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[54] **HYDRAULIC SYSTEM**
6 Claims, 1 Drawing Fig.

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F15b 11/16
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170, 191; 60/10.5, 54.5, 54.5 HA

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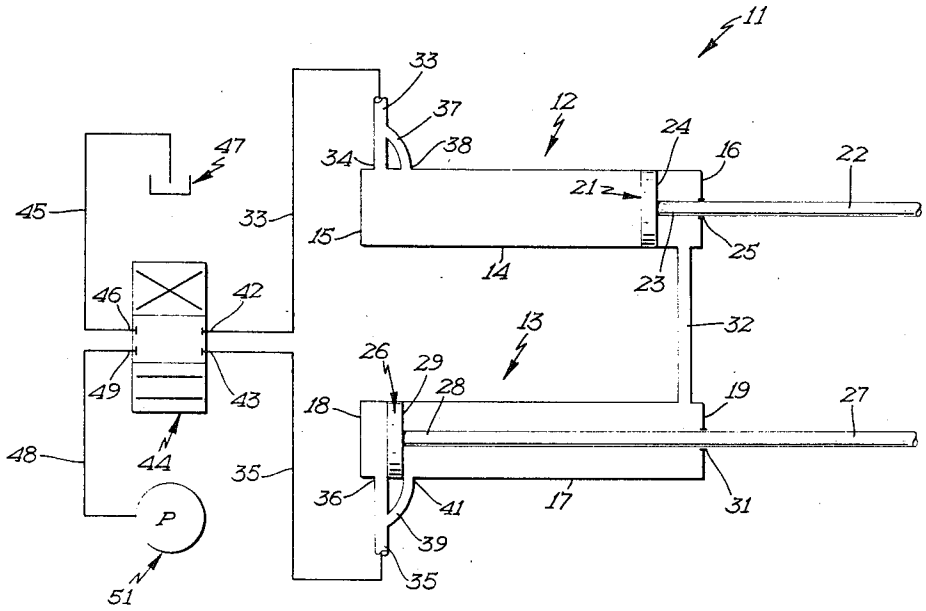
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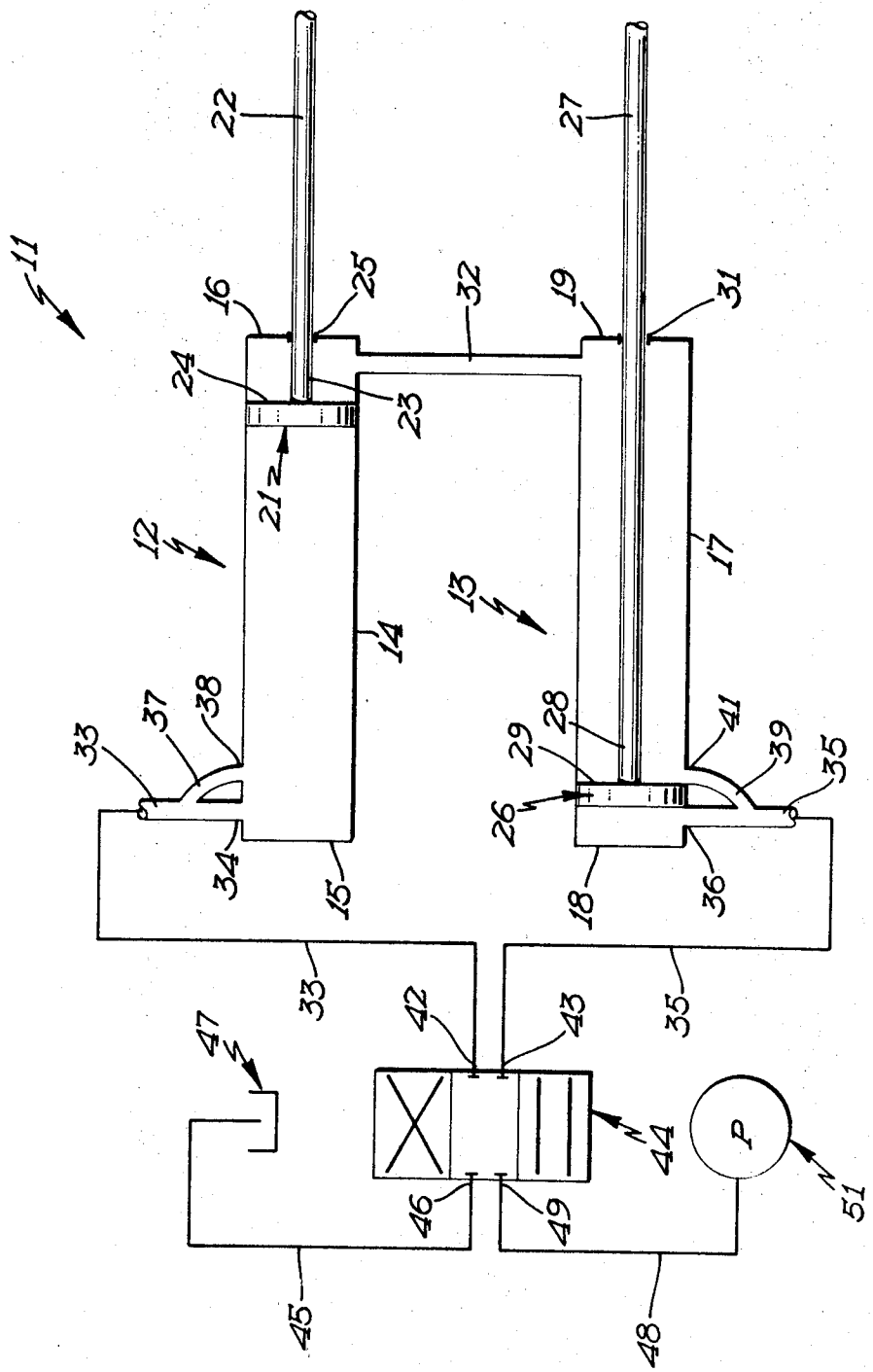
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ABSTRACT: An improved hydraulic system comprising a pair of hydraulic cylinders adapted to be used to operate devices requiring reciprocatory power inputs. Each of the hydraulic cylinders has a piston positioned for reciprocal movement therein, and the hydraulic cylinders are arranged so that the pistons move together in a master-slave relationship. A novel bypass arrangement is utilized to compensate for the loss, through leakage, of hydraulic fluid in the system. At the beginning of each stroke of the pistons, additional hydraulic fluid is introduced into the portion of the hydraulic cylinders between the piston in excess of that necessary to cause the pistons to move through their complete stroke, and at the end of each stroke of the pistons, this additional hydraulic fluid is removed from the system. This arrangement assures that the amount of hydraulic fluid in the closed portion of the system never falls below that necessary to cause the pistons to move through their complete strokes.





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HYDRAULIC SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to an improved hydraulic system, adapted to operate devices, such as the pumping cylinders of a concrete pump, which require reciprocatory power input, and more particularly, to an improved hydraulic system comprising a pair of hydraulic cylinders in which the pistons operate in a master-slave relationship.

In the past, hydraulic systems having a pair of pistons operably arranged in master-slave relationship have been utilized to operate various devices, including the pumping cylinders of a concrete pump. One problem with these prior hydraulic systems was that hydraulic fluid would unavoidably leak out of the system around the piston seals and shaft seal, and this loss of hydraulic fluid affected the operation of the system in that the length of the piston stroke would be correspondingly shortened. To overcome this problem, the prior hydraulic systems usually incorporated a means such as a needle valve, to introduce hydraulic fluid, either automatically or manually into the system. Furthermore, a pressure relief valve was generally used so that no damage occurred to the system if excess hydraulic fluid was inadvertently introduced into the system. The use of these valves, however, increased the initial cost and the expense of maintaining these prior hydraulic systems.

SUMMARY OF THE DISCLOSURE

In contrast to the prior hydraulic systems, the improved hydraulic system of the present invention eliminates the need for the valves heretofore used to regulate the amount of the hydraulic fluid in the closed portion of the hydraulic system between the pistons.

More specifically, an improved hydraulic system comprising a pair of hydraulic cylinders which are adapted to operate devices, such as the pumping cylinders of a concrete pump, requiring reciprocatory power input. Each of the hydraulic cylinders has a piston positioned for reciprocal movement therein, and the one ends of the hydraulic cylinders are interconnected so that there is fluid communication therebetween. The portions of the hydraulic cylinders between the pistons and the one ends thereof are filled with hydraulic fluid while the other ends of the hydraulic cylinders are selectively and alternatively connected with the outlet of a pump or with a sump whereby the two pistons move within the hydraulic cylinders in a master-slave relationship, i.e., when one piston moves toward the one end of its hydraulic cylinder, the other piston moves away from the one end of its hydraulic cylinder and vice versa.

Each of the conduits includes a bypass which extends from the conduit to the hydraulic cylinder and which is connected to the hydraulic cylinder at a point spaced from the other end of the hydraulic cylinder a distance greater than the thickness of the piston. During the part of the piston stroke when the piston is closest to the other end of the hydraulic cylinder, the bypass is placed in fluid communication with the portion of the hydraulic cylinder between the piston and the one end of the hydraulic cylinder and at the beginning of each stroke of the pistons, additional hydraulic fluid is introduced, through the bypass, into the closed portion of the hydraulic cylinder in excess of that necessary to cause the other piston to move through a complete stroke. At the end of each stroke of the pistons, i.e. after the other piston has been moved to a position adjacent to the other end of its hydraulic cylinder, the additional hydraulic fluid is removed from the closed portion of the hydraulic cylinder through the bypass. This introduction and removal of additional hydraulic fluid from the closed portion of the hydraulic cylinder occurs during each stroke and is utilized to compensate for losses of hydraulic fluid due to leakage, by assuring that the amount of hydraulic fluid in the closed portion of the hydraulic system never is less than the minimum needed to cause the pistons to move through their complete strokes.

Accordingly, it is a primary object of the present invention to provide an improved hydraulic system for operating devices, such as the pumping cylinders of a concrete pump, which system includes a pair of hydraulic cylinders having pistons positioned for reciprocal movement therein, with the pistons being arranged to operate in a master-slave relationship and which system utilizes a novel bypass arrangement to compensate for the loss, due to leakage, of hydraulic fluid in the closed portion of the hydraulic system between the pistons.

Another object of the present invention is to provide an improved hydraulic system of the type described wherein at the beginning of each stroke of the pistons, additional hydraulic fluid is introduced into the closed portion of the hydraulic system in excess of that necessary to cause the pistons to be moved through their complete strokes; and wherein at the end of each stroke of the pistons, this additional hydraulic fluid is removed from the hydraulic system.

Another object of the present invention is to provide an improved hydraulic system of the type described wherein one ends of the hydraulic cylinders are in fluid communication; wherein a novel bypass extends between each of the hydraulic cylinders and the conduits connecting the hydraulic cylinders selectively and alternatively with the outlet of a pump or with a sump; wherein the bypass is connected with the hydraulic cylinder at a point spaced from the other end of the hydraulic cylinder a distance greater than the thickness of the piston so that when the piston is adjacent to the other end of the hydraulic cylinder, the bypass is in fluid communication with the portions of the hydraulic cylinders between the pistons and the one ends thereof; and wherein additional hydraulic fluid is introduced into and removed from the closed portion of the hydraulic system through the bypasses.

These and other objects of the present invention will become apparent from the following description of the preferred embodiment.

DESCRIPTION OF THE DRAWINGS

The FIGURE is a schematic view of the improved hydraulic system of the present invention.

Throughout the description of the preferred embodiment, the terms "right," "left," "right end" and "left end" are used, and it should be understood that these terms are used only with reference to the structure shown in the FIGURE of the drawing, as it would appear to a person viewing the FIGURE.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the FIGURE, the improved hydraulic system of the present invention is shown generally at **11**. The system **11** includes a pair of hydraulic cylinders **12** and **13**. Hydraulic cylinder **12** includes a cylindrical sidewall **14**, a left end wall **15** and a right end wall **16**. Hydraulic cylinder **13** is substantially structurally identical to hydraulic cylinder **12** and includes a cylindrical sidewall **17**, a left end wall **18** and a right end wall **19**.

A conventional piston **21** is positioned within the hydraulic cylinder **12** and is adapted to move reciprocally within the hydraulic cylinder in a direction parallel to the longitudinal axis of the cylinder **12**. Conventional piston seals, not shown, are carried by piston **21** to minimize leakage of fluid between the periphery of the piston and the sidewall **14**. A piston rod **22** is secured at one end **23** to the right face **24** of the piston **21** so that the rod **22** moves with the piston **21**. The piston rod **22** extends through a sealed aperture **25** in the right end wall **16** of the cylinder **12**.

A conventional piston **26** is positioned within the hydraulic cylinder **13** and is likewise adapted to move reciprocally in the hydraulic cylinder in a direction parallel to the central longitudinal axis of the cylinder **13**. Conventional piston seals, not shown, are carried by the piston **26** to minimize leakage of fluid between the periphery of the piston and the sidewall **17**. A piston rod **27** has one end **28** secured to the right face **29** of the piston **26** so that the piston rod **27** moves with the piston

26. The piston rod 27 extends through a sealed aperture 31 in the right end wall 19 of the cylinder 13.

The other ends of the piston rods 22 and 27 may be connected to various devices which use reciprocatory input power, such as the pumping pistons utilized in the pumping cylinders of a concrete pump.

A conduit 32 interconnects the hydraulic cylinders 12 and 13 at points adjacent to the right end walls 16 and 19 thereof. A conduit 33 is connected at one end 34 with the sidewall 14 of the hydraulic cylinder 12 at a point adjacent to the left end wall 15 of cylinder 12 so that the conduit 33 communicates with that portion of the interior of the hydraulic cylinder 12 to the left of piston 21. A conduit 35 is connected at one end 36 with the sidewall 17 of the hydraulic cylinder 13 at a point adjacent to the left end wall 18 of the cylinder 13 so that the conduit 35 communicates with that portion of the interior of the hydraulic cylinder 13 to the left of piston 26.

A bypass conduit 37 is connected at one end with the conduit 33 and at its other end 38 with the sidewall 14 of the cylinder 12 so as to permit fluid communication between the conduit 33 and the interior of the hydraulic cylinder 12. The distance between the left end wall 15 of the hydraulic cylinder 12 and the end 38 of the bypass conduit 37 is greater than the thickness, in a direction parallel to the longitudinal axis of the cylinder 12, of the piston 21 so that when the piston 21 is in its leftmost position within the hydraulic cylinder 12, there is fluid communication between the conduit 33, through the bypass conduit 37, and that portion of the interior of the hydraulic cylinder 12 to the left of the piston 21.

A bypass conduit 39 is connected at one end with the conduit 35 and at its other end 41 with the sidewall 17 of the hydraulic cylinder 13 so as to permit fluid communication between the conduit 35 and the interior of the hydraulic cylinder 13. Like bypass conduit 37, the bypass conduit 39 is connected to the cylinder sidewall 17 at a point spaced from the left end wall 18 a distance greater than the thickness, in a direction parallel to the longitudinal axis of the cylinder 13, of the piston 26 so that when the piston 26 is in its leftmost position, as shown in FIG. 1, there is fluid communication between the conduit 35, through the bypass conduit 39, and that portion of the interior of the hydraulic cylinder 13 to the right of piston 26.

The other ends 42 and 43 of the conduits 33 and 35, respectively, are connected with a conventional three-way valve 44. The valve 44 may be actuated automatically or manually by any conventional means, not shown. A conduit 45 is connected at one end 46 with the valve 44 at its other end with a conventional sump 47 which is adapted to receive hydraulic fluid. A conduit 48 is connected at one end 49 with the valve 44 and at its other end with the outlet of a conventional pump 51 which is adapted to pump hydraulic fluid. The valve 44 is arranged so that if the valve is in its first position, as shown on the FIGURE, there is no communication between the conduits 33, 35, 45 and 48. However, when the valve is moved into its second position, communication is permitted between conduits 33 and 45 and between conduits 35 and 48. When the valve 44 is moved to its third position, communication is permitted between conduits 33 and 48 and between conduits 33 and 45.

OPERATION

Conventional hydraulic fluid fills the portions of the hydraulic cylinders 12 and 13 to the right of the pistons 21 and 26, respectively, and the conduit 32. To begin operation of the hydraulic system 11, the valve 44 is moved from its first position, shown in the FIGURE, to its second position wherein the outlet of the pump 51 communicates with the conduit 35 and the conduit 33 is in communication with the sump 47. The pressure of the hydraulic fluid from the pump 51 forces the piston 26 to move to the right from the position shown in the FIGURE. As a result of the hydraulic fluid in the portions of the hydraulic cylinders 12 and 13 to the right of the pistons 21 and 26 and in the conduit 32, this rightward movement of the piston 26 causes the piston 21 to be moved to the left in hydraulic cylinder 12. Any fluid in hydraulic cylinder 12 to the left of the piston 12 flows out of the cylinder 12, through the conduit 33 and to the sump 47.

While piston seals are used about the pistons 21 and 26 and while the apertures 25 and 31 include conventional shaft seals, not shown, to minimize leakage of fluid between the apertures 25 and 31 and the rods 22 and 27, respectively, there will always be, in practice, a certain amount of hydraulic fluid which will leak past these seals during each stroke of the pistons. This "lost" hydraulic fluid must be compensated for or else the length of the strokes of the pistons will be reduced.

In the improved hydraulic system of the present invention, the novel bypass arrangement is utilized to compensate for the normal losses, due to leakage of hydraulic fluid from the closed portion of the hydraulic system. More specifically, at the beginning of the stroke of the piston 26, the outlet of the pump 51 also communicates with that portion of the interior of the cylinder 13 to the right of piston 26 through the bypass conduit 39, and additional hydraulic fluid is introduced into the closed portion of the hydraulic cylinders 12 and 13 to the right of the pistons 21 and 26, and the conduit 32 in excess of that necessary to cause the pistons 21 and 26 to move through their complete strokes. The addition of relatively high-pressure hydraulic fluid continues until the bypass 39 is blocked by the piston 26, as the piston 26 moves to the right in cylinder 13.

At the end of the stroke of piston 21, this additional hydraulic fluid is removed from the closed portion of the hydraulic cylinders 12 and 13 by means of the bypass 37 and flows to the sump 47 through conduits 35 and 45. Furthermore, when the piston 26 has been moved to its rightmost position within the hydraulic cylinder 13, and thus piston 21 has been moved to the leftmost position within the hydraulic cylinder 12, the valve 44 is actuated, either manually or automatically, so that the valve 44 is switched from its second position to its third position. As a result of switching of the valve 44 from its second to its third position, the conduit 33 is placed in fluid communication with the outlet of the pump 51 while the conduit 35 is placed in communication with the sump 47. Thus, high-pressure fluid in conduit 33 causes the piston 21 to begin moving to the right within cylinder 12 and additional hydraulic fluid is again introduced into the closed portion of the hydraulic cylinders through bypass 37 until the movement of the piston 21 to the right blocks the bypass 37. Movement of the piston 21, in response to the high-pressure fluid in conduit 33, together with the hydraulic fluid in the hydraulic cylinders 12 and 13 to the right of the pistons 21 and 26, cause piston 26 to be moved to the left in the hydraulic cylinder 13. This movement of piston 26 causes any hydraulic fluid in the hydraulic cylinder 13 to the left of piston 26 to be forced into conduit 35 and thus to the sump 47. At the end of this leftward movement or stroke of piston 26, the additional hydraulic fluid in the closed portion of the hydraulic cylinders is removed from the cylinder 13 through the bypass 39 and flows to the sump 47 through conduits 35 and 45. The master-slave operation of the pistons 21 and 26 continues until the valve 44 is switched to and held in its first position.

In accordance with the foregoing, it is apparent that the hydraulic system of the present invention is an improvement over the prior hydraulic systems in that it permits a system, utilizing a master-slave piston relationship, to operate without the use of relatively expensive pressure regulators and valves that heretofore have been needed to insure that the closed portion of the hydraulic system remains sufficiently full of hydraulic fluid so that the pistons will travel through the same stroke length during each cycle of operation.

It should be apparent to those skilled in this art that the improved hydraulic system of the present invention may be embodied in other specific forms without departing from the spirit or central characteristics of the invention described herein. For example, different valves could be utilized in place

of valve **44**, and, of course, the conduits **32**, **33** and **35** do not need to be connected with the side of the hydraulic cylinders but could be connected with the ends of the hydraulic cylinders. Therefore, the preferred embodiment of the improved hydraulic system described herein is to be considered in all respects as illustrative and not restrictive, the scope of the present invention being indicated by the appended claims, rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

I claim:

1. An improved hydraulic system comprising; a first hydraulic cylinder having a sidewall and first and second closed end walls; a first piston positioned within the first hydraulic cylinder for reciprocal movement therein in a direction parallel to the central longitudinal axis of the first hydraulic cylinder; a first piston rod secured to one face of the first piston and extending from the first hydraulic cylinder through a sealed aperture in one of the end walls thereof; a second hydraulic cylinder having a sidewall and first and second closed end walls; a second piston positioned within the second hydraulic cylinder for reciprocal movement therein in a direction parallel to the central longitudinal axis of the second hydraulic cylinder; a second piston rod secured to one face of the second piston and extending from the second hydraulic cylinder through a sealed aperture in one of the end walls thereof; means for permitting fluid communication between the first hydraulic cylinder, adjacent to its first end wall, and the second hydraulic cylinder, adjacent to its first end wall; pump means for pumping hydraulic fluid; sump means for receiving hydraulic fluid; first conduit means adapted to be selectively and alternatively connected with the portion of the first hydraulic cylinder between the first piston and the second end wall with the outlet of the pump means or the sump means; second conduit means adapted to be selectively and alternatively connected with the portion of the second hydraulic cylinder between the second piston and the second end wall with the sump means or the outlet of the pump means; first bypass means extending from the first conduit means to the first hydraulic cylinder, with the point of connection between the first bypass means and the first hydraulic cylinder being spaced from the second end wall of the first hydraulic cylinder a distance greater than the thickness of the first piston so that during the portion of the stroke of the first piston when the first piston is closest to the second end wall of the first hydraulic cylinder, the first bypass means permits fluid communication between the first conduit means and the portion of the first hydraulic cylinder between the first piston and the first end wall of the first hydraulic cylinder; and a second bypass means extending from the second conduit means to the second hydraulic cylinder, with the point of connection between the second bypass means and the second hydraulic cylinder being spaced from the second end wall of the second hydraulic cylinder a distance greater than the thickness of the second piston so that during the portion of the stroke of the second piston when the second piston is closest to the second end wall of the second hydraulic cylinder, the second bypass means permits fluid communication between the second conduit means and the portion of the second hydraulic cylinder between the second piston and the first end wall of the second hydraulic cylinder.

2. The improved hydraulic system described in claim **1** wherein the means for permitting fluid communication between the first and second hydraulic cylinders includes third conduit means.

3. The improved hydraulic system described in claim **1** wherein the first piston rod extends through a sealed aperture in the first end wall of the first hydraulic cylinder; and wherein the second piston rod extends through a sealed aperture in the first end wall of the second hydraulic cylinder.

4. The improved hydraulic system described in claim **1** which includes valve means being selectively operable to connect the first conduit means with the outlet of the pump and the second conduit means with the sump or to connect the first conduit means with the sump and the second conduit means with the outlet of the pump.

5. The improved hydraulic system described in claim **1** wherein the means for permitting fluid communication between the first and second hydraulic cylinders includes third conduit means; wherein the first piston rod extends through a sealed aperture in the first end wall of the first hydraulic cylinder; and wherein the second piston rod extends through a sealed aperture in the first end wall of the second hydraulic cylinder.

6. The improved hydraulic system described in claim **5** which includes valve means being selectively operable to connect the first conduit means with the outlet of the pump and the second conduit means with the sump or to connect the first conduit means with the sump and the second conduit means wit the outlet of the pump.