

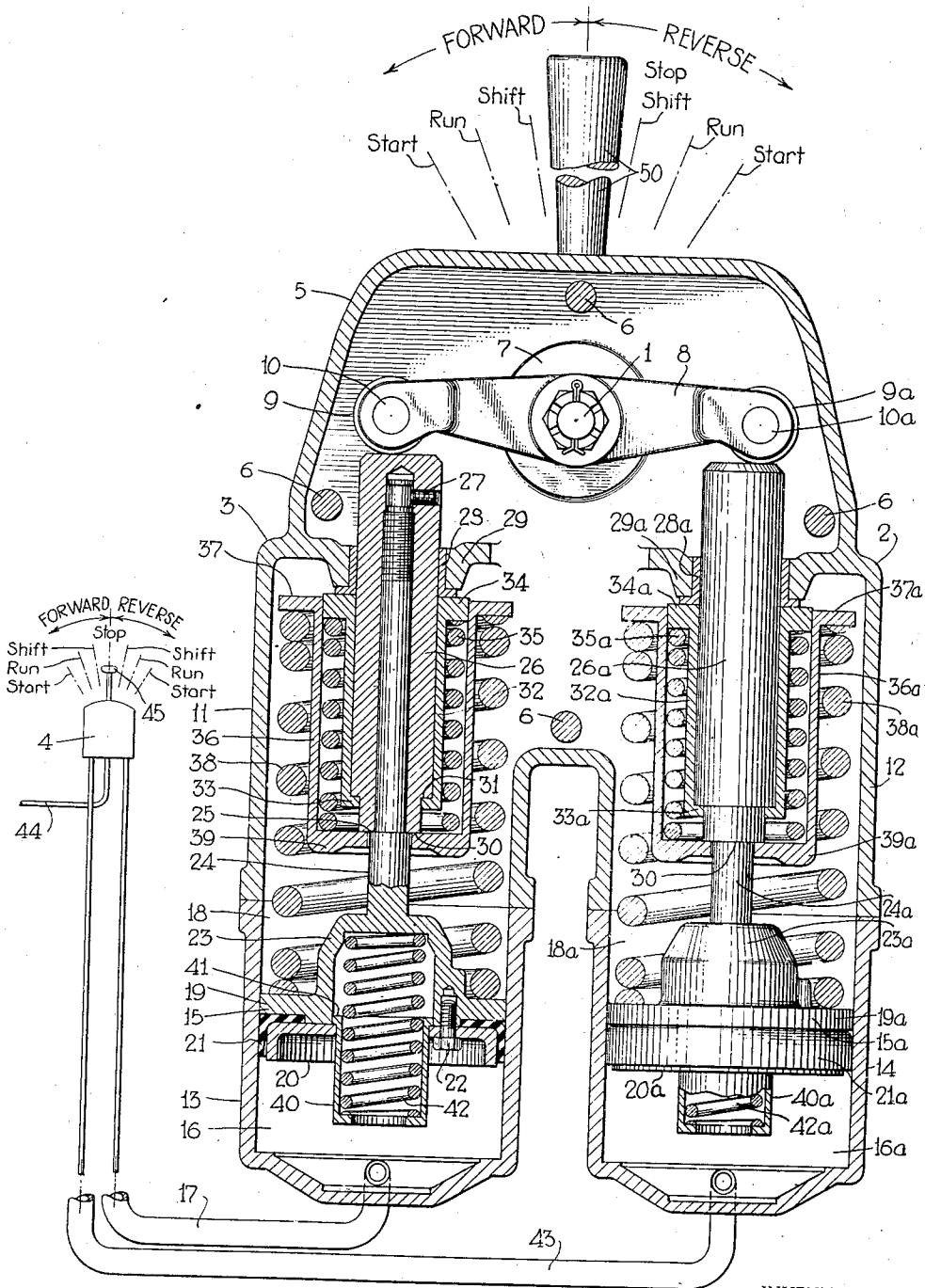
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CONTROL APPARATUS

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CONTROL APPARATUS

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This invention relates to control apparatus and more particularly to means for selectively controlling the positioning of a multi-position device.

Reversible Diesel engines such as employed in marine service are provided with a maneuvering gear operable to control different operations of the engines. Certain maneuvering gears have seven different positions. There is a neutral or stop position for stopping the engine. At one side of stop position there is a shift position for positioning the cams in the engine to provide for running of the engine in a direction which may be called forward, a start position for starting the engine in said direction, and a run position to which the gear is moved and in which it is then carried after the engine is started. At the opposite side of stop position there is a shift position for positioning the engine cams to provide for reverse operation of the engine, a start position for starting the engine in reverse and a run position to which the gear is moved and in which it then remains after the engine is started in reverse.

One object of the invention is the provision of means including a fluid motor controlled by the opposing pressures of springs and fluid under pressure for moving a device, such as maneuvering gear above described, to any selected one of a plurality of different positions.

With the maneuvering gear in either of its run positions it would be undesirable to have same move back to stop position and stop the engine in case of failure of the actuating fluid pressure in the motor.

Another object of the invention is therefore the provision of a fluid pressure motor operable in accordance with predetermined pressures of fluid to selectively position a device such as a maneuvering gear and so constructed as to provide for the maneuvering gear remaining in certain selected positions to which it may have been moved by fluid pressure in case of failure of such pressure.

Other objects and advantages will be apparent from the following more detailed description of the invention:

In the accompanying drawing, the single figure is a diagrammatic view, partly in section and partly in outline, of a control apparatus embodying the invention.

Description

As shown in the drawing, the reference numeral 1 indicates a rockable maneuvering gear control shaft of a reversible Diesel engine such as

above described, and as indicated in the drawing by lines designated by appropriate legends, said shaft has a plurality of different positions including a neutral or "stop" position and at a "forward" side thereof "shift," "run" and "start" positions and at the opposite or a "reverse" side of "stop" position reversely arranged "shift," "run" and "start" positions, the two "start" positions being most remote from "stop" position, and the two "shift" positions immediately adjacent the "stop" position. Suitable detent means not shown in the drawing and not constituting a portion of the invention are usually provided for holding the shaft 1 against unintended movement out of any one or more of the different positions such as the positions indicated by the legends "run" and "stop." The means controlled by the shaft 1 for accomplishing the starting, reversing, stopping, etc., of the engine are not shown in the drawing and will not be described since such means are not pertinent to the invention or an understanding thereof.

The apparatus for controlling movement of shaft 1 to its different positions comprises a forward motor 2, an opposingly arranged reverse motor 3 and a manually operative control device 4.

The forward and reverse motors 2 and 3 comprise a common casing section 5 arranged to be rigidly secured to the engine (not shown) over the shaft 1 by any suitable securing means 6. The casing section 5 has interiorly a boss 7 through which the shaft 1 extends into said casing section. A lever 8 contained in the casing section 5 is secured at its center to shaft 1 for rocking said shaft to its different positions. In the opposite ends of lever 8 are rollers 9 and 9a journaled on pins 10 and 10a, respectively.

The two rollers 9 and 9a are disposed over two parallel arranged cylindrical portions 11 and 12 of the casing section 5. Secured to the lower open ends of the portions 11 and 12 are the open ends of two cup-shaped cylinders 13 and 14, respectively, said portions and cylinders constituting parts of the reverse and forward motors 3 and 2 respectively, both of which are identical in structure and operation.

The reverse motor 3 further comprises a piston 15 contained in cylinder 13 and cooperating with the closed end of said cylinder to form a pressure chamber 16 which is open to a control pipe 17 leading to the control device 4. At the opposite side of piston 15 is a non-pressure chamber 18 open to the cylindrical portion 11 of the casing section 5.

The piston 15 comprises a head 19, a combined stop and follower 20 and a flexible packing cup 21 clamped between said head and follower by screws 22 extending through said follower and having screw-threaded engagement with said head. The head 19 is provided centrally with a hollow extension 23 projecting into the non-pressure chamber 18, and projecting from said extension is a piston stem 24. The stem 24 is joined at an annular shoulder 25 to a portion of reduced diameter and mounted over this reduced portion, with one end engaging shoulder 25, is a sleeve 26 the opposite end of which engages the roller 9. The sleeve 26 is secured to the stem 24 by screw-threaded engagement with the end of the reduced portion of said stem, and a set screw 27 carried by the sleeve is jammed against said reduced portion. Sleeve 26 is mounted to slide in a bearing 28 supported in a shelf 29 in the casing section 5 adjacent roller 9.

The end of sleeve 26 engaging the shoulder 25 on the piston stem 24 is of greater diameter than said stem to provide an annular collar 30, but is of smaller diameter than the remainder of the sleeve for a chosen distance back from said end to provide a second but spaced annular collar 31. A spring cage 32 is slidably mounted on sleeve 26 and has at one end an intumed annular collar 33 overlying collar 31 on said sleeve. At the opposite end of cage 32 is an out-turned annular flange 34 provided to engage the bearing 28 and to also support one end of the coil spring 35 which encircles the cage.

The spring 35 is contained in a second spring cage 36, one end of which is mounted to slide over the flange 34 of cage 32, and said one end also has an out-turned annular flange 37 supporting one end of a coil spring 38, the opposite end of which bears against the piston head 19. The opposite end of spring cage 36 has an intumed annular flange 39 which overlies the collar 30 on one end of sleeve 26 and which also supports the opposite end of spring 35.

With the parts in the condition shown in the drawing, it will be noted that spring 38 is caged between the piston head 19 and cage 36 which is supported at one end on collar 30 on sleeve 26, while spring 35 is caged between the cage 36 and cage 32 which latter is connected to collar 31 of sleeve 26. Both springs are thus confined under a chosen degree of pressure, and the force of spring 38 is greater than that of spring 35.

A spring cage 40 projecting into pressure chamber 16 is slidably mounted in an aperture provided centrally through the follower 20 and is provided within the piston head 19 with an annular out-turned collar 41 arranged to cooperate with said said follower to limit movement outwardly of piston 19, but to provide for movement inwardly of said piston. A coil spring 42 under pressure supported at one end on the piston head 19 within the hollow extension 23 thereof, extends into the cage 40 with its opposite end bearing against said cage and is provided to oppose movement of said cage into said piston head.

The forward motor 2 is structurally identical to the reverse motor 3 as above mentioned and corresponding parts and chambers thereof have therefore been indicated by the same reference numerals each bearing a suffix *a*. In motor 2 the pressure chamber 16a is connected to a control pipe 43 which leads to the manual control device 4, and the upper end of sleeve 26a engages roller 9a.

A lever 50 may be connected to shaft 1 back

of the casing section 5 in any desired manner not shown in the drawing, for manual operation by an operator to rock said shaft to its different position.

The manual control device 4 which is provided for varying the pressure of fluid in pipes 17 and 43, may be of any suitable structure for accomplishing this end, for example, it may be similar to a device fully disclosed in the copending application of R. R. Stevens and Arthur G. Larson, Serial No. 494,612, filed July 14, 1943, and assigned to the assignee of the present application.

Briefly, the manual control device 4 comprises a casing to which is connected the two control pipes 17 and 43, and a pipe 44 through which fluid under pressure from any suitable source may be supplied to the device. The device further comprises a control lever 45 having a neutral or stop position and at either thereof other positions indicated by lines and legends corresponding in name and relative disposition to the different positions of the maneuvering gear shaft 1.

In "stop" position of lever 45 the control device 4 is operative to provide fluid at equal degrees of pressure, such as 20 lbs., in both pipes 17 and 43. With the lever 45 at the "forward" side of "stop" position the control device is operative to open pipe 17 to atmosphere and to provide fluid in pipe 43 at pressures such as 35 lbs., 55 lbs., and 100 lbs. in the "shift," "run" and "start" positions, respectively. At the "reverse" side of "stop" position like pressure will be provided in pipe 17 in the corresponding positions while pipe 43 will be open to atmosphere.

Operation

With the lever 45 in "stop" position providing fluid at equal degrees of pressure, such as 20 lbs., in both pipes 17 and 43, such pressures effective in pressure chambers 16 and 16a on pistons 15 and 15a urge said pistons in an upwardly direction. This pressure of fluid provided on piston 15 in the reverse motor 3 is transmitted through spring 38 and cage 36 to spring 35, the precompressed force of which, however, exceeds the force developed by such pressure of fluid on piston 15 so that said piston will move to but not beyond the position shown in the drawing. In a like manner piston 15a in the forward motor 2 will be moved to but not beyond the position shown in the drawing by the pressure of fluid provided in chamber 16a with the control lever 45 in "stop" position. With the two pistons 15 and 15a thus positioned, the sleeves 26 and 26a will engage the respective rollers 9 and 9a with the lever 8 and maneuvering gear shaft 1 in the "stop" position shown in the drawing.

If the operator now desires to start the engine in a forward direction, he moves the control lever 45 from "stop" position to "shift" position at the "forward" side of "stop" position. In this "shift" position pipe 17 and thereby piston chamber 16 are opened to the atmosphere while fluid at for instance 35 lbs. is provided in pipe 43 and thereby in chamber 16a below the piston 15a.

Since in the reverse motor 3 the springs 38 and 35 are at this time confined under pressure between the piston 15 and sleeve 26, the release of fluid under pressure from chamber 16 will permit these parts to freely move, except for frictional resistance, from the position shown in the drawing in a downwardly direction until the spring cage 40 engages the closed end of cylinder 13. In the forward motor 2 the increase in pressure in chamber 16a on piston 15a from 20 lbs.

to 35 lbs. provides however a force which applied through spring 38a and cage 36a to spring 35a overcomes the force of the latter spring so that the piston 15a is enabled to move in the direction of lever 8 and relative to the spring cage 32a which is held against movement by contact with the bearing 28a. The piston 15a will thus continue to move under the pressure of fluid in chamber 16a against the opposing force of spring 35a until flange 39a on spring cage 36a contacts collar 33a on the spring cage 32 which prevents further movement of cage 32a, so that the force of spring 38a then becomes effective to oppose further movement of piston 15a. The pressure of spring 38a exceeds the force developed by the 35 pounds pressure of fluid in chamber 16a on piston 15a, so that movement of said piston will therefore cease at this time in the position defined by contact between flange 39a and collar 33a. This limited movement of piston 15a from the position shown in the drawing rocks lever 8 in a counterclockwise direction and is such as to rock shaft 1 from its "stop" position to the "shift" position at the "forward" side of its "stop" position.

After the cams in the engine have been shifted incident to movement of shaft 1 to "forward" "shift" position, then in order to start the engine the operator moves lever 45 from the "forward" "shift" position to the "forward" "start" position and thereby provides in pipe 43 fluid at for example 100 lbs. pressure, while maintaining pipe 17 open to the atmosphere. This higher pressure effective in chamber 16a on piston 15a provides a force which exceeds the opposing force of spring 38a so that the piston 15a then moves upwardly against the opposing force of spring 38a and rocks the lever 8 and maneuvering control shaft 1 from "forward" "shift" position in the direction of the "forward" "start" position. When the maneuvering gear shaft 1 attains the "forward" "run" position, spring cage 40 associated with the reverse piston 15 engages the closed end of cylinder 13 so that the pressure of spring 42 will then oppose further movement of piston 15a. The pressure of fluid effective in chamber 16a on piston 15a at this time is however sufficient to continue movement of said piston against the opposing force of spring 38a plus that of spring 42 until follower 20 associated with the piston 15 engages the closed end of cylinder 13. In this position of the pistons 15 and 15a, the lever 8 and thereby the maneuvering gear control shaft 1 will be in their "forward" "start" position to provide for starting of the engine in a forward direction.

After the engine is thus started, the operator moves lever 45 back to "forward" "run" position for thereby reducing the pressure of fluid in pipe 43 to a degree such as 55 lbs. while still maintaining pipe 17 open to the atmosphere. This reduced pressure acting in chamber 16a on piston 15a produces a force on said piston less than the opposing force of spring 38a plus that of spring 42, as a result of which piston 15a is moved downwardly in its cylinder and the piston 15 moves upwardly under the action of spring 42 until collar 41 on the end of spring cage 40 engages the follower 20 for rendering the spring 42 ineffective. The 55 lbs. pressure in chamber 16a acting on piston 15a exceeds however the force of spring 38a at this time so that when the force of spring 42 is removed from piston 15 as just mentioned the two pistons will stop in the position in which the spring 42 is rendered ineffective. This movement of piston 15 by spring 42 as provided for by

the reduction in pressure of fluid in chamber 16a on piston 15a rocks the control lever 8 and thereby the maneuvering gear shaft 1 from its "forward" "start" position to its adjacent "run" position in which position the parts will then remain as long as it is desired that the engine continue running in a forwardly direction.

If the operator desires to stop the engine, he moves lever 45 back to its "stop" position for thereby reducing the pressure of fluid in pipe 43 and pressure chamber 16a to the 20 lbs. above mentioned and for providing fluid at the same pressure in pipe 17 and piston chamber 16. The reduction in pressure in chamber 16a on piston 15a renders the springs 38a and 35a successively effective to return the piston 15a to the "stop" position shown in the drawing, while the pressure of fluid provided in chamber 16 moves the piston 15 back to the position also shown in the drawing. This movement of piston 15 rocks the lever 8 and thereby the maneuvering control shaft 1 back to their "stop" position in which the opposite end of the lever will substantially contact sleeve 26a of the forward motor 2.

If the operator now desires to start the engine in the reverse direction, he moves lever 45 to the "reverse" "shift" position to provide fluid at the 35 lbs. pressure in pipe 17 while opening pipe 43 to the atmosphere. This pressure of fluid in chamber 16 acting on piston 15 provides a force which exceeds the opposing force of spring 35 as a result of which said piston moves in the direction of lever 8 to the position defined by contact between collar 33 and flange 39 on the two spring cages. Further movement of the piston 15 is prevented at this time due to the greater force of spring 38, but this movement is adequate to rock lever 8 and thereby the maneuvering control shaft 1 to the "reverse" "shift" position.

After the cams in the engine have been properly conditioned in response to shaft 1 being moved to its "reverse" "shift" position, the operator moves lever 45 to the "reverse" "start" position for providing fluid at the 100 lbs. pressure in pipe 17 while opening pipe 43 to the atmosphere. This higher pressure provided through pipe 17 on piston 15 then moves said piston against spring 38 and rocks the lever 8 to move the piston 15a to a position in which cage 40a contacts the closed end of cylinder 14, and then continues such movement against the opposing pressure of spring 42a to the position in which the follower 20a engages the closed end of said cylinder. In this position of the two pistons the lever 8 and the maneuvering gear shaft 1 will occupy the "reverse" "start" position for causing starting of the engine in the reverse direction.

After the engine is thus started in reverse, the operator moves the control lever 45 from the "reverse" "start" position to the adjacent "run" position for thereby reducing the pressure fluid in pipe 17 to the 55 lbs. above mentioned. This pressure on piston 15 develops a force exceeding that of spring 38 but less than the combined forces of said spring and of spring 42a acting on piston 15a, as a result of which the latter spring moves the two pistons in opposite directions to positions in which spring 42a becomes ineffective and in which positions movement of the pistons will cease, and this movement of piston 15a turns the lever 8 and maneuvering control shaft 1 from the "reverse" "start" position to the adjacent "run" position in which it will remain as long as it is desired that the engine operate in the reverse direction.

To subsequently stop the engine the operator

returns lever 45 to its "stop" position to thereby reduce the pressure of fluid in pipe 17 to the 20 lbs. above mentioned and to at the same time supply fluid through pipe 43 to piston chamber 16a at the same pressure. This reduction in pressure on piston 15 permits springs 38 and 35 to return said piston to the position shown in the drawing, while the pressure of fluid provided on piston 15a returns same to the position also shown in the drawing, and this movement of piston 15a moves lever 8 and the maneuvering gear shaft 1 to "stop" position for stopping the engine.

From the above description it will now be noted that under both the forward and reverse conditions of operation, one of the motors 2 or 3 rocks the lever 8 and maneuvering gear shaft 1 in the direction away from "stop" position but the other motor is required for rocking said lever and shaft in the opposite direction back toward and to "stop" position. In other words, the forward motor 2 can rock lever 8 and shaft 1 from "stop" position to "forward" "shift" and "start" positions, but spring 42 in the reverse motor rocks said lever and shaft from the "forward" "start" position back to "forward" "run" position, while fluid pressure supplied through pipe 17 to the reverse motor is required to rock said lever and shaft from the latter position back to "stop" position. Likewise, the reverse motor 3 can rock the lever 8 and shaft 1 from "stop" position to the "reverse" "shift" and "start" positions, but return to "reverse" "run" position to the "stop" position is desire of spring 42a on the forward motor piston 15a while return of said lever and shaft from the "reverse" "run" position to the "stop" position is dependent upon supply of fluid under pressure to act on the forward piston 15a.

With this structure it will therefore be seen that there is no need for any connection between the piston operated sleeves 26 and 26a and lever 8 other than mere contact with rollers 9 and 9a respectively, whereby said pistons and sleeves are both capable of movement away from and relative to the lever 8 and shaft 1. This is very important since with the lever 8 and shaft 1 in either "run" position a failure of fluid pressure on piston 15 or 15a will merely result in movement of said piston under the action of spring 38 or 38a, respectively, relative to and away from lever 8 and will not therefore result in movement of lever 8 out of either "run" position causing possibly an undesired stopping of the engine. Under such a condition, the engine can, however, be stopped whenever desired and also subsequently started and reversed by manual operation of lever 50, as will be apparent.

In case the pressure of fluid on piston 15 or 15a should fail with lever 8 and shaft 1 in either "start" position, said lever and shaft will automatically be moved to the adjacent "run" position by the action of either spring 42a or 42 which then becomes ineffective, so that lever 8 and shaft 1 will stop in the "run" position while piston 15 or 15a will continue movement relative to said lever back to the normal position shown in the drawing. If the engine has already been started, this automatic return of lever 8 to the adjacent "run" position will therefore allow the engine to run as intended in spite of the failure of fluid pressure.

In addition to the above, lever 50 also provides for manually moving the maneuvering gear shaft 1 to any selected position for starting, stopping and reversing of the engine at a time when there is no fluid pressure available in pipe 44. Upon

each manual operation spring 42 will oppose manual movement of shaft 1 from the "ahead" "run" position to the "ahead" "start" position, while spring 42a will oppose manual movement of shaft 1 to the other "start" position, but upon relief of manual force on lever 50, said springs will automatically return the maneuvering gear shaft 1 to the adjacent "run" position, thus avoiding the possibility of shaft 1 being in a "start" position when not intended. The several springs will offer no resistance to manual adjustment of shaft 1 by lever 50 between the two "run" positions.

As above described, movement of the lever 8 and shaft 1 from "forward" "run" position to "stop" position is accomplished by the provision of 20 lbs. pressure in chamber 16 or piston 15, which pressure however is insufficient to move said piston against spring 35 to in turn move lever 8 and shaft 1 past "stop" position, while to move said lever from "reverse" "run" position to "stop" position the same degree of pressure is provided in chamber 16a to act on piston 15. It will therefore be apparent that in the former case where fluid pressure is supplied to actuate piston 15 it is not necessary to supply fluid under pressure to act on piston 15a since it will accomplish no purpose, and the same is true in the latter case. However as above described, when fluid under pressure is supplied to actuate piston 15 to move lever 8 and shaft 1 from "forward" "run" position to "stop" position the same pressure of fluid is also provided on piston 15a, while when fluid under pressure is supplied to actuate the latter piston to turn lever 8 and shaft 1 from "reverse" "run" position to "stop" position the same pressure is provided on piston 15. In other words, under these two different conditions the same degrees of pressure are provided on both pistons 15 and 15a at the same time and this is desirable in that it permits the use of a single "stop" position for the operator's control lever 45 to stop the engine when operating in either the forward direction or in reverse direction; otherwise two "stop" positions for lever 45 would be required.

Summary

It will now be seen that we have provided an apparatus embodying two oppositely arranged fluid pressure motors which are operative to move a member being controlled to any selected one of a number of different positions as determined by different pressures of fluid selectively provided in either one or the other of said motors. Each of the motors comprises a piston controlled by the opposing pressure of fluid and of springs and the parts are so arranged that the failure of fluid pressure on the controlling piston, with consequent movement of said piston by its springs, will not move the member being controlled from the position to which it had been previously moved. The motor structure is relatively simple and compact in construction and positive and accurate in operation in response to the different pressures of fluid to which it may be subjected.

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

1. In combination, a movable member having a neutral position and another position either side thereof, two independently operative fluid pressure controlled motors oppositely connected to said member and selectively operable by fluid under pressure to move said member, respectively, in either one direction or in the reverse direction

to said neutral and other positions, each motor comprising a casing, a piston in said casing having positions corresponding to those of said member and having a one-way drive connection with said member for moving same when subject to fluid under pressure, spring means arranged to oppose pressure of actuating fluid on said piston in neutral position thereof and upon movement thereof by fluid under pressure past said neutral position to the said other position at one side of neutral position, means arranged to render said spring means ineffective to oppose pressure of fluid on said piston at the opposite side of neutral position, said member also having at each side of neutral position a mid-position between said neutral position and the said other position and said piston having a corresponding mid-position, other spring means arranged to move said piston and thereby said member from said other position to the respective mid-position, and means limiting control action of said other spring means on said piston to between the two last named positions.

2. In combination, a movable member having a neutral position and at either side thereof a plurality of positions including an extreme position most remote from said neutral position, two fluid pressure controlled motor means oppositely connected to said member and selectively operable by fluid under pressure to move said member respectively in either one direction to said positions or in the opposite direction to said positions in the reverse order, each motor comprising a casing, a piston in said casing having positions corresponding to said positions of said member and having a one-way drive connection with said member for moving same in one direction when subject to pressure of fluid and providing for movement away from and relative to said member when not subject to fluid under pressure; spring means, caging means connecting said spring means to said piston rendering said spring means effective to oppose pressure of fluid on said piston in neutral position of said piston and upon movement of said piston out of neutral position by fluid under pressure in the direction of one of said extreme positions and ineffective upon movement out of neutral position in the opposite direction, other spring means associated with said piston arranged to oppose movement of said piston to the said extreme position thereof, and means arranged to render said other spring means effective to control movement of said piston between the last named extreme position and the position next adjacent said last named extreme position and ineffective in all other positions.

3. In combination, a movable member having a neutral position and at either side thereof a plurality of positions including an extreme position most remote from said neutral position, two fluid pressure controlled motor means oppositely connected to said member and selectively operable by fluid under pressure to move said member respectively in either one direction to said positions or in the opposite direction to said positions in the reverse order, each motor comprising a casing, a piston in said casing having positions corresponding to said positions of said member and having a one-way drive connection with said member for moving same in one direction when subject to pressure of fluid and providing for movement away from and relative to said member when not subject to fluid under pressure; a plurality of springs associated with said piston, cag-

ing means connecting said springs under pressure to said piston in such a manner as to render one of said springs effective to oppose pressure of fluid on said piston in neutral positions thereof and to also oppose movement of said piston by fluid under pressure in a direction out of neutral position to another position and to render another of said springs effective to oppose further movement of said piston by fluid under pressure from the last named position to the respective extreme position and said caging means being operative upon movement of said piston in the opposite direction to render said other and one springs ineffective to oppose pressure of fluid on said piston in the said last named and neutral positions, respectively, of said piston, and other caging means operative to render a third one of said springs effective to oppose movement of said piston in the said opposite direction to and between the respective extreme position and the next adjacent position and ineffective in all other positions.

4. In combination, a movable member having a neutral position and at either side thereof a plurality of positions including an extreme position most remote from said neutral position, two fluid pressure controlled motor means oppositely connected to said member and selectively operable by fluid under pressure to move said member respectively in either one direction to said positions or in the opposite direction to said positions in the reverse order, each motor comprising a casing, a piston in said casing having positions corresponding to said positions of said member, a rod connected to one side of said piston and arranged to engage said member for moving said member in one direction to successively its different positions when said piston is subject on its opposite side to fluid pressure, said rod being capable of movement in the opposite direction with said piston, out of engagement with and relative to said member, two springs mounted on said rod, means including said piston confining said springs under pressure and rendering one of said springs effective to oppose pressure of fluid on said piston in neutral position thereof and to also oppose movement of said piston by fluid under pressure out of neutral position in said one direction to another one of its positions and to then render the other spring effective to oppose further movement of said piston to the extreme position and said means rendering said other and one springs successively ineffective in said another one and neutral positions, respectively, to oppose pressure of fluid on said piston upon movement of said piston in the opposite direction, another spring associated with said piston operable to oppose movement thereof in said opposite direction to the respective extreme position from an adjacent position, and means arranged to render the last named spring ineffective in said adjacent position to control movement of said piston upon movement thereof in said one direction.

5. In combination, a movable member having a neutral position and two extreme positions, one at either side of said neutral position, and two intermediate positions one between each extreme position and said neutral position, means for moving said member comprising a casing, a piston in said casing operable by fluid under pressure to move said member in the direction of one of said extreme positions, a second piston in said casing movable by fluid under pressure to move said member in the direction of the other extreme position, each of said pistons being capable of

movement relative to said member upon a reduction in pressure of fluid, spring means cooperative with each piston to oppose operation thereof to move said member from either intermediate position to the adjacent extreme position and operable upon a reduction in pressure of fluid on the piston to move said member from the last named extreme position to the adjacent intermediate position, other spring means arranged to oppose operation of each piston by fluid under pressure to move said member from neutral position to the respective extreme position, and means cooperative with the last named spring means to render same ineffective to oppose pressure of fluid on the respective abutment upon movement thereof in the opposite direction from a position in which said member is in neutral position.

6. In combination, a movable member having a neutral position and two extreme positions one at either side of neutral position and two intermediate positions one between each extreme position and said neutral position, means for moving said member comprising a casing, two pistons in said casing oppositely connected to said member, each piston being operative by a certain pressure of fluid to move said member to said neutral position, by a greater pressure of fluid to move said member to one intermediate position, and by a still greater pressure of fluid to the adjacent extreme position, precompressed spring means acting on each piston to define the position thereof in which said member is in neutral position when the piston is subject to said certain pressure of fluid, other precompressed spring means associated with each piston to define the intermediate position of said member to which it is moved by the last named piston when subject to said greater pressure of fluid and yieldable to permit movement of said member to the adjacent extreme position by the said last named piston when subject to said still greater pressure of fluid, said other spring means being operative to move said member from the extreme position back to the adjacent intermediate position upon a reduction in the pressure of fluid on the said last named piston to said greater pressure, the connections between said pistons and member providing for movement of either piston relative to said member upon a reduction in pressure of fluid on the abutment.

7. In combination, a movable member having a neutral position and three positions at either side of neutral position, means for moving said member comprising a casing, two pistons in said casing having corresponding positions and selectively operative by fluid under pressure to move said member either in one direction or in the opposite direction to said positions and each piston being operable upon operation by fluid pressure to move the other piston with said member, a plurality of spring means associated with each piston cooperative with different pressures of fluid thereon to define said neutral position and an adjacent position of said member and to oppose operation of the last named piston by fluid under pressure to move said member from the last named position to the next adjacent or a third position, other spring means associated with each piston cooperative with pressure of fluid thereon to define the said third position of said member and to oppose further movement of said member to the next or a fourth position and operable upon a reduction in pressure of fluid on the last named piston to move said member back to said third position and being then rendered ineffective.

8. In combination, a movable member having a neutral position, two fluid pressure motors oppositely connected to said member, one for moving said member in one direction and the other for moving same in the opposite direction, each motor comprising a casing, a piston in said casing having a connection with said member for moving said member in one direction and providing for movement of said piston by said member and relative to said member in the opposite direction, said piston being subject to variations in pressure of fluid in a pressure chamber in said casing and having a neutral position therein for contact with said member in its neutral position, spring means arranged to oppose movement of said piston out of neutral position in the direction of said member upon an increase in fluid pressure on said piston, means arranged to render said spring means ineffective to oppose movement of said piston upon movement thereof out of neutral position in the opposite direction, stop means arranged to limit movement of said piston in said opposite direction to define an extreme position of said member out of neutral position, and other spring means arranged to oppose movement of said piston from a position of said member out of said extreme position into engagement with said stop means and for moving said piston out of contact with said stop means, and means arranged to render the last named spring means ineffective upon movement of said piston to the position in which said member is in the position adjacent said extreme position.

9. In combination, a movable member having a neutral position, two fluid pressure motors oppositely connected to said member, one for moving said member in one direction and the other for moving same in the opposite direction, each motor comprising a casing, a piston in said casing having a connection with said member for moving said member in one direction and providing for movement of said piston by said member and relative to said member, in the opposite direction, said piston being subject to variations in pressure of fluid in a pressure chamber in said casing and having a neutral position therein for contact with said member in its neutral position, said piston in one motor being movable upon an increase in fluid pressure in said chamber from said neutral position in a direction to move said member from neutral position and for moving said piston in the other motor from neutral position in the opposite direction, each motor further comprising a plurality of caged springs arranged to become successively effective or ineffective to oppose pressure of fluid on the respective piston in different positions thereof and of said member according to the pressures of such fluid, and another caged spring associated with each piston arranged to oppose movement thereof and of said member by the piston of the other motor to an extreme position of said member, and to return said member from said extreme position to another position adjacent said extreme position.

10. In combination, a member movable in either direction from a neutral position, motor means comprising a casing, a piston in said casing operable by fluid under pressure to move said member in one direction, another piston in said casing operable by fluid under pressure to move said member in the opposite direction, means providing a one-way drive connection between each piston and said member for rendering the respective piston capable of movement relative to and

out of driving relation with said member, spring means acting on each piston and operable to oppose pressure of fluid on the respective piston in neutral position of said member and upon movement of said member to one side of neutral position by the respective piston, means confining said spring means under pressure and operative to render same ineffective to oppose pressure of fluid on the respective piston with said member at the opposite side of neutral position, and control means operable to provide on either piston fluid

5 at a pressure to move the piston against the respective spring means while at the same time subjecting the other piston to atmospheric pressure, said control means being also operable to provide on both pistons at the same time fluid at pressures in excess of atmospheric pressure but less than required to move the pistons against the respective spring means.

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