May 27, 1941. R. L. LEVY 2,243,385

HYDRAULIC REMOTE CONTROL DEVICE

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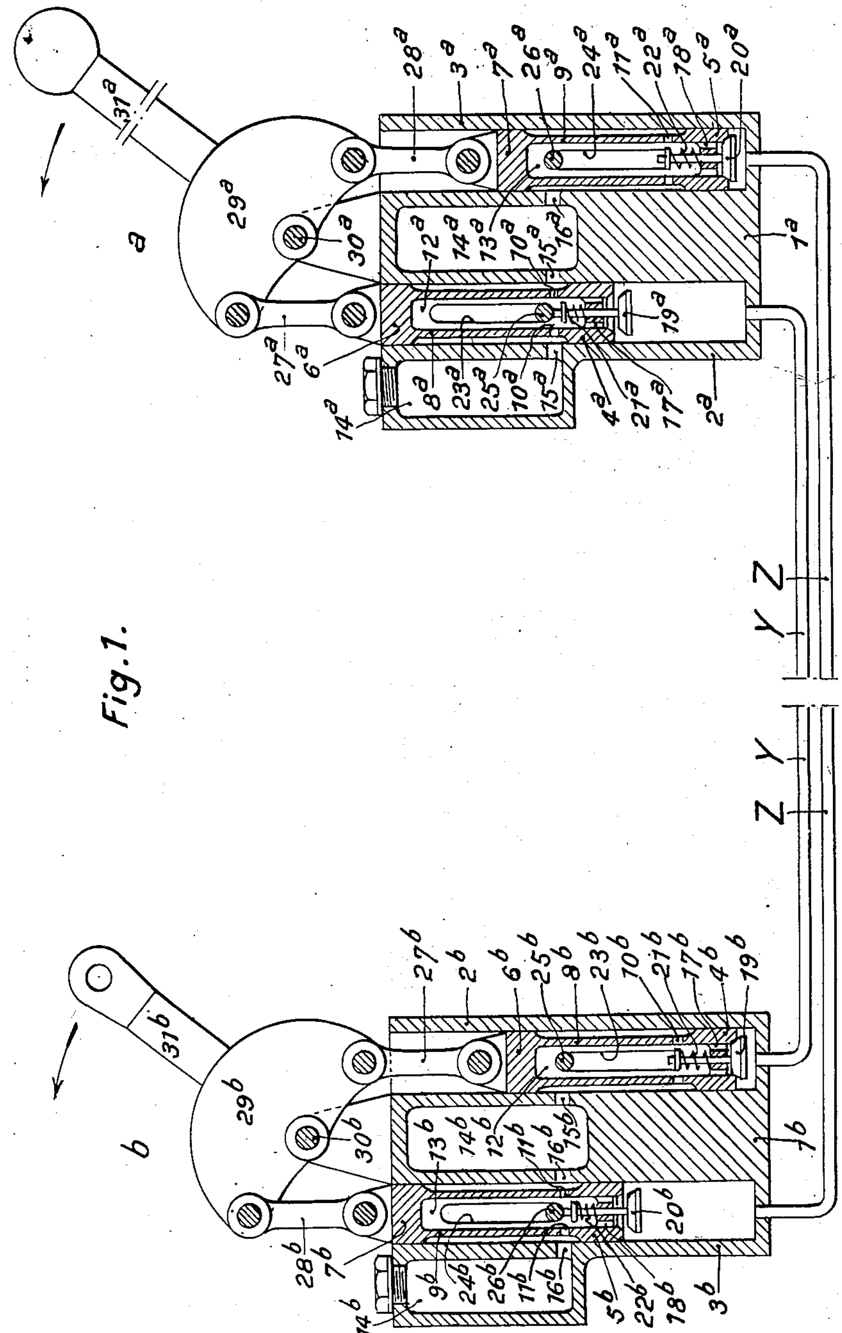

Fig. 1.

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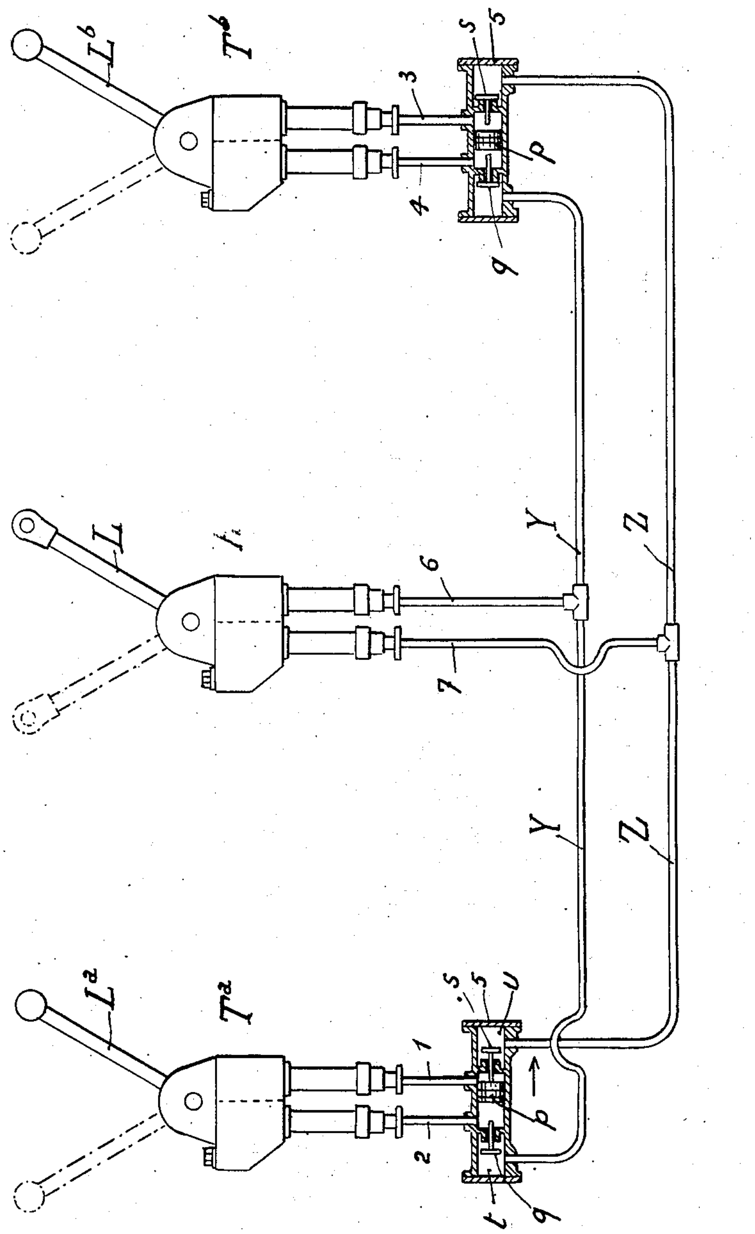
Fig. 2.



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HYDRAULIC REMOTE CONTROL DEVICE

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The invention has for its object a hydraulic device which enables the movement of a transmitting member to be reproduced at a distance on a receiving member, the actual operation of the device automatically effecting the compensation of the losses, expansions or contractions, that may occur in the hydraulic system, so that to a given position of the transmitting member there corresponds in practice a very definite position of the receiving member.

The device according to the invention essentially comprises a double hydraulic transmission, each of which becomes operative for one direction of rotation of the transmitting and receiving members, a communication being established between the two transmissions only at the end of the travel of one of the members, by means of a reservoir which corresponds to such member, so that in the event of loss of liquid, the continuation of the movement of the other member ensures the perfect filling of the device.

In a preferred embodiment which forms an important part of the invention, said communication is effected through the pistons which form the ends of the two coupled transmissions, by means of valves which are normally held closed by a resilient force exerted towards the outside of the transmissions, and which open at the end of the travel of the corresponding transmitting and receiving members, by abutting against fixed cross-pieces or the like.

The invention will be clearly understood from the ensuing description, taken in conjunction with the accompanying drawings in which Figure 1 and 2 illustrate two embodiments of the invention.

Referring to Figure 1, the device is provided with a transmitting station *a* and a receiving station *b*, the element of the receiving station being denoted by the same characters used on similar elements of the transmitting station with the addition of the exponent *b* thereto.

Each of the stations, *a* for example, includes a block 1^a in which are bored two cylinders 2^a—3^a. In each of said cylinders are adapted to move two pistons, respectively 4^a—5^a and 6^a—7^a. The pistons of the same cylinder are connected to each other by a cylindrical wall, respectively 8^a—9^a of smaller diameter than the cylinders.

Ports 10^a—11^a extend radially through the walls 8^a—9^a and place the chambers 12^a—13^a which limit the latter, in communication with the space between said walls 8^a—9^a and the cylinders 2^a—3^a. Said space is in communication with a reservoir 14^a which is common to the two cylinders of the same station through orifices 15^a—16^a. In order to give the stations a compact shape, said reservoir is preferably made in the shape of a cylindrical annulus surrounding one of the cylinders, 2^a in the example shown.

Orifices 17^a—18^a are provided in the pistons 4^a—5^a. They are normally closed by a valve 19^a—20^a which is subjected to the action of a spring, respectively 21^a—22^a, that acts towards the outside of the transmissions, that is to say towards the top of the figure.

Through elongated slots 23^a—24^a provided in the walls 8^a—9^a, fixed cross-pieces 25^a—26^a secured to the block 1^a penetrate into the chambers 12^a—13^a.

The pistons of the two cylinders of the same station are connected together by an equalizer system which comprises the connecting rods 27^a—28^a pivoted on a segment 29^a which is pivotally mounted on a fixed pin 30^a.

On the segment 29^a of the transmitting station is fixed an actuating arm 31^a; on the segment 29^b of the receiving station is fixed a finger 31^b which is connected to the member to be controlled.

The corresponding cylinders of the two stations are connected to each other by pipes Y and Z.

The device operates as follows:

If the arm 31^a is moved a certain angle in one direction or in the other, the arm 31^b moves through an angle which is the same in magnitude and direction, owing to the double hydraulic connection existing between the two stations.

Normally, the corresponding pistons, that is to say 4^a—4^b on the one hand, and 5^a—5^b on the other hand, occupy symmetrically opposite positions in their cylinder, so that to a given position of the arm 31^a there corresponds a predetermined position of the arm 31^b, which is identical with that of the arm 31^a in the example shown in the figure.

However, if for any reason viz.: leaks, expansions or contractions of the liquid for example, a deviation occurs between the positions of the arms 31^a and 31^b, the device is such that by its sole operation the univocal correspondence of the positions is automatically re-established, the leakages, expansions or contractions of the liquid being automatically compensated owing to the communication that exists between the pipes and the reservoirs.

If a leakage, expansion or compression of liquid occurs for a position in which the valves 19 and 20 are closed, the device is such that its actual operation automatically causes said leakage, etc., to be compensated.

Assume, for example, that a loss has occurred in the pipe Y for a position of the device near that shown in Fig. 1, but in which, however, the valves 19 and 20 are closed.

An operation in the direction in which the device is brought back into the position of the figure effects the compensation of this leakage. The lever 31^a being actuated in the direction of the arrow, the piston 4^a first of all moves inwards without lifting the piston 4^b. During this phase, the upward movement of the piston 5^a, which is mechanically connected to the piston 4^a, creates a vacuum below said piston 5^a; the valve 20^a is lifted from its seat responsive to the pressure of the liquid contained in the reservoir 14^a and a certain amount of said liquid passes through it, so as to keep the pipe Z full, the excess of liquid thus introduced being equal to the amount lacking in the pipe Y.

If the actuation of the lever 31^a is continued, the two pistons 4^a and 4^b move in unison and so do the pistons 5^b and 5^a. If the actuation is further continued, the pistons 4^a and 5^a reach their extreme low and high positions respectively, before the pistons 4^b and 5^b have reached the end of their possible stroke.

In order to effect the re-synchronization of the two stations, which is necessary since the levers 31^a and 31^b do not occupy, as is obvious, homologous positions on account of the assumed leak of liquid in the pipe *y*, it is then sufficient to actuate the lever 31^a in the direction opposite to that of the arrow. The pistons 4^a—4^b, 5^a—5^b are first of all moved in unison. However, the pistons 4^b—5^b reach the end of their stroke before the pistons 4^a—5^a have reached the end of their stroke since the former have not completed the preceding stroke. As the lever 31^a is always actuated in the same direction from this moment, the liquid driven by the piston 5^a passes through the piston 5^b while flowing through the valve 20^b the stem of which has encountered the cross-piece 26^b by causing the opening of said valve 20^b, then the liquid passes through the orifices 16^b and 15^b and is discharged through the valve 19^b, which is opened on account of the vacuum created in the pipe *y* owing to the fact that the piston 4^a has continued its up-stroke.

Consequently when the lever 31^a has returned to its initial position to the right, all the excess of liquid, which passed into the pipe *z* during the travel of the lever 31^a in the direction of the arrow, is transferred again into the pipe *y* and the re-synchronization is ensured since the two pipes *y* and *z* have obtained their normal degree of filling again and the two levers 31^a and 31^b occupy their position at the end of the stroke shown in the figure.

When operation is effected in the opposite direction (by rotating the lever 31^a in the opposite direction to that of the arrow marked in the figure), the pistons 4^a and 4^b, 5^a and 5^b first of all move in unison.

The pistons 4^b and 5^b reach the end of their stroke before the pistons 4^a and 5^a. When the actuation is continued, the liquid driven by the piston 5^a passes through the piston 5^b—owing to the lifting of the valve 20^b from its seat by the abutment of its stem against the cross-piece 26^b—through the orifices 16^b and 15^b, lifts the valve 19^b and reaches the pipe Y.

At the end of the actuation, all the excess of liquid in the pipe Z has been transferred into the pipe Y. The two pipes thus obtain their normal degree of filling again and the arms 31^a and 31^b take up identical positions.

A leak in Z would be compensated for by the reverse operation.

It should be observed that the two stations perform an absolutely symmetrical function and that the receiver becomes a transmitter, and conversely, without the device's being modified in any way.

In practice, it is frequently required to control, at will, a receiving station alternately by means of two or more independent transmitting stations, under such conditions that the control action exerted by any one of said transmitting stations only affects the receiving station and does not exert any influence on the other transmitting stations.

Controls of this type are required in particular on trains driven by automotive cars, in which it has to be possible to control a motor from a front station or from a rear station, according to the direction of circulation of the vehicles.

At present, in such cases, in order to neutralize the station which is not being used for the control, the driver has to actuate cocks interposed on the pipes that connect said station to the motor, or again in other systems, he has to lock a lever or the like of said station.

In order to avoid these manipulations and consequently eliminate the drawbacks that may be involved by their accidental omission, the invention also includes a device which enables a receiving station to be alternately controlled by means of two or more transmitting stations, without the action of any one transmitting station affecting the other transmitting stations.

Said device, which is fitted at the output of each of the transmitting stations, on the two pipes issuing from said station, consists of an irreversibility box. Said box essentially comprises a cylinder containing a floating piston, said pipes opening on either side of said piston, the opposite faces of which are adapted to act respectively on two valves which open in opposite directions, the outer compartments of said valves respectively communicating with the two general pipes which are connected to the other transmitting stations and on which the receiving station is mounted in parallel.

In the example (Fig. 2), two transmitting stations T^a—T^b have to be able to control a receiving station R alternately, under such conditions that the controlled member L of said receiving station occupies at every instant a homologous position to that of the controlling member, either L^a or L^b.

At the output of each of the transmitting stations T^a and T^b an irreversibility box 5—5 is interposed on the pipes 1—2 or 3—4 issuing respectively from said stations.

Each irreversibility box contains a floating piston *p* which normally occupies a mean position in the box. Valves *q*—*s* are mounted on corresponding seats which are fixed inside the box, beyond the opening of the pipes 1 and 2 relatively to the centre of the box.

Said valves *q*—*s* are adapted to open in opposite directions and away from said centre.

The extreme compartments *t*—*u* of the box communicate with the general pipes Y—Z which connect the two transmitting stations to each other and on which the receiving station R is mounted in parallel by means of pipes 6—7.

This device operates as follows:

For example, by acting on the lever L^a in the direction of the arrow *f*, the liquid which is driven into the pipe 2, on the one hand opens the valve *q* and on the other hand urges the piston *p* in the direction of the arrow, so that the valve *s* also opens.

Consequently, on the one hand the liquid which is driven into the pipe 2 can flow through the pipe Y and the branch 6 into the right hand cylinder of the receiver R, so that the controlled lever L reproduces the movements of the lever L^a in a homologous manner.

On the other hand, the liquid which is driven into the left hand cylinder of the receiver R by the actual operation of said receiver, can flow into the compartment *u* through the pipes 7 and Z, then, the valve *s* being open, can flow into the pipe 1 and into the right hand cylinder of the transmitting station T^a. The circulation of the liquid is therefore effected under absolutely similar conditions to those which were described with reference to Fig. 1, but it will readily be seen that the transmitting station T^b remains inoperative owing to the fact that the liquid which is driven into the pipes Y and Z closes the valves *q* and *s* of said station T^b. The controlling action of T^a does not therefore exert any influence on T^b.

Similarly, the control of the receiving station R by T^b does not exert any influence on T^a.

Finally, when the control of the receiving station by one of the transmitters, for example by the station T^a, is terminated and the receiving station is to be controlled by the other transmitting station, T^b, the control member L^b and the controlled member L do not necessarily occupy homologous positions at this instant. By applying the features of the stations, it will in that case be an easy matter to re-synchronize said members by causing the control member L^b to effect a forward and a return stroke. At the end of the return stroke, the members L and L^b necessarily occupy homologous positions and the control of the first by the second can be effected under normal conditions. Of course, during this re-synchronizing operation, the other transmitting station T^a has continued to remain inoperative.

Although the example considered above relates to the case of two transmitting stations associated with a single receiving station, it is obvious that the irreversibility boxes could be applied, with the same results, to systems comprising more than two transmitting stations.

The applications of these irreversible control systems are multiple: for example, the control of the gases for an engine from a plurality of cockpits.

It should be noted, finally, that said irreversibility boxes can be used, without exceeding the scope of the invention, in hydraulically controlled systems of transmitting and receiving stations, in which the internal formation of the stations is different from that of the stations having automatic re-synchronization which have been described.

In the case of a single transmitting station, this device provides the irreversibility of the control.

I claim:

1. A positive hydraulic remote control device comprising a transmitting station, a receiving station, each formed by two cylinders in each of which a piston is displaceably mounted, a liquid reservoir for each pair of cylinders, a control member at the transmitting station, a controlled member at the receiving station, two pipes connecting one of the cylinders of one of the pairs to one of the cylinders of the other pair, spring actuated valves mounted in the head of the pistons in such manner that the pressure produced in said pipes by the displacement of said pistons tends to cause the closure of said valves, a stop member encountered by said valves at the end of the stroke of the corresponding piston towards the outside of the station, a chamber inside each piston and communicating with the orifices controlled by the corresponding valve, and orifices provided in the body of said pistons and placing said chambers in communication with the liquid reservoir of the station.

2. A positive hydraulic remote control device comprising a transmitting station, a receiving station, each formed by two cylinders in each of which a piston is displaceably mounted, a liquid reservoir for each pair of cylinders, a control member at the transmitting station including a movement equalizing connection between the pistons of the transmitting station, a controlled member at the receiving station including a movement equalizing connection between the pistons of the receiving station, two pipes connecting one of the cylinders of one of the pairs to one of the cylinders of the other pair, spring actuated valves mounted in the head of the pistons in such manner that the pressure produced in said pipes by the displacement of said pistons tends to cause the closure of said valves, a stop member encountered by said valves at the end of the stroke of the corresponding piston towards the outside of the station, a chamber inside each piston and communicating with the orifices controlled by the corresponding valve, and orifices provided in the body of said pistons and connecting said chambers with the liquid reservoir of the station.

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