Nov. 23, 1943. G. K. NEWELL 2,334,834

RELAY VALVE

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Fig. 1

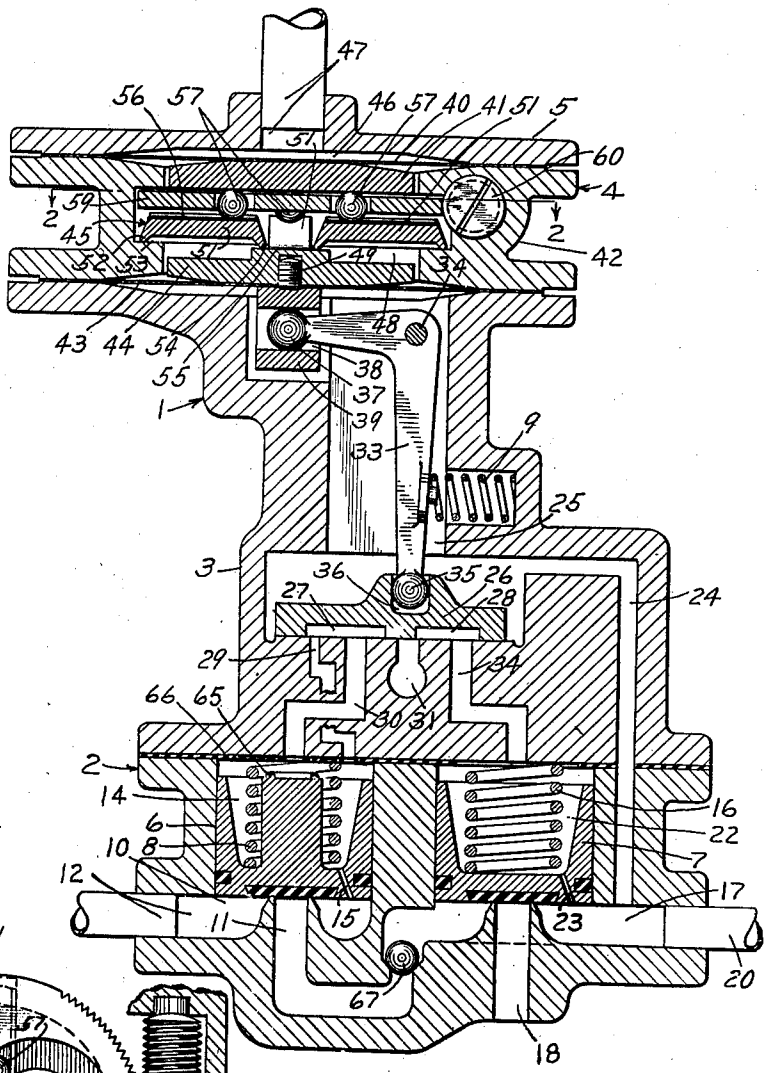
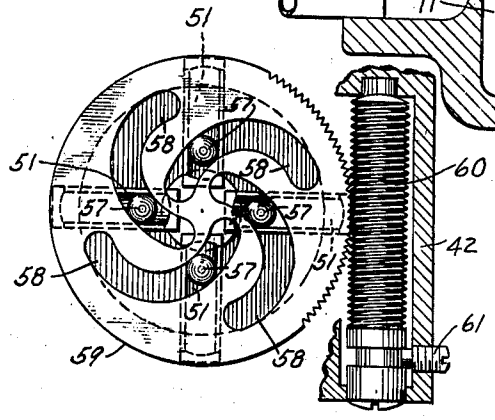


Fig. 2



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RELAY VALVE

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8 Claims. (Cl. 303—22)

This invention relates to control valve devices of the type adapted to be located between a source of fluid supply and a delivery pipe through which fluid under pressure is adapted to be supplied for controlling fluid pressure controlled apparatus and more particularly to the type operated according to variations in pressure in a control pipe.

One object of the invention is to provide a control valve device of the above type which is adjustable to provide different pressures for any given control pressure to which the device is subjected.

This control valve device is particularly adapted for use in railway car brakes where, due to variations in the weight of cars, it is the practice to provide a higher braking ratio for the heavier cars than for the lighter ones.

It is therefore another object of the invention to provide a control valve device of the above type employing a diaphragm assemblage which is adjustable to different pressures for operating a brake cylinder or other apparatus for any given control pressure to which the device is subjected.

Another object of the invention is to provide a novel pressure responsive diaphragm assemblage having adjusting means which is operative to vary the operating characteristics of the assemblage.

Still another object of the invention is to provide an improved fluid pressure control valve device of the above character mentioned which is simple in construction, and reliable and exact in function under all conditions of service.

The invention also comprises certain new and useful improvements in the construction, arrangement, and combination of the several parts of which it is composed, as will be hereinafter more fully described and claimed.

Fig. 1 is a vertical sectional view of a fluid pressure control valve device constructed in accordance with the invention; and Fig. 2 is a fragmentary sectional view taken on the line 2—2 of Fig. 1.

For illustrative purposes only the control valve device 1 shown in the drawing is of a type particularly suitable for use as a relay valve device to control the supply of fluid under pressure to and the release of fluid under pressure from the brake cylinder of a fluid pressure brake equipment, and may comprise a sectional casing having a combined pipe bracket and valve section 2, an intermediate body section 3 and a diaphragm assemblage 4 interposed between the body section 3 and a cap section 5, which sections are secured together in any suitable manner.

Contained in the combined pipe bracket and valve section 2 of the casing is an application valve 6 and a release valve 7 both of which are in the form of valve pistons.

The application valve piston 6 is normally urged, by means of a spring 8, into seating engagement with an annular valve seat, thus closing communication between a chamber 10 to which the outer seated area of the seated valve is exposed and a passage 11. The chamber 10 is charged with fluid under pressure from a source of fluid under pressure (not shown) through a supply pipe and passage 12. A chamber 14 at the back of the application valve is connected to the chamber 10 through a flow restricted passage 15 provided in the valve piston 6.

The release valve piston 7 is normally urged, by means of a spring 16, into seating engagement with an annular valve seat, thus closing communication between a chamber 17 to which the outer seated area of the seated valve is exposed and an exhaust passage 18. The chamber 17 is in constant open communication with the passage 11 and also with a passage and pipe 20 leading to a brake cylinder or other fluid pressure responsive device (not shown).

The intermediate body section 3 is provided with a chamber 25 which is open at its upper end and which is connected to the passage 17 by means of a passage 24.

Contained in chamber 25 is a slide valve 26 for effecting operation of the application and release valve pistons 6 and 7, respectively. This slide valve is provided with a cavity 27 and a cavity 28, which cavities are adapted to establish communication between ports and passages 29, 30, 31 and 32 provided in the seat for the slide valve 26, as will hereinafter more fully appear. Also contained in chamber 25 is a bell crank lever 33 for controlling the operation of the slide valve 26.

The bell crank lever 33 is pivotally mounted on a pin 34 carried by the casing. One arm of this lever is vertically disposed and provided with a ball shaped end 35 which is disposed in a recess 36 provided in the top of the slide valve 26 and the other arm of the lever is horizontally disposed and provided with a similar ball shaped end 37 which is operatively mounted in a bore 38 provided in an actuating member 39.

Interposed between and operatively engaging the vertically disposed arm of the bell crank lever

33 and the inner wall of the body section 3 is a light coil spring 9 which tends at all times to urge the lever and thereby the slide valve 26 to release position, as shown in the drawing.

The diaphragm assemblage 4 for actuating the member 39 and thereby the bell crank lever 33 comprises a diaphragm 40, a diaphragm follower 41, a hollow filling piece 42, a diaphragm 43, a diaphragm follower 44 and an adjustable lever mechanism 45 interposed between the diaphragm followers 41 and 44.

As shown in the drawing, the diaphragms 40 and 43 are spaced apart axially and are suitably clamped between the filling piece 42 and the cap section 5 and between the filling piece 42 and the intermediate body section 3, respectively. The upper face of diaphragm 40 and the inner surface of the cap section 5 define a chamber 46 which is in constant open communication with a control passage and pipe 47. The diaphragm 43 closes the open end of chamber 25 in the intermediate body section 3. The diaphragms 40 and 43, together with the filling piece 42 define a chamber 48.

Contained in chamber 48 and abutting the upper face of the diaphragm 43 is the diaphragm follower 44 to which the actuating member 39 is secured by means of a stem 49 extending through the diaphragm and having screw-threaded engagement with the diaphragm follower 44. Also contained in chamber 48 and abutting the lower face of diaphragm 40 is the diaphragm follower 41. The adjustable lever mechanism 45 is disposed between and operatively associated with the diaphragm followers 44 and 46.

This adjustable lever mechanism 45 comprises a plurality of radially disposed levers 51, the outer ends of each of which is provided with a downwardly projecting portion 52 arranged to engage an annular shoulder 53 formed on the filling piece 42, while the inner ends of the levers are each provided with a similar downwardly projecting portion 54 adapted to engage a central boss 55 provided on the upper face of the diaphragm follower 44. The upper face of each lever 51 is provided with a longitudinally extending guide channel 56 in which a metal ball 57 is mounted to roll, which ball engages both the lever and the follower 41 and forms a fulcrum for the lever.

As best shown in Fig. 1 of the drawing there is interposed between the follower 41 and levers 51 a horizontally disposed circular plate or disk 59 which is rotatable relative to the follower and levers. This disk is provided with a plurality of slotted openings 58 through each of which a fulcrum ball 57 extends, the openings being so arranged that the disk when rotated will function to shift the fulcrum balls in directions toward or away from the periphery of the disk depending upon the direction of rotation of the disk. For illustrative purposes only each of the slotted openings 58 is shown in Fig. 2 as of spiral form, but it is to be understood that they may be of any other form so long as they provide for the above mentioned movement of the fulcrum balls.

The disk is adapted to be rotated by means of a worm gearing which comprises gear teeth provided on the peripheral edge of the disk and a worm 60 which operatively engages the teeth. This worm is rotatably mounted in the filling piece 42 and is held in place against longitudinal movement relative to the filling piece by means of a set screw 61 which has screw-threaded engagement with the filling piece. The inner end of the set screw extends into a circular groove provided in the worm and thereby locks the worm in place and at the same time permits rotation of the worm.

The outer end of the worm is provided with a groove for the reception of the end of a suitable tool such as a screw driver whereby the worm may be rotated. As shown in Fig. 2 the slotted end of the worm is accessible for rotation from the exterior of the filling piece.

When the worm 60 is rotated about its axis, the disk 59 is caused to rotate and since movement of the fulcrum balls 57 in the same direction is prevented by the side walls of the grooves in the levers 51, the disk will, due to the arrangement of the slotted openings 58, propel the fulcrum balls outwardly or inwardly along the grooves or channels in the levers depending upon the direction of rotation of the disk. Since the balls 57 constitute the fulcrums for the levers, any change in their position along the levers will produce a change in the leverage ratio. Hence any given control fluid pressure in chamber 46 will be balanced by a lower pressure in chamber 25 depending upon the position of the fulcrum balls with relation to the levers. If the control pressure in chamber 46 is varied, the balancing pressure in chamber 25 will, due to the action of the levers, also vary in the same proportion.

The flexible diaphragm assemblage has been hereinbefore described in connection with a relay valve device for use in fluid pressure brake equipment but it is not intended to limit its use to such a device for it is obvious that it is susceptible to more general use for control purposes. The use of the assemblage in apparatus such, for instance, as feed valve devices, variable load mechanism, compressor unloader mechanism, etc. is contemplated.

Operation

Assuming that the fulcrum balls 57 are positioned as shown in the drawing, and the control pipe 47 and connected chamber 46 vented, the diaphragm assemblage 4 and the several parts associated therewith will be in their normal position as shown in Fig. 1 of the drawing. In this position the spring 9 maintains the bell crank lever 33 and thereby the slide valve 26 in its release position.

Assuming further that the chamber 14 at the upper side of the valve piston is charged with fluid by way of restricted passage 15 to a pressure equal to the pressure of fluid in supply chamber 10, the spring 8 maintains the valve piston seated as shown, thereby preventing the flow of fluid from the supply chamber 10 to passage 11 leading to the pipe 20. With the slide valve 26 in its normal position as shown the cavity 27 of the valve connects passages 29 and 30 and also isolates the chamber 14 from the atmospheric passage 31, the connection between the passages 29 and 30 serving no useful purpose at this time.

Further with the slide valve in this position the chamber 22 at the upper side of the release valve piston 7 is connected to the atmosphere by way of passage 34, cavity 28 in the slide valve and passage 31 leading to the atmosphere. The chamber 25, pipe 20 and chamber 17 are all connected together and are open to the atmosphere by way of the flow restricting passage 23 leading from chamber 17 to chamber 22. Since there is no fluid pressure in chamber 17, the spring 16 maintains the release valve piston seated so that

the exhaust passage 18 is isolated from the chamber 17.

Now if it is desired to admit fluid under pressure from the supply chamber 10 and fluid pressure storage supply connected therewith to the pipe 20 and thereby to the device to be operated such as a brake cylinder device, fluid under pressure is admitted by way of pipe and passage 47 to diaphragm chamber 46.

Fluid under pressure admitted to chamber 46 causes the diaphragm 40 to flex inwardly thereby moving the follower 41 and associated fulcrum balls in the same direction. The balls, as they are thus moved, act to rotate the levers 51 about their pivotal connection with the filling piece so that their inner ends move downwardly forcing the follower 44, diaphragm 43 and actuating member 39 in the same direction. This movement of the member 39 causes the associated bell crank lever to rock in a counterclockwise direction about its pivot 34 against the opposing action of the spring 9. By this movement the vertically disposed arm of the lever causes the slide valve 26 to move from the position in which it is shown to a position in which the exhaust passage 34 is disconnected from the atmospheric passage 31 and in which the passage 30 is connected to the passage 31. The slide valve in this position laps the passage 29 for a reason which will be discussed later.

By reason of the establishment of the communication between the passage 30 and the passage 31 fluid under pressure is vented from the chamber 14 at a much more rapid rate than fluid under pressure can flow thereto from the chamber 10 by way of the flow restricting passage 15 and as a consequence the pressure of fluid in chamber 14 will be quickly reduced.

When the pressure of fluid in chamber 14 is thus reduced, the pressure of fluid in chamber 10 and acting on the outer seated area of the supply valve piston 6 will cause the valve piston to move upwardly against the opposing pressure of the spring 8, first unseating the valve on the underside of the valve piston and then seating the valve 65 on the gasket 66. It should here be mentioned that since the passage 29 is lapped by the slide valve the portion of the chamber surrounding the seated valve 65 will be maintained charged with fluid at the pressure of fluid in chamber 15. Obviously the fluid in this portion of the chamber acts over only a portion of the area of the valve piston so that the pressure of fluid in chamber 10 will maintain the valve unseated and at the same time render the valve piston quickly responsive to cut off the supply of fluid to the passage 11 when the slide valve 25 is moved from supply position to lap position, as will be understood from the following description.

With the valve piston in this position fluid under pressure flows from the supply chamber 10 through passage 11, past the ball check valve 67, chamber 17 and pipe 20 to the device to be actuated. From the chamber 17 fluid under pressure will flow through passage 23 to the upper side of the release valve piston, and the pressure of the spring together with the pressure of fluid admitted to the chamber will maintain the valve piston seated thereby maintaining the exhaust passage 18 isolated from the chamber 17.

Fluid under pressure also flows from the chamber 17 through passage 24 to chamber 25 and acts on the underside of the flexible diaphragm 43.

Now when the pressure of fluid in chamber 25 has been increased sufficiently to overcome the downwardly directed force transmitted to the diaphragm 40 by the levers 51 this diaphragm will be caused to flex upwardly. As the diaphragm flexes it moves the follower 44, actuating member 39, the inner ends of the levers 51, fulcrum balls 57, follower 41 and diaphragm 40 upwardly.

The member 39 as it is being moved upwardly causes the bell crank lever to be rocked in a clockwise direction about its pivot pin 34 and the vertically disposed arm of the lever shifts the slide valve 26 in a direction toward the left hand to its lap position. The slide valve in its traverse first cutting off communication between the passage 30 to the atmospheric passage 31 and then establishing communication between the passage 30 and passage 29. Fluid under pressure now flows from the chamber 14 through passage 29, cavity 27 in the slide valve and passage 30 to the portion of the supply valve piston which is encircled by the valve 65, so that fluid at substantially the same pressure as that of the fluid in chamber 10 now acts over substantially the entire area of the inner face of the valve piston. Since the fluid pressures acting on opposite sides of the valve piston are now substantially equal the spring 8 acts to quickly move the valve piston downwardly, unseating the valve 65 and seating the valve on the opposite face of the valve piston to cut off the supply of fluid from the chamber 10 to pipe 20 and diaphragm chamber 25.

As soon as the supply of fluid under pressure to the chamber is cut off the upward movement of the diaphragm assemblage will cease and as a result the slide valve 26 will come to a stop in lap position.

When, with the control valve device in lap position, it is desired to effect a complete release of fluid under pressure from the pipe 20, the fluid under pressure in the chamber 46 is vented in any suitable manner by way of pipe 47, thus reducing the pressure of fluid in the chamber. Upon thus reducing the pressure of fluid in chamber 46 the higher pressure acting in chamber 25 causes the diaphragm 43 to flex upwardly thus causing the diaphragm follower 44 and attached actuating member 39 to move in the same direction. This upward movement of the diaphragm follower 44 is transmitted to levers 51, thereby causing the levers to pivot at their ends 52 on the shoulder 53 and thus transmit the upward movement through the fulcrum balls 57 to the diaphragm follower 41 which in turn causes the diaphragm 40 to deflect upwardly. Movement of the actuating member 39 in this direction causes the bell crank lever 33 to rotate in a clockwise direction about the pivot pin 34, thus moving the slide valve 26 in a direction toward the left hand until communication is established between ports and passages 32 and 31, respectively, by way of cavity 28 in the slide valve 26.

With this communication between passages 32 and 31 established, fluid under pressure in chamber 22 flows to the atmosphere at a rate faster than it can be supplied to the chamber through passage 23 in the valve piston 7 so that the pressure in chamber 17 acting on the outer seated area of the valve piston overcomes the opposing pressure of the spring 16 and causes the valve piston 7 to move to its unseated position.

With the valve piston 7 unseated, fluid under pressure in pipe 20 flows to the atmosphere by way of chamber 17 past unseated valve piston 7 and passage 18. At the same time fluid under

pressure in chamber 25 is vented to the atmosphere through the passage 24 and connected chamber 17.

When the pressure of fluid in chamber 17 and connected chamber 25 has been reduced to a degree sufficient to permit spring 16 acting on the upper side of release valve piston 7 to move the valve to its seated position, the venting of fluid under pressure from chamber 17 by way of exhaust passage 18 is cut off. However, the release of fluid under pressure from chamber 25 permits the diagram assemblage to return to its normal position, in which it is shown in Fig. 1 of the drawing, so that the spring 9 through the medium of the bell crank lever 33 maintains the slide valve in its normal position. With the slide valve thus positioned fluid under pressure in chamber 17 and connected chamber 25 and pipe 20 is completely vented to the atmosphere by way of flow restricting passage 23 in the valve piston 7, chamber 22, passage and port 32, cavity 28 in the slide valve and exhaust port 31.

When, with the control valve device in lap position, it is desired to effect a partial release of fluid under pressure from the pipe 20, the pressure of fluid in chamber 46 is reduced a predetermined degree. Upon such a reduction in the pressure of fluid in chamber 46 the device will operate in a manner hereinbefore described in connection with a complete release to reduce the pressure of fluid in pipe 20 and connected chamber 25.

When the pressure of fluid in pipe 20 and connected chamber 25 has been reduced to a degree sufficient to balance the opposing pressure in in chamber 46 the bell crank lever 33 will actuate the slide valve 26 to its lap position.

As hereinbefore described, with the slide valve in lap position, communication is cut off between passages 32 and 31, thus the flow of fluid from chamber 22 to the atmosphere is cut off and as a result chamber 22 is quickly charged by way of passage 23 in the valve piston to substantially the same pressure as chamber 17. Since the fluid pressure acting on opposite sides of the valve piston 7 is now substantially equal the spring 16 acts to quickly move the valve piston downwardly seating the valve piston 7, thus isolating the chamber 17 from the exhaust passage 18, so that the release of fluid under pressure from chamber 17, connected chamber 25 and pipe 20 is cut off and a predetermined degree of fluid under pressure is maintained in pipe 20.

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

1. In a fluid pressure controlled mechanism comprising in combination, a casing, spaced movable abutments mounted in said casing adapted to be subjected to opposing fluid pressures and operative in response to variations in one of said fluid pressures, a plurality of levers operatively associated with said casing and one of said abutments, an adjustable fulcrum for each of said levers associated with the other of said abutments each fulcrum being movable relative to one of said levers, a rotatable member for simultaneously moving said fulcrums relative to said levers, and means operatively connected to said rotatable member for rotating said member.

2. In a fluid pressure controlled mechanism comprising in combination, a casing, spaced movable abutments mounted in said casing adapted to be subjected to opposing fluid pressures and operative in response to variations in one of said fluid pressures, a plurality of levers operatively associated with said casing and one of said abutments, a fulcrum for each of said levers associated with the other of said abutments, each fulcrum being movable relative to one of said levers, a disk member rotatably mounted in said casing for moving said fulcrums relative to said levers, said disk member having teeth on its peripheral edge, and an adjusting worm carried by said casing for engaging said teeth and operative for rotating said disk member.

3. In a fluid pressure controlled mechanism comprising in combination, a casing, spaced movable abutments mounted in said casing adapted to be subjected to opposing fluid pressures and operative in response to variations in one of said fluid pressures, a plurality of levers operatively associated with said casing and one of said abutments, a fulcrum for each of said levers associated with the other of said abutments, each fulcrum being movable relative to said levers, a disk member rotatably mounted in said casing for simultaneously moving said fulcrums relative to said lever, said disk member having teeth on its peripheral edge, and an adjusting worm carried by said casing for engaging said teeth, said worm being operable from the exterior of the casing to rotate said disk member.

4. In a fluid pressure controlled mechanism comprising in combination, a casing, spaced movable abutments mounted in said casing adapted to be subjected to opposing fluid pressures and operative in response to variations in one of said fluid pressures, a plurality of levers operatively associated with said casing and one of said abutments, a circular rotatable member interposed between said levers and the other of said abutments and having a spirally formed opening extending therethrough, an adjustable fulcrum for each of said levers disposed in said groove and associated with the other of said abutments, said opening being so arranged that the rotatable member when rotated will simultaneously adjust said fulcrums relative to said levers, means comprising an adjusting worm carried by the casing for rotating said rotatable member to adjust said fulcrums.

5. In a fluid pressure controlled mechanism comprising in combination, a casing, spaced movable abutments mounted in said casing adapted to be subjected to opposing fluid pressures and operative in response to variations in one of said fluid pressures, a plurality of levers operatively associated with said casing and one of said abutments, a plate member rotatably mounted in said casing and interposed between said levers and the other of said abutments, said plate member having a plurality of spirally formed slots extending therethrough, an adjustable fulcrum for each of said levers and operatively associated with said other abutment, said adjustable fulcrum comprising a ball disposed in each of said slots and being movable by said plate member relative to the lever, and means carried by the casing for rotating the plate member.

6. In a fluid pressure controlled device comprising in combination, a casing, a supply valve and a release valve operatively mounted in said casing, a control valve operative at one time to effect the operation of said supply valve to its open position and the operation of said release

valve to its closed position, said control valve being operative at another time to effect the operation of said supply valve to its closed position and the operation of said release valve to its open position, and a mechanism subject to opposing fluid pressures and responsive to variations in either of said pressures for actuating said control valve.

7. In a fluid pressure controlled device comprising in combination, a casing, a supply valve and a release valve operatively mounted in said casing, a control valve operative at one time to effect the operation of said supply valve to its open position and the operation of said release valve to its closed position, said control valve being operative at another time to effect the operation of said supply valve to its closed position and the operation of said release valve to its open position, a bell crank lever for actuating said control valve, and a mechanism subject to opposing fluid pressures and responsive to variations in either of said pressures for actuating said bell crank lever.

8. In a fluid presssure controlled device comprising in combination, a casing, a supply valve and a release valve operatively mounted in said casing, a slide valve operative at one time to effect the operation of said supply valve to its open position and the operation of said release valve to its closed position, said slide valve being operative at another time to effect the operation of said supply valve to its closed position and the operation of said release valve to its open position, a bell crank lever for operating said slide valve, and a mechanism comprising a diaphragm assemblage subject to opposing fluid pressures and responsive to variations in either of said pressures for actuating said bell crank lever.

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