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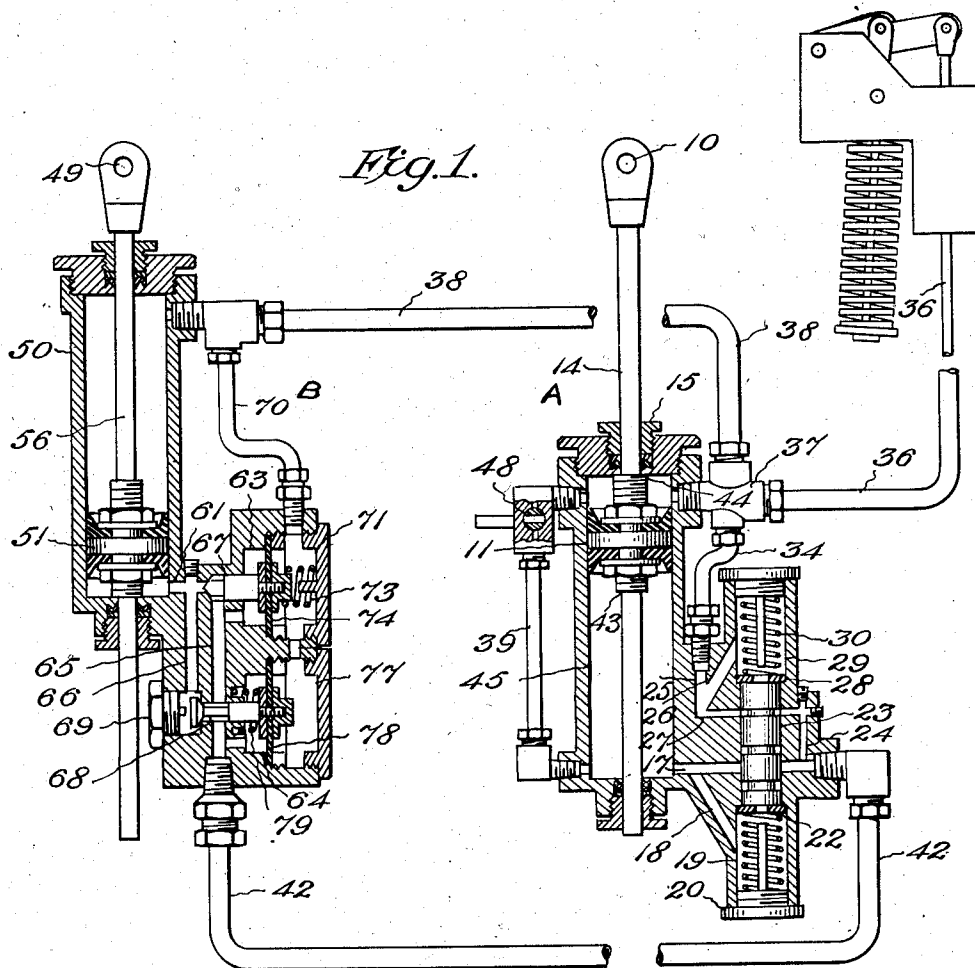
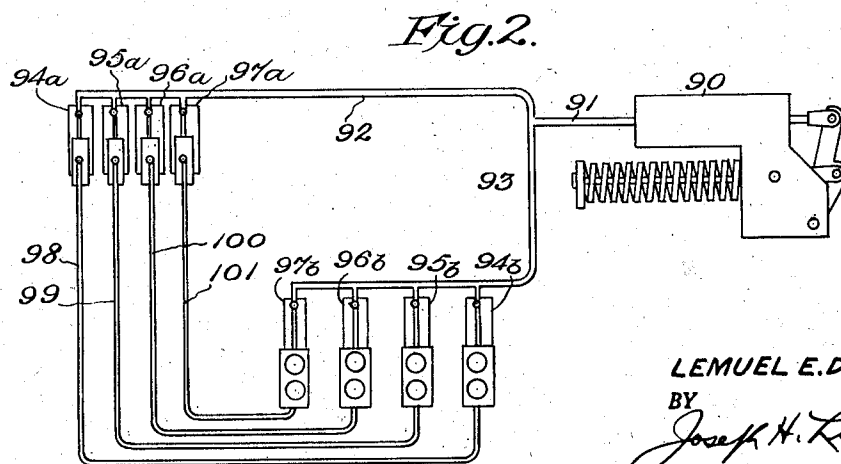
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HYDRAULIC REMOTE CONTROL SYSTEM

Filed April 29, 1943

2 Sheets-Sheet 1



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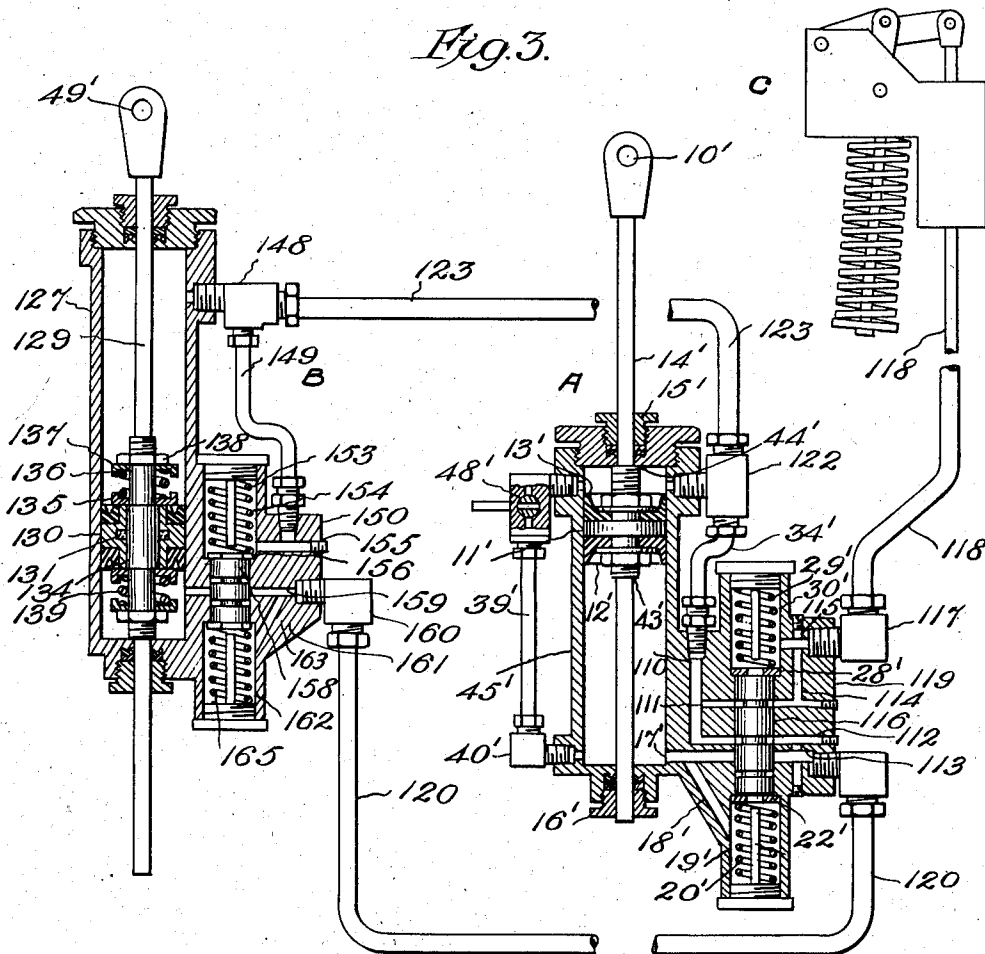
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HYDRAULIC REMOTE CONTROL SYSTEM

Lemuel E. Dougherty, Fairhope, Ala.

Application April 29, 1943, Serial No. 484,987

4 Claims. (Cl. 60—54.5)

This invention may be considered a further development of my hydraulic remote control system as described in my co-pending patent application, Serial No. 484,998, filed April 29, 1943. In said application, means are provided whereby expansion or contraction of the hydraulic fluid in the connecting tube between the transmitter and receiver is automatically compensated for so that the transmitter and receiver remain in synchronization regardless of temperature changes and consequent expansion or contraction of the hydraulic fluid in the system. This compensating means was adapted to a control system of the single tube type in which resilient loading means are applied to the transmitter piston and to the receiver piston so that the fluid in the cylinders and the connecting transmission tube or duct is held under compression.

While a control system of this type may work satisfactorily in many installations, the transmitter and receiver assemblages must necessarily be of considerable bulk and weight inasmuch as heavy springs must be provided for the proper return action in the system. In systems of this type there is also the problem of obtaining springs which will apply substantially constant fluid pressure in the system in all positions of transmitter and receiver. In many installations, such as in aircraft, where there will be a plurality of units, it will be to great advantage to eliminate individual springs for each transmitter cylinder and each receiver cylinder and provide a single compressor unit to maintain the fluid pressure for the proper operation of the system. It is therefore one of the principal objects of this invention to provide a single fluid compressor unit in place of the multiplicity of compressor units heretofore employed in fluid transmission and receiving systems which will apply a predetermined fluid pressure at all times to the transmitter and the receiver.

It is a further object of this invention to provide for fluid pressure for an arrangement in which a plurality of fluid transmission systems are employed, each system comprising a transmitter, a receiver and a connecting duct, in which a single source of fluid under pressure is employed to provide the fluid pressure for all of said transmitters and receivers.

Still another object of this invention is to provide a single source of fluid under pressure in a plurality of fluid transmission systems in which a common pipe leading to all of said transmitters, and a common return pipe leading from all of said receivers may be employed.

Still another object of this invention is to pro-

vide an arrangement such as specified above wherein a single fluid compressor is employed for supplying fluid pressure to the transmitter and receiver, means for normally connecting the transmission line and the return line between the transmitter and receiver to the compressor; but upon actuation of the transmitter both lines are disconnected from the compressor, thus making the system a closed system. This permits actuation of greater loads with the same size pistons as compared with an open system where the return line remains connected to the compressor.

Further objects and advantages of this invention will become apparent in the following detailed description thereof:

In the accompanying drawings,

Fig. 1 is a cross sectional assembly view of a hydraulic control equipment embodying one form of my invention.

Fig. 2 is a diagram of a single compressor unit used in conjunction with a plurality of operating units.

Fig. 3 is a cross sectional assembly view of a modified form of hydraulic control equipment in which dual lines are employed between each transmitter unit and receiver unit and also employs a modified form of locking apparatus in the receiver.

Referring to Fig. 1, the transmitter unit A is connected by the tube or transmission duct 42 to the receiver unit B from whence the connecting or return tube 38 returns back to the transmitter unit and by the tube 36 to the compressor unit C. While the compressor unit C here illustrated is of the type which will maintain a substantially constant fluid pressure in the system, such a type of compressor need not necessarily be used. As the parts of the system are inter-connected and always in balance, the proper operation of this system does not depend upon constant fluid pressure. The fluid pressure maintained by the compressor unit must be sufficient for movement of the receiver piston in one direction and as a holding means against unauthorized movement.

In the operation of this device a suitable lever or other control device may be connected at 10 to the transmitter piston rod 14 in order to transmit movement to the piston 51 and rod 56 of the receiver, the load being connected to rod 56 at 49. The fluid pressure from the compressor through the line 36 and the fitting 37 is present in the upper part 44 of the transmitter cylinder 45, thus exerting downward force on this piston so that fluid in the lower part of the cylinder will be under the same pressure. The transmitter

piston 11 is integral with or securely attached to the piston rod 14. The receiver cylinder and piston are very similar to the transmitter cylinder and piston, fluid pressure from the compressor being present in the upper part of the receiver cylinder 50 by means of the return tube 38. This tube 38 is at all times in open communication with the upper ends of cylinders 45 and 50 and with the compressor C. Thus it will be seen that a predetermined fluid pressure from the single source, i. e., compressor C, supplies the pressure for both the transmitter and the receiver.

The transmitter is equipped with the same type of valve apparatus as described in Fig. 4 of my said co-pending application, Ser. No. 484,998, that is, the piston type valve 23 normally closes the passage 17 between the transmitter cylinder and the connecting tube 42 to the receiver and opens the passage 27 which, by means of the passages 24 and 25, provides fluid connection between the compressor unit and the receiver. Fluid pressure from the compressor unit by means of the tube 34 and passages 25 and 26 is present in the chamber 25 and acts upon the upper end of the piston valve 23. Fluid pressure from the lower part of the transmitter cylinder by means of passages 17 and 18 is present in the chamber 19 and acts against the lower end of the piston valve.

With the system at rest these fluid pressures at both ends of the piston valve are equal, so it remains in the position shown with the transmitter disconnected from transmission duct 42 which is in communication with the compressor. Force exerted downwardly on the transmitter piston, increasing the fluid pressure in the lower part of the cylinder, causes upward movement of the piston valve, overcoming the force of the spring 30, thus closing passage 27 and opening passage 17 so that the transmitter cylinder is then connected to the receiver and the compressor is disconnected. Upward movement of the transmitter piston and consequent lowering of pressure in the lower end of the cylinder allows downward movement of the piston valve due to the fluid pressure from the compressor being greater than that at the lower end of the valve. This, of course, also closes the passage 27 and opens the passage 17 so that fluid may flow from the receiver to the transmitter and the compressor is disconnected from the system. It is thus seen that with the system at rest that the connecting tube 42 is disconnected from the transmitter but is open to the compressor unit so that expansions or contractions of the fluid therein will cause no movement in the transmitter.

In the receiver assemblage a locking valve is employed very similar to the locking valve as used in my said co-pending application, Ser. No. 484,998, and claimed in my co-pending application, Serial No. 449,942, filed July 6, 1942. However, as this is a balanced system subject to a common fluid pressure, this locking valve apparatus is adapted to use this common source of fluid pressure, rather than heavy springs tending to balance such pressure as described in aforementioned application. Fluid pressure from the compressor unit is present in the tube 38 and conveyed by the tube 70 into the chambers 71 and 76. Fluid pressure from the transmitter, by means of the tube 42, the passage 65 and connecting passages, is present in the chambers 63 and 64 at the opposite sides of the diaphragms 74 and 78. The tube 42 is normally connected

to the compressor unit through the valve 23 in the transmitter so that the fluid pressure upon the opposite sides of these diaphragms are equal. The compression spring 73 seated upon the diaphragm 74 normally holds the valve 67 closed. The compression spring 79 seated upon diaphragm 78 normally holds the valve 68 closed. With both valves closed, there is no connection to the receiver cylinder. This, of course, effectively locks the receiver, as any tendency of the piston to move upward encounters the fluid pressure from the compressor unit, and any downward movement of the piston is prevented by allowing no escape for the fluid in the lower part of the cylinder. An increase in fluid pressure from the transmitter, caused by the operator's exertion of force to move the piston downwardly, causes the valve 67 to open. Movement of the transmitter piston in the opposite direction and consequent decrease in fluid pressure from the transmitter will cause the valve 68 to open. If either valve 67 or valve 68 is open, fluid connection between the receiver cylinder and the transmitter cylinder is obtained. These valves are normally closed and lock the system but unlock and allow passage of fluid between transmitter and receiver upon authorized movement of the transmitter piston.

Any expansion or contraction of the fluid in either of the connecting tubes between the transmitter and receiver will cause movement in the compressor unit but will cause no movement in either the transmitter or receiver. The pistons of the receiver and transmitter, when once established in proper relation, will remain in synchronization regardless of temperature changes to which the connecting tubes may be subject. To establish the proper relation of the transmitter piston to the receiver piston and resynchronize the transmitter with the receiver, as it becomes necessary, I employ a shut-off valve 48 and the connecting tube 39 between the upper and lower ends of the transmitter cylinder. It is apparent that with the valve 48 open movement of the transmitter piston will bypass fluid from one end of the transmitter cylinder to the other without causing any movement in other parts of the system. By moving the receiver piston to one end of its stroke and then opening the valve 48, the transmitter piston can then be moved to its proper position at the end of its stroke. Valve 48 is then closed and the pistons are established in proper relation to each other. It should be observed that while the upper ends of both transmitter and receiver cylinders are always open to the compressor, no actual movement in the compressor takes place through the operation of this control system. Therefore the volume of the compressor need only be sufficient to compensate for expansions or contractions of the fluid in the connecting tubes.

In Fig. 2 is diagrammatically illustrated a plurality of independent controls connected to a single compressor unit. The transmitters 96a, 95a, 96a, 97a are connected to corresponding receivers 94b, 95b, 96b, 97b by the tubes 98, 99, 100 and 101 respectively. All of the transmitters may be connected to the common tube 92 and all the receivers to the common tube 93, which are then connected to the compressor 80 by the tube 91. A system of this type offers great saving in weight and size of the individual units over a system in which springs must be provided at each individual transmitter and receiver unit,

and also provides a great saving in weight over the conventional dual line systems.

Referring to Fig. 3, there is illustrated a modification of the apparatus as illustrated in Fig. 1 in that it provides, in addition, for making a closed system during operation. One advantage of this is that by using the same piston areas and normal fluid pressure twice the force can be transmitted than with the type of system shown in Fig. 1, which is always open to the compressor unit. This system will operate under a much heavier load upon the receiver with the same pressure from the compressor unit than would be possible with the previously described system, as fluid pressure generated in the compressor is used only to lock the system and not to move any load.

The transmitter assemblage is very similar to that already described in Fig. 1 and parts of which are identical with those in Fig. 1 have the same designating numeral primed. The only difference in this transmitter assemblage and that shown in Fig. 1 is in the valve assemblage in which a different arrangement of the passages provides for disconnecting the fluid connection from the upper part of the receiver cylinder from the compressor unit whenever motion is imparted to the transmitter. There is no direct connection from the compressor to the transmitter cylinder, such connection being made through the sliding piston valve 116. Fluid pressure from the compressor through the tube 112 and the passage 115 is present at the upper end of the piston valve, and, with this valve in its normal position, may pass through the passages 114, 111 and 110 and the tube 34'. By means of the T-fitting 122 the fluid under pressure enters the transmitter cylinder, and by means of the tube 123 enters the receiver cylinder. Fluid connection from the connecting tube 120 to the compressor unit is by means of the passages 113, 112, 111 and 114, thence by the tube 118 to the compressor unit. An increase or decrease in fluid pressure in the lower part of the transmitter cylinder causes movement of the piston valve 16 and closes both the passages 112 and 111, thus disconnecting the compressor from both sides of the system. Movement of the valve also opens the passage 17', thus establishing fluid connection between the transmitter and the receiver.

This system will operate properly with the type receiver as illustrated in Fig. 1, but I have here illustrated a different type of locking valve as in some installations it may be desirable to use a sliding piston type valve rather than the poppet valves and diaphragms. This locking valve is very similar to the piston valve in the transmitter. With the system at rest fluid pressure from the compressor is present at both ends of the piston valve 158 in the chambers 154 and 162. The pressure of the compressor is applied to chamber 162 by way of passages 118, 114, 111, 112, 113, 120, 159, and 163. Springs 153 and 165 in said chambers normally centralize the valve. Movement of the transmitter piston downwardly, thus increasing the fluid pressure in the lower part of the transmitter cylinder and disconnecting the compressor from the system causes an increase in fluid pressure in the chamber 162, thus shifting the piston valve until its port coincides with the passage 159, thus allowing the passage of fluid to the lower part of the receiver cylinder and consequent upward movement of the receiver piston. Upward movement of the transmitter piston causes a reduction of

fluid pressure in the lower part of the transmitter cylinder and shifting of the transmitter valve 116. As soon as this valve has moved and disconnected the compressor from the system there is an increased pressure in the upper part of the transmitter cylinder and a decreased pressure in the lower part of the transmitter cylinder. As the two ends of the sliding locking valve 158 are now subject to the pressures in the transmitter cylinder, the valve will move downwardly, thus opening the passage 159 and allowing fluid to flow from the lower part of the receiver cylinder to the transmitter cylinder. This is then, in effect, a dual line pulsator system; but upon the cessation of movement of the transmitter piston, both sides are reconnected to the compressor and the receiver piston is hydraulically locked against downward movement by the piston valve 158. At the same time, piston 11' is also locked against downward movement so that temperature variations in the fluid will not destroy synchronism between transmitter and receiver but will only affect the compressor.

Use of the sliding type of locking valve, rather than the poppet type valves and diaphragms, has the disadvantage that the valve will not open and allow an escape of fluid in case of excessive pressure in the lower part of the receiver cylinder, neither will it open and allow fluid to enter into the lower part of the cylinder in case of deficiency in pressure therein. To overcome this difficulty, in this receiver using this type of locking valve, I use a piston which may move against the force of a spring in either direction, thus preventing either too high or too low a pressure from developing in the lower part of the receiver cylinder. The piston 130 is supported slidably upon an enlarged section 134 of the piston rod 129 and is equipped with the packing 131 to prevent leakage. The spring 136 is preloaded between the spring retainers 137 and 135. The spring retainer 135 seats against the shoulder of the piston rod caused by the enlarged part 134 thereof, while spring retainer 137 abuts against lock-nut 138 on rod 129. Likewise, the force of the spring 139 is normally against the shoulder on the piston rod. Both the springs 136 and 139 are preloaded so as to prevent any movement of the piston under normal operating loads, but will allow movement of the piston if an extremely high or extremely low fluid pressure should develop in one end of the cylinder. If the receiver piston is at the upward extent of its stroke and thermal expansion of the fluid in the cylinder below the piston should take place, the piston could move upwardly against the force of the spring 136 sufficiently to prevent a destructive pressure from arising. If the receiver piston is at the lower extent of its stroke and subsequent thermal contraction of the fluid take place, so that pressure below the piston decreases until it approaches atmospheric pressure, then the receiver piston will move downwardly against the force of the spring 139 and prevent the fluid pressure from falling below atmospheric pressure and subsequent danger of air entering the system.

In accordance with the provisions of the patent statutes, I have herein described the principle and operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other equivalent means. Also, while it is

designed to use the various features and elements in the combination and relations described, some of these may be altered and others omitted without interfering with the more general results outlined, and the invention extends to such use.

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

1. In a fluid transmission system comprising a transmitter, a receiver and a duct adapted to connect the transmitter and the receiver, a compression chamber having a supply of fluid and means for placing said fluid under predetermined pressure, means whereby said fluid maintains said transmitter and said receiver continuously under predetermined pressure, means for normally disconnecting said duct from said transmitter and said receiver and connecting said duct to said chamber, and means responsive to the actuation of said transmitter and effective as long as said transmitter is being actuated for disconnecting said duct from said chamber and connecting said duct to said transmitter and said receiver.

2. In a fluid transmission system comprising a transmitter, a receiver and a duct adapted to connect the transmitter and the receiver, a compression chamber having a supply of fluid and means for placing said fluid under predetermined pressure, means for causing said fluid to maintain said transmitter and said receiver continuously under predetermined pressure, means for normally disconnecting said duct from said transmitter and said receiver and connecting said duct to said chamber, and means responsive to the actuation of said transmitter for dis-

necting said duct from said chamber and connecting said duct to said transmitter and said receiver.

3. In a fluid transmission system, a transmitter, a receiver, a transmission duct connecting said transmitter and said receiver, a return duct connecting said transmitter and said receiver, a compression chamber having a supply of fluid and means for placing said fluid under predetermined pressure, a connection from said chamber to said return duct, means for normally disconnecting said transmission duct from said transmitter and said receiver and connecting said transmission duct to said chamber, and means responsive to the actuation of said transmitter for disconnecting said transmission duct from said chamber and connecting said transmission duct to said transmitter and said receiver.

4. In a fluid transmission system, a transmitter, a receiver, a transmission duct connecting said transmitter and said receiver, a return duct connecting said transmitter and said receiver, a compression chamber having a supply of fluid and means for placing said fluid under predetermined pressure, means for normally connecting said return duct to said chamber, means for normally disconnecting said transmission duct from said transmitter and said receiver and connecting said transmission duct to said chamber, and means responsive to the actuation of said transmitter for disconnecting said transmission duct and said return duct from said chamber and connecting said transmission duct to said transmitter and said receiver.

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