the conduit 8, which pressure is conveyed to the device 67 by means of the conduit 68 communicating with the conduit 8 and the pressure responsive device 67. The pressure responsive device 67 may be of any convenient structure but preferably a device is employed of

the type described in U. S. Patent application, Serial No. 214,772 to Ernst, filed June 20, 1938, now issued as Patent No. 2,224,957.

Operation

Assume that all parts occupy the position shown in the drawing and that it is now desired to operate the pistons 4, 5 and 6 sequentially. To this end the pumps 12, 23 and 35 are started in any convenient manner. The lever system 10 is then operated either manually or electrically, by any convenient means, so as to effect communication between the conduits 11 and 8 while placing the conduit 13 in communication with the conduit 14. The piston 4 then moves downwardly while pressure fluid delivered by the pump 12 passes through conduit 11, the four-way valve 9 and the conduit 8 into the upper portion of the cylinder bore 7. At this time the constant delivery pump 23 delivers pressure fluid through the conduit 21, the check valve 22, the conduit 11, the four-way valve 9 and the conduit 8 likewise into the upper portion of the cylinder bore 7 so that, due to the combined delivery of the pumps 12 and 23, a fast transverse movement of the piston 4, in this instance in the downward direction, is obtained. The fluid expelled from the retraction side of the piston 4 passes through the conduits 13, 14 and 15 into the tank 16.

As soon as a predetermined pressure is built up in the upper portion of the cylinder bore 7, for instance by engagement of a work piece, this pressure is conveyed through the conduit 11 and the conduit 27 to the unloading valve 26, thereby opening the latter and by-passing the delivery of the low pressure constant delivery pump 23 into the conduit 28. Since the fluid pressure in conduit 11 closes the check valve 22, escape from conduit 11 through check valve 22 is prevented. The variable delivery pump 12 which continues to deliver sufficient fluid to maintain the desired pressure in cylinder bore 7, then alone delivers pressure fluid into the cylinder bore 7 for completing the working stroke of the piston 4. When, at the end of the working stroke of the piston 4, a predetermined high pressure is built up in the cylinder bore 7 this high pressure is conveyed through the pilot line 20 to the servomotor 19, thereby shifting the pump 12 to substantially neutral position. Simultaneously the high pressure in the lines 11 and 8 is conveyed through the conduit 68 to the pressure responsive device 67 which then closes the circuit comprising the solenoids 64 and 65, provided that the switch 66 has not been opened.

Energization of the solenoids 64 and 65 causes the lever systems 44 and 61 to move so as to respectively establish communication between the conduits 39 and 48 and between the conduits 28 and 60. Pressure fluid is then delivered by the pump 35 through the conduits 34 and 36, on one hand through the check valve 37, the four-way valve 40 and the conduit 48 into the upper portion of the cylinder bore 47, and on the other hand through the conduit 28, the four-way valve 43 and the conduit 60 into the right side of the cylinder bore 58. The delivery of the pump 35 is supplemented by the delivery of the constant delivery low pressure pump 23, the fluid of which passes through the conduit 21, the unloading valve 26, the conduit 28, on one hand through the check valve 41, conduit 39, four-way valve 40 and conduit 48, and on the other hand through check valve 42, four-way valve 43 and conduit 60. The fluid expelled by the retraction

side of the piston 5 passes through the conduit 46, the four-way valve 43, the conduit 45 and the conduit 15 into the tank 16. Similarly, the fluid expelled by the retraction side of the piston 6 passes through the conduit 59, the four-way valve 43 and the conduit 15 into the tank 16.

As soon as a predetermined low pressure is built up in the cylinder bores 47, 58, this pressure is conveyed through the pilot line 31 to the unloading valve 30 so as to open the latter and to by-pass the delivery of the low pressure pump 23 through the conduit 21, unloading valve 26, conduit 29, unloading valve 30 and the conduits 32 and 15 into the tank 16. Check valves 41 and 42 close to prevent escape of pressure fluid from conduits 39 and 28 through said check valves respectively. The variable delivery pump 35 then alone delivers pressure fluid to the cylinder bores 47 and 58 for completing the working stroke of the pistons 5 and 6. When, at the end of the working stroke of the said pistons, a predetermined pressure is built up in the cylinder bores 47 and 58 this pressure acts through the conduit 34 and the pilot line 53 on the servomotor 52 so as to move the pump 35 into substantially no-delivery position. However, if this pressure tends to decrease, the pump 35 delivers sufficient fluid to maintain the desired pressure in cylinder bores 47 and 58.

If, for some reason, no automatic operation of the lever systems 44 and 61 is required, it is merely necessary to open the switch 66, thereby breaking the circuit comprising the solenoids 64 and 65 and thereby making the operation of the pressure device 67 ineffective. In this instance the lever systems 44 and 61 may be operated manually, either simultaneously or sequentially. The operation of the pistons 5 and 6, however, will be the same as before. It may be mentioned that pressure can be built in cylinder bore 47 and trapped there by the action of check valves 41 and 37 while pressure fluid at a lower pressure is admitted to cylinder bore 58. If the latter pressure is below that required to open unloading valve 30, fluid from both pumps 23 and 35 will be available. The effectiveness with which pressure can be trapped in cylinder bore 47 is of course dependent upon the ability of the check valves 41 and 37 and the operating valve 40 to tightly close conduits 39, 36, 46, and 45. In a similar manner it is possible to first build pressure in cylinder bore 58, trap it and later build pressure in cylinder bore 47. Likewise it is possible to trap pressure in either cylinder bore while fluid is admitted to the retraction side of the other piston.

The pistons 4, 5 and 6 now are in their lowermost position and remain there until the lever systems 10, 44 and 61 are moved to their other position in which the retraction side of the said pistons is connected with the pressure side of the pump. To effect the retraction stroke of the pistons 4, 5, and 6, the lever systems 10, 44 and 61 may be shifted selectively in any desired sequence, either manually or automatically. In this last mentioned instance at the end of the working stroke, or at least a predetermined time thereafter, the circuit comprising the solenoids 64 and 65 may be interrupted, either in response to the position of the pistons 5 and 6 or in response to a predetermined pressure acting thereupon. If desired, the pistons 4, 5 and 6, or at least one of them may, at the end of its working stroke or a predetermined time thereafter, break the circuit comprising the solenoids 64 and 65, while

shifting the lever systems pertaining to the pistons 4, 5 and 6 so as to establish communication between the retraction stroke of said pistons and the pressure side of the pumps.

Assuming that hand operation is desired and that the piston 4 is to remain in its lowermost position during the first portion of the retraction stroke of the pistons 5 and 6, the operator shifts the lever systems 44 and 61 so as to effect communication between the conduits 39 and 46 and between the conduits 28 and 59 respectively. This causes a pressure drop in the pilot line 31 with the result that the unloading valve 30 closes so that the fluid delivered by the pump 23 passes through the conduits 21, 28, on one hand through the conduits 39 and 46 into the lower portion of the cylinder bore 47, and on the other hand through the conduit 59 into the left hand portion of the cylinder bore 58. The pressure drop in the pilot line 31, conduit 34 and the pilot line 53 places the pump 35 again on full stroke so that the latter delivers pressure fluid through the conduits 34 and 36 and the conduits 39 and 28 into the lower portion of the cylinder bore 47 and into the left hand portion of the cylinder bore 58. In other words, the pumps 23 and 35 deliver pressure fluid to the retraction side of the pistons 5 and 6, thereby causing a fast retraction movement of the said pistons. The fluid expelled by the piston 6 during its retraction stroke is passed through the conduits 60 and 15 into the tank 16, while the fluid expelled by the piston 5 during its retraction stroke is passed through the conduits 48, 45 and 15 likewise into the fluid tank 16.

When the pistons 5 and 6 have reached their uppermost positions, the cams 55 and 57, connected with the piston shafts 5a and 6a respectively, actuate the valve arms 54 and 56 so as to open the valves 50 and 51. As a result thereof, the pressure prevailing in the conduit 46 is conveyed through the pilot line 49 to the servomotor 52, thereby moving the variable delivery pump 35 to substantially neutral or no-delivery position. It should be noted that when pressure in pilot line 49 is acting on servomotor 52, the same pressure is also acting upon another piston area of the servomotor through pilot line 53. This combined action serves to move the variable delivery pump 35 to substantially neutral or no-delivery position when a pressure much lower than normal working pressure has been built up in the retraction system, and thereby reduces the pressure the pump must generate during its idle period and the power it consumes. Only when both pistons 5 and 6 are fully retracted, is pilot pressure admitted to conduit 49; at all other times the discharge of the pump is not reduced until the maximum desired working pressure is approached.

The piston 4 may, at the end or at any time during the retraction stroke of the pistons 5 and 6, likewise be returned to its initial position by shifting the lever system 10 so as to effect communication between the conduits 11 and 13. When the lever system is so shifted, a pressure drop occurs in the pilot line 20 so that the pump 12 is again moved to its full stroke position and now delivers pressure fluid through the conduits 11 and 13 into the lower portion of the cylinder bore 7, thereby lifting the piston 4. The pressure drop in the conduit 20 and thereby also in the conduits 11 and 27 closes the unloading valve 26 so that the fluid delivered by the pump 23 passes through the conduit 21 and the conduits 11 and

13 likewise into the lower portion of the cylinder bore 7, thereby supplementing the delivery of the pump 12 and effecting a fast lifting movement of the piston 4. The fluid expelled by the piston 4 during its retraction stroke is passed through the conduits 8, 14 and 15 into the tank 16. When the piston 4 has reached its uppermost position and a predetermined pressure is built up on the retraction side of the piston 4, this pressure is conveyed through the pilot line 18 to the servomotor 19, thereby shifting the pump 12 to substantially neutral position. The condition set forth above in connection with the explanation of the situation when pressure in pilot line 49 is acting on servomotor 52, also exists here with the exception that the pump is shifted to nearly neutral position at any time the reduced pressure is reached in the retraction conduit 13 irrespective of the position of the piston. This pressure is determined so that it is always sufficient to return piston 4. The pressure prevailing in the conduits 11 and 27 again opens the unloading valve 26, while the pressure prevailing in the conduit 31 opens the unloading valve 30 so that the delivery of the pump 23 is again by-passed to the tank 16, as previously described. All parts are then again in the position shown in the drawing and ready for a new cycle. It should be noted that though piston 4 is in the retracted position, and unloading valve 30 is open, fluid from pump 23 is available to cylinder 2 and 3 anytime the pressure in pilot conduit 31 drops sufficiently to close valve 30.

While the invention has been described in connection with two vertically and one horizontally arranged pistons, it is of course understood that the position of the pistons may be varied. It is furthermore understood that instead of feeding only one cylinder-piston-assembly by the pump 12 also more cylinder-piston-assemblies may be supplied with fluid by the pump 12. The pistons 4, 5 and 6 may be used for various purposes, for instance, the piston 4 may be used for clamping and holding a work piece during the pressing operation, while the pistons 5 and 6 may perform the actual pressing operation. If desired, either or both pistons 5 and 6 may be used to clamp the work while the other piston 4 or both perform the actual pressing operation.

The hydraulic system of the present invention is particularly useful for operating a press for flanging steel plate and for operating a multiple cylinder bulldozing machine or any other type of bending machine. However, the hydraulic system of this invention is not limited to these fields, but is applicable to any machine requiring the operation of a multiple of hydraulic cylinders or fluid drives where such cylinder and drives are in operation for a period less than the total machine cycle, and where they operate with a sequence of rapid traverse motions.

It will be understood that I desire to comprehend within my invention such modifications as come within the scope of the claims.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a hydraulic system, a plurality of fluid

motors operable independently of each other, a plurality of separate main pressure sources to respectively supply pressure fluid to said motors, an auxiliary fluid source adapted to supply pressure fluid to one or another of said motors and normally connected in parallel with one main fluid pressure source, means responsive to pressure in said one main source which disconnects said auxiliary source therefrom and connects it in parallel with the second main source, and means whereby pressure in said second main source operates means to by-pass the auxiliary source.

2. In a hydraulic system, a first fluid operable motor, a first main fluid source adapted to supply pressure to said first motor, a second fluid operable motor, a second main fluid source for supplying pressure fluid to said second motor, automatic means for reducing the delivery of each of said main fluid sources to its respective motor in response to a predetermined pressure therein, an auxiliary fluid source normally connected in parallel with one main source, means responsive to pressure in said one main source which disconnects said auxiliary source therefrom and connects it in parallel with the second main source, and means whereby pressure in said second main source is caused to operate means to by-pass the auxiliary source.

3. In a hydraulic system, a first cylinder-piston-assembly, a second cylinder-piston-assembly, a separate main fluid source for supplying pressure fluid to each of the cylinder-piston-assemblies, a hydraulic circuit interconnecting each main fluid source and its cylinder-piston-assembly so as to allow operation of one cylinder-piston-assembly without effecting operation of the other cylinder-piston-assembly, an auxiliary fluid source normally connected in parallel with one main source means responsive to pressure in said one main source which disconnects said auxiliary source therefrom, and connects it in parallel with the other main source, and means whereby pressure in said last-named main source operates means to by-pass the auxiliary fluid source.

4. In a hydraulic system, a primary cylinder-piston-assembly, a first variable delivery pump adapted to supply main pressure fluid to said primary cylinder-piston-assembly, a group of secondary cylinder-piston-assemblies, a second variable delivery pump for supplying main pressure fluid to said secondary cylinder-piston-assemblies to operate the same independently of said primary cylinder-piston-assembly, a constant delivery pump connected in parallel with said first variable delivery pump for supplying pressure fluid to said primary cylinder-piston-assembly during the first portion of the working stroke thereof, means responsive to pressure from said first variable delivery pump for disconnecting said constant delivery pump from the first variable delivery pump and connecting it in parallel with the second variable delivery pump, and means in said second variable delivery pump to cause the pressure therein to by-pass said constant delivery pump.

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