Nov. 16, 1943. R. F. CARR ET AL 2,334,383

HYDRAULIC CONTROL

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Fig. 1

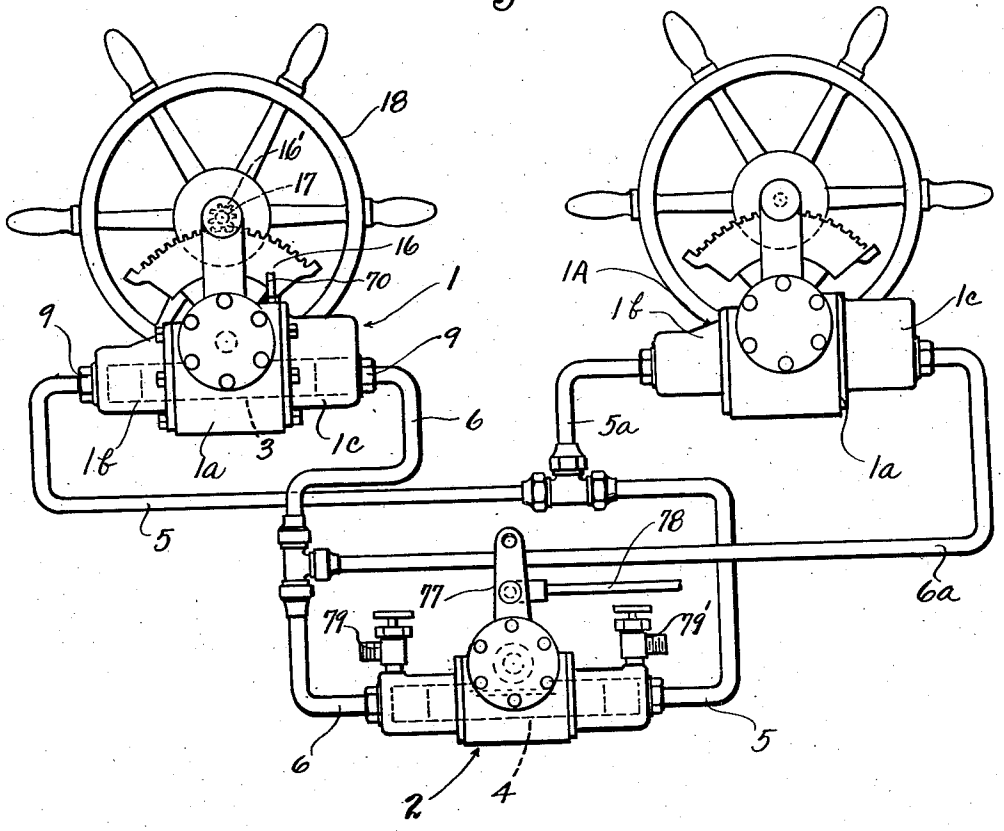
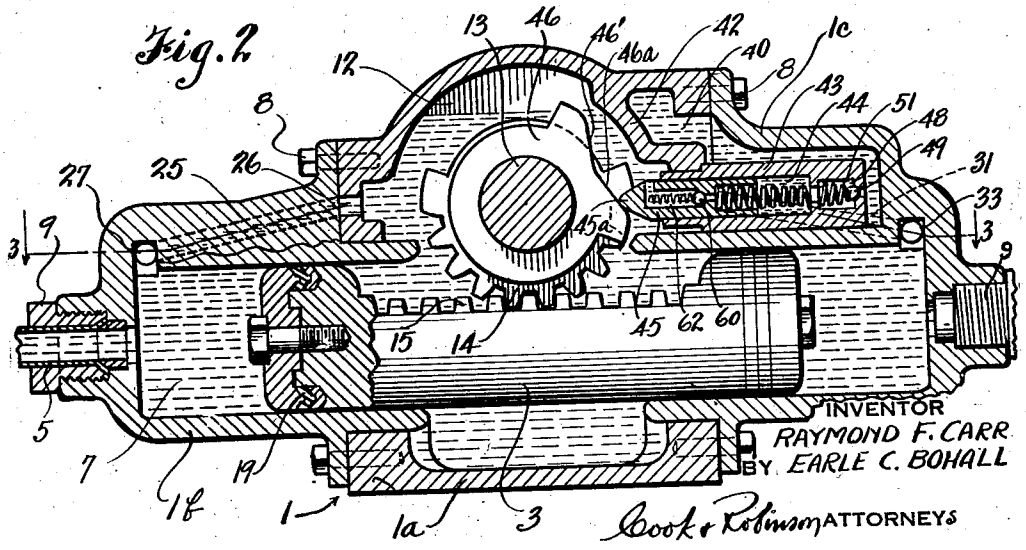


Fig. 2



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Fig. 3

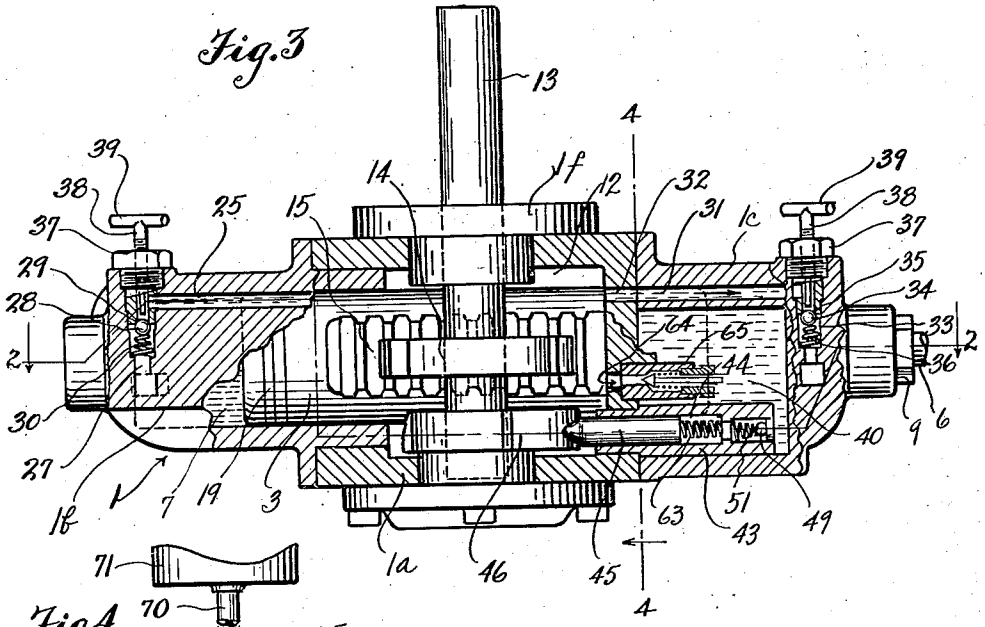


Fig. 4

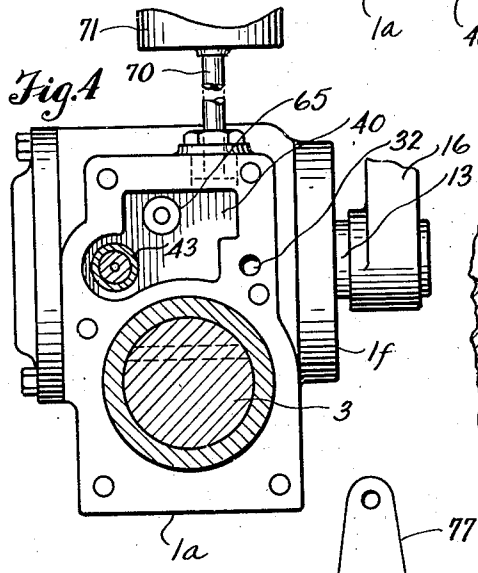


Fig. 5

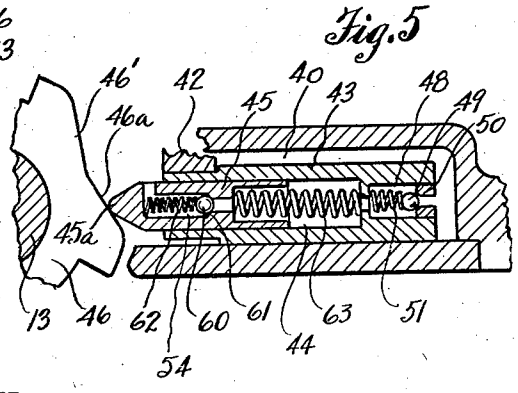
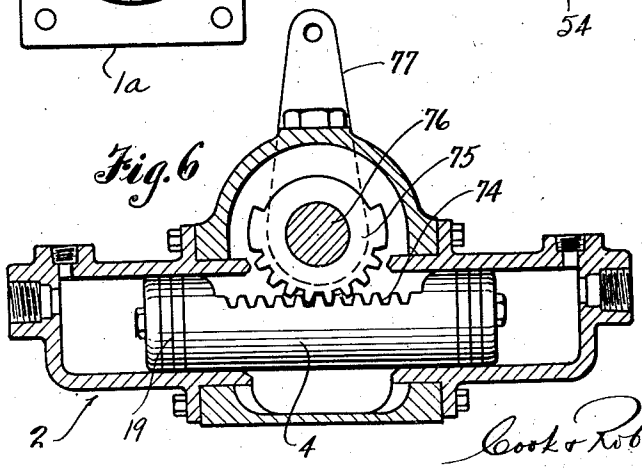


Fig. 6



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Fig. 7

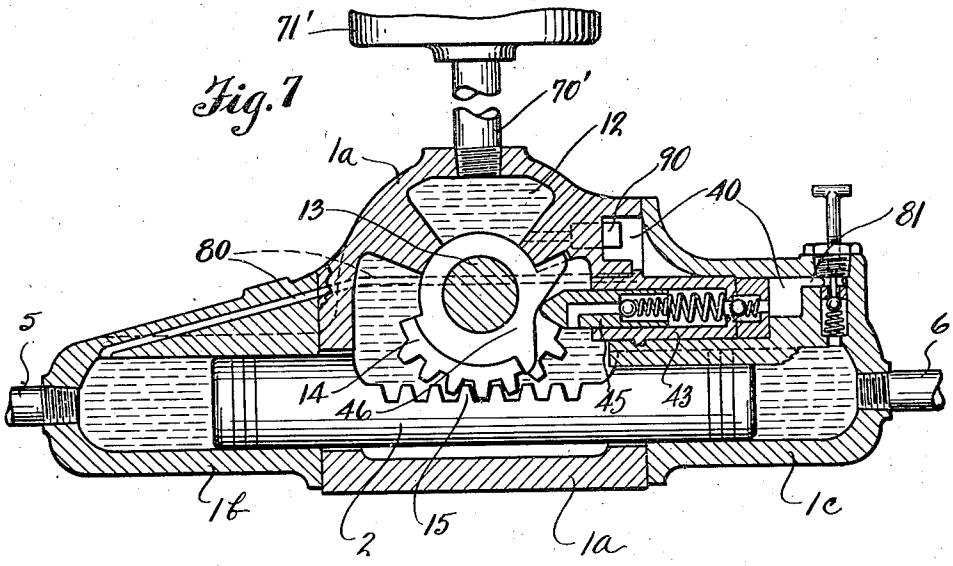
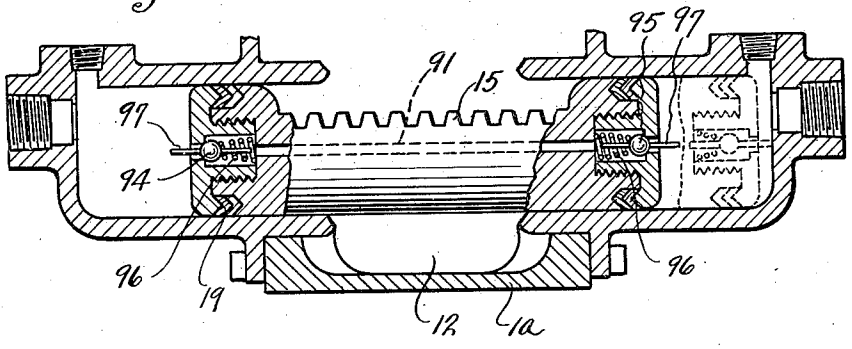


Fig. 8



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HYDRAULIC CONTROL

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Application August 4, 1941, Serial No. 405,382

4 Claims. (Cl. 60—54.6)

This invention relates to hydraulic power transmission means and remote control systems. More particularly, the invention has reference to improvements in closed, hydraulic control systems sometimes referred to as "pulsator systems," characterized by having a transmitter piston or plunger operable in one cylinder of the closed hydraulic system to effect, through the mediacy of a confined hydraulic medium, an instant and corresponding movement of a piston or plunger in a receiver cylinder, which might be located at some remote distance from that first mentioned.

More specifically stated, the present invention relates to an improved, hydraulic system of remote control, wherein there are at least two hydraulic cylinders, each containing a double acting piston and wherein corresponding ends of the cylinders are connected by closed conduits, and the whole system filled with a hydraulic medium, thus providing that the controlled movements of the transmitter piston in its cylinder, in either direction, will cause a positive, instant and corresponding movement of the piston of the other or receiver cylinder for the functional actuation of a mechanism operating under control of the present system.

Explanatory to the present invention, it will be stated here that the maximum effectiveness, efficiency and positiveness of a system of control of the above kind is dependent, among other things, on maintaining the closed or torque transmitting portion of the system free of air, or vacuum and completely filled with the operating hydraulic medium under super-atmospheric pressure.

It will be mentioned also, as explanatory to the invention, that leakage of the hydraulic pressure medium from the system is not always or only past the valves, piston packing, or other movable parts or loose connections between parts which confine the hydraulic medium, but frequently is the result of seepage through the pores of the metal pipes, housings and other parts in which the oil, or whatever hydraulic medium is used, is confined. It is a fact, also, that whenever leakage of this character, referred to as "weeping," does occur, even though it be measured in drops, it is essential that the loss be compensated for, or otherwise it will cause the system to lose its necessary positiveness of action and its timing or adjustment, without which it becomes unsatisfactory in use, if not inoperative.

In view of the above explanatory remarks, it has been the principal object of this invention to provide certain improvements in systems of this kind whereby any loss of hydraulic medium from the system that may occur from "weeping" or leakage incident to normal use of the device, will be automatically replaced. Furthermore, to provide a means for the replacement of leakage in a manner whereby a super-atmospheric pressure will be maintained at all times on the hydraulic medium confined in the system.

More specifically stated, it is the object of this invention to provide a system of the character above referred to wherein a pump of novel kind is operable to maintain a definite hydrostatic pressure on a stored supply of hydraulic medium, and this pressure will operate to effect the forced feed of medium from the supply as and when needed for replenishing or for compensating for any leakage that may occur in the closed system.

Other objects of the invention are to be found in the details of construction and arrangement of parts embodied in the pump, and in its means for and mode of operation, together with novel features employed in the various adaptations and modifications of the present type of equipment.

In accomplishing these and other objects of the invention, we have provided the improved details of construction, the preferred forms of which are illustrated in the accompanying drawings, wherein—

Fig. 1 is a view illustrating a hydraulic remote control system of the dual transmitter type in which the present invention is embodied.

Fig. 2 is an enlarged, longitudinal section of one of the transmitter cylinders and its contained parts, taken substantially on the line 2—2 in Fig. 3.

Fig. 3 is an irregularly taken, horizontal section of a transmitter cylinder, taken substantially on the line 3—3 in Fig. 2.

Fig. 4 is a cross section of the transmitter cylinder substantially on line 4—4 in Fig. 3.

Fig. 5 is an enlarged, longitudinal section of the pressure retaining pump.

Fig. 6 is a longitudinal section of the receiving cylinder and its enclosed piston.

Fig. 7 is a sectional detail of a transmitter piston and pump of an alternative form.

Fig. 8 is a sectional view of a receiver piston of alternative construction.

Referring more in detail to the drawings—

First, it is to be understood that the present type of system is applicable to many uses and to many different adaptations, but most generally is employed for the control of movable parts or instrumentalties located in places difficult to reach. For example, such systems are especial-

ly suited for the remote control of steering gear in boats, for actuation of engine throttle levers or reverse gear levers below closed hatches, or for the shifting or moving of doors, windows or the like, from a remote station of control and for many analogous uses where the transmission of power through practically a frictionless medium is desirable or advantageous. In the present drawings, we have not illustrated any particular mechanism under control, but have only shown the transmitting and receiving instrumentalties in which the present improved features are embodied and indicated a part that is operated by the receiver cylinder.

It is to be understood that the device, in the forms shown, or in modified forms of connection, might be adapted to various uses without any departure from the spirit of the invention. Therefore, these illustrations are to be considered as typical of many uses.

Referring first to Figs. 1 to 4:

In the system as here shown in Fig. 1, 1 designates, in general, what will hereinafter be referred to as the transmitter cylinder, and 2 designates, in general, what will be referred to as the receiver cylinder.

In the transmitter cylinder, a double acting piston 3 is fitted for reciprocal action; this being shown in detail in Fig. 2. Likewise, in receiver cylinder 2, there is fitted a double acting piston 4 which may be of the same general type of construction as piston 3. Closed pipes 5 and 6, respectively, connect the opposite ends of the cylinder 1 with the opposite ends of cylinder 2, and, as illustrated in Fig. 1, it is possible to so arrange these pipe connections that movement of the piston in the transmitter cylinder will cause the piston in the receiver cylinder to move in the same direction; this is, however, a matter of choice or preferred arrangement. The whole system, that is, the two cylinders and their pipe connections, are filled with a suitable hydraulic medium, 7, such as oil, and it is through this medium that power impulses are transmitted from the piston of the transmitter cylinder 1 to the piston of the receiver cylinder 2.

In Fig. 1, we have illustrated a dual control for the receiver cylinder in that a second transmitter cylinder, 1A, is provided and is connected at its ends by pipes 5*a* and 6*a*, with the pipes 5 and 6. It is thus provided that the receiver cylinder may be placed under control of either transmitter cylinder, 1 or 1A, provided that, when a selected transmitter cylinder is in use, the other is locked, or secured in a neutral position. Therefore, the following description, insofar as it pertains to the transmitter cylinder 1 and its associated parts, will be considered to apply equally to transmitter cylinder 1A and its associated mechanisms.

By reference to Fig. 2, in particular, it will be understood that the transmitter cylinder 1 comprises a central housing section 1*a*, with opposite end housings 1*b* and 1*c*, fitted thereto and all held in assembled relationship by connecting bolts 8. The parts 1*b* and 1*c* are formed with cylindrical body portions. These are arranged in axial alinement and contain therein, respectively, the opposite end portions of the piston 3 for reciprocal action. The outer ends of these cylindrical portions are closed by integral end walls into which the ends of the connecting pipes 5 and 6 are extended and secured by the fittings 9.

The central housing 1*a* is formed with a relatively large closed chamber 12 into which the inner ends of the cylindrical housings 1*b* and 1*c* open, and which surrounds the medial portion of the piston 3. Rotatably mounted in the upper portion of the housing 1*a* and within chamber 12, and extending transversely of and above the piston 3, is the transmitter shaft 13 on which a gear segment 14 is fixed. The teeth of this segment are arranged to operatively mesh with the teeth of a rack 15 formed along the top side of the medial portion of the piston 3. It will readily be understood that with this arrangement of parts, rotation of shaft 13 and gear segment 14 in opposite directions, will cause reciprocal action of the piston 3 in opposite directions in its cylinder, and incident to such action, the piston 4 of the cylinder 2 will be actuated accordingly under the influence of the hydraulic medium with which the system is filled.

The shaft 13 extends to the outside of the housing 1*a* through a side cover plate 1*f* which may be removed for access to the interior of the cylinder.

It is immaterial by what means or devices the shaft 13 is rotated for the actuation of the transmitter shaft and piston. The shaft may be, and in many cases is, equipped at its outer end with a hand lever. In Fig. 1, we have indicated the transmitter shaft as being equipped with a gear segment 16 operated by a gear 16', fixed on the mounting shaft 17 of a hand wheel 18. The kind of control lever generally would be determined by choice of construction or in view of the character or use of the particular system with which this device is employed.

It is to be understood that each of the pistons 3 and 4 should be equipped with suitable packing at its ends to prevent, to the maximum extent possible, any possible leakage past the piston. In the present instance, we have illustrated, at 19, a certain type of "chevron" packing found to be the most satisfactory, but we do not wish to be confined in any way to any particular kind, or type of packing.

In the present equipment, the housing 1*a* and chamber 12 serve as a storage receptacle in which a supply of liquid medium may be confined under hydrostatic pressure and from which small amounts may be automatically released, as will presently be explained, to the system to replace or compensate for any amounts that leak from the system.

By reference now to Figs. 2 and 3, in particular, it will be observed that the housing section 1*b* of the transmitter cylinder is formed along one side with a longitudinally directed channel 25 which, at its inner end, communicates with a port 26 in the adjacent end wall of housing 1*a* and which opens into the upper portion of chamber 12. At its outer end, this channel 25 communicates with a channel 27 that is directed transversely of the cylindrical body and which opens into the outer end of the cylinder 1 at its top side. Located in the channel 27 is a back check valve 28, as seen best in Fig. 3, urged to closing position against a seat 29 by a coiled spring 30; the disposition of this check valve being such that it will operate to retain the liquid medium under pressure in the cylinder, but will open when there is a greater pressure at the outside of the valve than in the cylinder resulting from leaking from the cylinder or piping system.

It will also be observed by reference to Figs. 2 and 3, that the housing section 1*c*, likewise is formed along one side with a longitudinal chan-

nel 31 which, at its inner end, registers with a port 32 in the adjacent end wall of the housing 1a and opening into chamber 12. At its outer end, this channel 31 opens into a transversely directed channel 33 which, at its inner end communicates with the adjacent outer end of the cylinder 1. Likewise, in the channel 33, is a back check ball valve 34 urged to closed position against a seat 35 by a coil spring 36 and this valve operates to retain pressure in that end of the cylinder, but will open to admit medium to the cylinder when pressure inside the cylinder is less than that at the outside of the valve due to leakage from the cylinder or the pipe connections of the system.

In order that the ball check valves 28 and 34 may be manually moved to and then held in open position, as is desired when charging the system with a hydraulic medium, there is provided at the outer ends of the transverse channels 27 and 33, closing fittings 37 through each of which a stem 38 is threaded. The inner end of each stem is adapted to be extended into its corresponding channel beyond the valve seat to engage and unseat the ball valve thus to provide for free flow of medium through the channel. For turning the stems, 38, each has a handle member 39 at its outer end.

As was previously explained, unavoidable leakage occurs in systems such as that above discussed, and thus, in accordance with the objects of this invention, we have provided means for the automatic replenishing of oil that may leak from the system. Our preferred means comprises the following:

As will be observed best in Figs. 2 and 5, there is a chamber 40, set off in the top side of the cylinder housing, located partly in the housing 1a and partly in housing section 1c. This chamber is entirely separated from the chamber 12 by a partition wall 42 shown in Figs. 2 and 3.

Mounted in the wall, 42, parallel with the axis of the cylinder 1 is a small pump cylinder 43 formed with a piston chamber 44 in which a pump piston 45 is reciprocably contained. The cylinder 43 opens at one end through the wall 42 into chamber 12, and the piston 45 extends through and beyond that open end into the chamber 12 and there has a rounded outer end portion 45a engaged with a cam 46 that is fixed on the shaft 13. The cam has rises 46' and 46a diverging outwardly, and the pump piston 45 has its rounded end engaged with the cam surface so that on rotating the shaft 13 in either direction from a neutral position, the cam will actuate the piston outwardly in its chamber 44.

The outer end of pump cylinder 43 has a channel 48 opening from chamber 44 into chamber 40 and in this channel is a back check ball valve 49 urged against its seat 50 by a coiled spring 51. This valve closes under back pressure that is created in passage 48 incident to outward travel of piston 45 under influence of cam 46. Also, there is a longitudinal channel 54 in the piston 45 opening at its opposite ends into the piston chamber 44 and through the outer end portion of the piston into the chamber 12. In this channel is a back check ball valve 60 urged toward its seat 61 by a spring 62. This valve and seat are so arranged that the valve may be forced open by pressure of liquid, confined in chamber 44 when the piston 45 is actuated outwardly by the cam action. A coiled spring 63 contained in the piston chamber 44, engages the piston 45 to urge it outwardly against the cam.

Also, there is a passage 64 through the wall 42, providing for communication between chambers 40 and 12 and this passage, as observed in Fig. 3, is equipped with a pressure relief valve 65 that may be regulated to open at any predetermined pressure for flow of oil from chamber 12 into chamber 40 through passage 64.

Now assuming the parts to be so constructed and assembled, it will be understood that incident to oscillation of the actuating lever for shaft 13 for actuation of the transmitter piston 3 in either direction, the cam 46 will impart a pumping action to the piston 45 and this will effect the pumping of oil from storage chamber 40 into chamber 12 against the head of trapped air, thus to build up and maintain the supply of oil in chamber 12 at a predetermined hydrostatic pressure that is regulated or determined by and in accordance with the setting of the pressure relief valve 65. When this pressure in chamber 12 is exceeded by reason of the continued pumping of oil thereinto from chamber 40, the oversupply of oil is merely released back into chamber 40. However, at all times a supply is maintained under pressure in chamber 12 for feeding into channels 25 and 31 which supply the system at opposite ends of the cylinder 1.

Now, assuming that leakage should occur that would reduce the pressure of oil in the cylinders 1 or 3, or in the piping system connecting the cylinders, or at any other point in the system that might affect the positiveness of operation, or change in piston timing, such leakage would reduce the hydrostatic pressure in the affected parts of the system and there would be an automatic opening of the valve 28 or 34 for replenishing this loss from chamber 12.

It will be understood also that the pumping action imparted to the piston 45 incident to normal use of the system, will operate to maintain the medium in chamber 12 under super-atmospheric pressure at all times and this pressure will be maintained in the piping system, insuring that at no time will there be air allowed to enter the system due to the super-atmospheric pressure maintained on the hydraulic medium which fills and supplies the system.

In order that at no time will there be any shortage of liquid for replenishing the system, we have provided a connection 70 leading from a source of supply of liquid designated at 71 and opening into the top of chamber 40. Thus, chamber 40 may be kept full at all times by gravity flow from the source of supply.

Now referring to the receiver cylinder 2: This preferably would be constructed substantially in accordance with the cylinder 1, except that the chamber 40 and pump mechanism of the transmitter cylinder would be omitted. The piston 4 is equipped with a longitudinal rack surface 74 and there is a gear segment 75 operatively in mesh therewith. Gear segment 75 is fixedly mounted on a transverse shaft 76 extending rotatably through the housing walls and equipped at its outer end with a lever arm 77 to which a link, as at 78, may be operatively attached for the control of some movable member or instrumentality under the control of the transmitter cylinder.

The piston 4, like piston 3, would be suitably packed to prevent leakage past its ends, and also, the connections of the cylinder with the pipes 5 and 6 would be as leak-tight as possible. At opposite ends of the cylinder, are valves 79–79' that may be opened as is desirable in charging the system and these are equipped with

fittings for making connections with the charging pipes.

In Fig. 7, we have illustrated a transmitter cylinder of an alternative form of construction, and in which the pump arrangement is somewhat different than that of the device of Fig. 2, but not changed in principle or mode of operation. In this alternative form the parts that are substantially like those of the device of Fig. 2 have been given corresponding reference numerals. The housing *1a* has been formed with a storage chamber **12**, and there is also a chamber **40** from which channels **80** and **81** lead to the opposite ends of the cylinder for the automatic supplying of liquid to compensate for leakage should it occur. It will be explained that the channel **80** that leads to the left hand end of the cylinder as shown in Fig. 7 comprises a section that is formed horizontally in the central section *1a* of the housing and a continuing part that is formed in the housing section *1b*. These channels commence with their respective ends of the cylinder through the valve equipped channels **27** and **33** the same as previously described in connection with the device of Fig. 2.

In the device as shown in Fig. 7, the pump cylinder and pump piston are arranged in a manner similar to those of the device previously described, except that the pump piston is equipped with valve devices whereby its operation under the influence of the cam **46** is to force the pressure medium from the chamber **12** into the chamber **40**. Chamber **12** is equipped with a top connection **70'** with a source **71'** of supply of liquid medium, and there is a pressure relief valve **90** in the housing for relief of the medium from chamber **40** into the chamber **12**.

It is anticipated also that the chamber **40** might be connected with the opposite ends of the cylinder **1**, through outside pipe connections instead of through the channels in the body of the structure if such is found more practical or desirable. In this way the difficulty of boring the connecting channels would be avoided. In the use of this device the functional operations of the shaft **13** actuate the cam **46** to effect the pumping action of the pump piston **45**, and this causes pressure to be built up in the chamber **40** which will be relieved at a pre-determined point by passage of the liquid medium back to the chamber **12** through the pressure regulating valve.

In Fig. 8 we have shown a modified or alternative form of piston for use in the receiver for an automatic synchronization of the system should leakage occur past the piston or for other reasons. In this device the piston body is equipped with a longitudinal channel **91** extending from end to end and opening into the opposite ends of the enclosing cylinder. Mounted within the opposite ends of this channel are ball check valves **94** and **95** that are yieldingly urged to closed position by springs **96**. Each valve is equipped with a stem **97** projecting beyond the corresponding end of the piston, and these stems are adapted should the piston be actuated beyond a pre-determined limit in either direction, to engage with the end wall of the cylinder thus to open the valve and permit flow of liquid past the valve from the opposite end of the cylinder. In this way farther travel of the piston is prevented, and automatic synchronization of the receiver piston with the transmitter piston is accomplished within satisfactory limits.

Assuming the devices to be constructed as described, it is quite readily apparent that should leakage occur from the piping system or past the operating parts to any place that would affect the timing or the positiveness of operation of the receiver cylinder with respect to movements of the transmitter piston, this leakage will be instantly and automatically compensated for by reason of the fact that such loss of pressure medium creates a condition of low pressure at the outgoing side of the valves in channels **27** and **33**, and this permits flow of medium from chamber **12** to compensate for the loss. With the understanding that pressure in chamber **12** is always relatively high, it can be understood that the system will always be charged under super-atmospheric pressure, and, therefore, the disadvantages that heretofore have been experienced due to air pockets or vacuum pockets in the piping system or in the cylinder is avoided.

It is quite readily apparent that details of construction other than herein shown might be employed in the arrangement of pumps and connecting passages, and still satisfactory results obtained. Therefore, it is not desired that the claims which terminate this specification should be confined to details of construction, but that they give an interpretation that is commensurate with the scope of the invention that is disclosed.

Having thus described my invention what I desire to secure by Letters Patent is:

1. In a closed hydraulic system of control of the character described, a cylinder, a piston reciprocally fitted therein, a fluid transmission conduit system connected with the cylinder, and a hydraulic pressure medium filling the cylinder and conduit to be acted on by the piston, a shaft mounted for rotative motion and having an operating connection with the piston, a cam on the shaft, an auxiliary supply of hydraulic medium, a pump having an inlet to receive liquid from said supply and having an outlet communicating with the conduit system; said pump being operable by the action of the cam upon rotation of the shaft to cause delivery of medium from the auxiliary supply into the conduit system and a spring loaded pressure relief valve for the pump.

2. The combination with a closed hydraulic cylinder-piston pulsator system of the character described and a shaft having a geared connection with the piston for its rotation in opposite directions in accordance with movement of the piston in opposite directions, of a pump, an auxiliary supply of hydraulic pressure medium for the pump, a cam on the shaft for actuation of the pump with each reciprocal movement of the piston, a pressure chamber having outlets to the opposite ends of the cylinder, back check valves in the outlets and a loaded pressure relief valve in the pressure chamber.

3. In a closed hydraulic pulsator system of the character described, a double ended cylinder body, a doubled ended piston reciprocally contained therein, fluid transmission conduits connected with opposite ends of the cylinder; said body comprising a closed liquid storage chamber in the body surrounding the medial portion of the piston; said chamber having outlets to the opposite ends of the cylinder, back check valves in said outlets, an auxiliary supply of hydraulic pressure medium, a pump cylinder in the cylinder body, a pump piston operable therein concurrently with the piston movements, means for supplying liquid to the pump from said auxiliary supply for delivery thereby into said storage chamber to maintain a supply therein under super-atmospheric pressure, a pressure relief valve from the storage

chamber, a shaft rotatably mounted in the cylinder body and having geared connection with the piston for rotation in opposite directions in accordance with reciprocal action of the piston, and a cam fixed on the shaft and adapted to actuate the pump piston.

4. In a closed hydraulic pulsator system of the character described, a housing enclosing therein a double ended cylinder, a double ended piston reciprocally fitted in the cylinder, and formed with a longitudinal gear rack, fluid transmission conduits connected with the opposite ends of the cylinder, a shaft rotatably mounted in the housing transversely of the piston, a gear fixed on the shaft and in operative mesh with the gear rack, a cam on the shaft, a pump cylinder mounted in the housing, a pump piston disposed to engage the cam for functional actuation thereby, a closed pressure chamber in the housing, having outlets to the opposite ends of the cylinder, back check valves in said outlets, another chamber for an auxiliary supply of hydraulic medium, having a feed connection to the pump, and a pressure relief connection leading from the pressure chamber to the chamber for said auxiliary supply of medium.

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