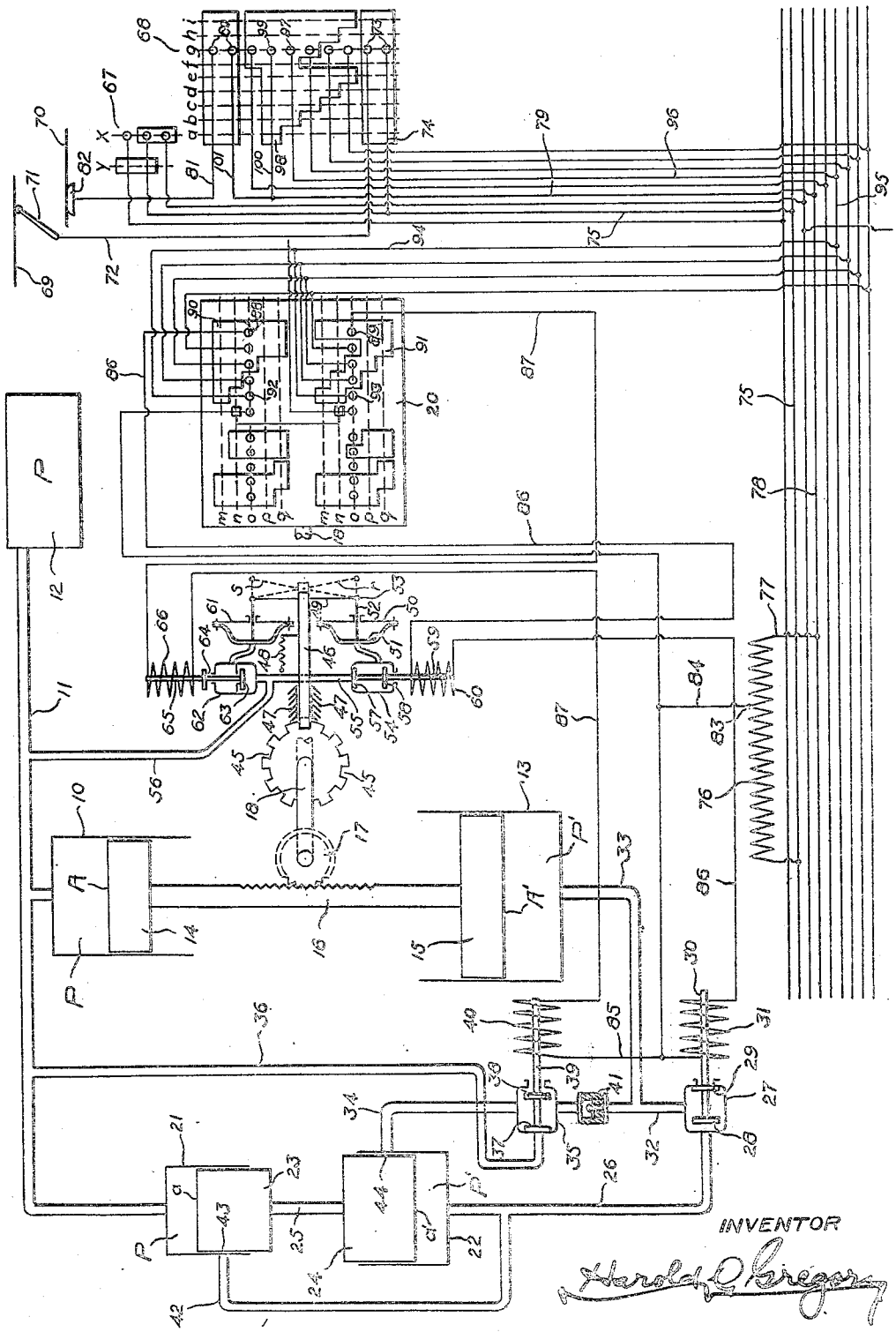
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CONTROL APPARATUS

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CONTROL APPARATUS

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This invention relates to improvements in control apparatus such, for example, as might be employed for operating the so-called motor control drum in multiple unit control systems for motor cars.

One of the objects of the present invention is to provide improved control apparatus of the character referred to wherein unbalanced fluid-pressures are employed to effect conditions of rest and forward or accelerating movement of the control drum, and wherein balanced pressures are employed to effect return or backward movement of the latter.

Another object is to provide, in control apparatus including fluid chambers, means providing for and maintaining fluid-pressure conditions in such chambers of different values and wherein such values bear substantially a predetermined relation to each other.

Another object is to provide, in control apparatus of the character referred to, improved means for insuring that the control drum or other controlled element assumes, during each operation of such apparatus, the proper position required and that the drum or element is locked or held in such position until further operation of the control apparatus.

Another object is to provide control apparatus having advantages over such apparatus constructed heretofore as regards simplicity of construction, cost of manufacture and the space occupied.

Other objects and advantages will hereinafter appear.

The drawing is a schematic view showing control apparatus constructed in accordance with the present improvements and the manner in which the same might be embodied in a multiple unit control system for motor cars, the various parts being shown in one of their intermediate positions.

Referring now to the drawing, the control apparatus shown and which represents one embodiment of the present invention, comprises the fluid chamber or cylinder 10 connected directly by the pipe connection 11 to a suitable fluid-pressure supply 12, a second fluid chamber or cylinder 13 of a greater diameter than the diameter of cylinder 10, and pistons or other equivalent fluid-actuated members 14 and 15 disposed in the respective cylinders and connected for movement together by the rack or operating member 16 with which meshes the pinion 17 fixed on the shaft 18 on which is also fixed the notched locking disk 19 and the motor control drum 20.

Associated and cooperable with cylinders 10 and 13 is the differential fluid-actuated means comprising the fluid chamber or cylinder 21 connected directly through pipe connection 11 to the fluid supply 12 as shown, a second fluid chamber or cylinder 22, and the pistons or valves 23 and 24 disposed in the cylinders, as shown, and connected for movement together by the rod or other suitable means 25.

Cylinder 22 is connected by the pipe connection 26 to the valve casing 27 within which operate the inlet valve 28 and the exhaust valve 29 carried by the stem 30 which is influenced by the coil 31, the arrangement being such that when the coil is deenergized inlet valve 28 is held open and exhaust valve 29 is held closed by a spring or other suitable means (not shown), excitation of the coil operating in the well-known manner to impart left-hand movement to stem 30 to close inlet valve 28 and open exhaust valve 29. The valve casing 27 is connected by pipe connections 32 and 33 to cylinder 13.

The pipe connection 34 is connected to valve casing 35 and to cylinder 22 at a point adjacent its open end, as shown, and the pipe connection 36 provides direct connection between valve casing 35 and pipe connection 11 leading to the fluid supply 12.

The inlet valve 37 and the exhaust valve 38 operate within casing 35 and are carried by the stem 39 which is influenced by coil 40, the arrangement being identical to that of valve 28—29, that is, when coil 40 is deenergized inlet valve 37 opens and exhaust valve 38 closes, while excitation of coil 40 operates to effect closing of inlet valve 37 and opening of exhaust valve 38.

A suitable ball-check valve 41, arranged

to close in the direction of the arrow shown, is connected in the pipe connection 32 at a point intermediate that where the latter connects with pipe connection 33 and valve casing 35. The pipe connection 42 provides communication between pipe connection 26 and cylinder 21 at a point adjacent its open end.

From the foregoing it will be seen that the pressures in cylinders 10 and 21 are always equal to each other and to the pressure P in the fluid supply tank 12.

When the operating member or rack 16 is in a condition of rest the pressure P′ in cylinder 13 is maintained, in the manner hereinafter explained, at such value that PA is substantially equal to P′A′, where A is the area of piston 14 and A′ is the area of piston 15, whereby substantially equal and opposing forces are applied to member 16.

In the drawing, wherein the various parts are shown in one of their intermediate positions, coil 31 is deenergized and inlet valve 28 accordingly open and exhaust valve 29 closed, while coil 40 is excited and inlet valve 37 accordingly closed and exhaust valve 38 open whereby communication is established between cylinders 13 and 22 by way of pipe connection 26, inlet valve 28 and pipe connections 32 and 33, at which time the pressure in cylinder 22 equals the pressure P′ in cylinder 13, it being noted in this connection that fluid under the pressure P′ is prevented from escaping to the atmosphere by way of the open exhaust valve 38 by the ball-check valve 41 arranged, as explained above, to close in the direction of the arrow shown and with the pressure P′.

The dimensions of the various parts are such that $\frac{A}{A'}=\frac{a}{a'}$ where a equals the area of the piston or valve 23 and a' equals the area of the piston or valve 24. It therefore follows that when PA is substantially equal to P′A′, Pa is substantially equal to P′a', so that when operating member 16 and its associated pistons 14 and 15 are subjected to substantially balanced forces, the connected pistons or valves 23 and 24 are likewise subjected to substantially balanced forces and are in a state of equilibrium or rest.

In event the pressure in cylinder 13 should drop an appreciable amount below the value P′, the forces acting on member 16 will be unbalanced and the latter urged downwardly, since at this time PA will be greater than P′A′. The member 16, however, is held against such movement by the locking or holding means hereinafter described. The pistons or valves 23 and 24, however, which are also acted upon at this time by unbalanced forces, since Pa would be appreciably greater than P′a', move downwardly so that valve 23 is in position to uncover the port 43 to provide communication between the fluid supply 12 and cylinders 13 and 22 by way of pipe connection 42, the valves 23 and 24 remaining in this position until the pressure in cylinders 13 and 22 again builds up to a value slightly in excess of the value P′, at which time the force P′a' will be sufficient to cause valves 23 and 24 to drift back to their former intermediate positions, in which position the valve 23 again covers port 43 to cut off communication between supply 12 and cylinders 13 and 22.

If the pressure in cylinder 13 should increase appreciably above the value P′, or if the pressure in cylinder 10 should drop appreciably below the value P, the operating member 16 will again be acted upon by unbalanced forces, only in the opposite sense, that is, the operating member and its associated pistons will tend to move upwardly, but will be held against such movement by the locking or holding means referred to above. At this time, however, the pistons or valves 23 and 24 will also be acted upon by unbalanced forces, P′a' being greater than Pa, so that they are moved upwardly, whereupon valve 24 is in position to uncover the port 44 whereby cylinders 13 and 22 are open to atmosphere by way of pipe connection 34 and the open exhaust valve 38, it being noted that the axial dimension of valve 23 is such that at this time it still covers or closes port 43. This relative position of the various parts is maintained until the pressure in cylinders 13 and 22 drops until it is slightly less than the value P′, at which time the pistons or valves 23 and 24 will drift back to their original intermediate position, and port 44 will again be closed by valve 24. It will therefore be seen that the differential fluid-actuated means, including cylinders 21 and 22 and their associated valves or pistons 23 and 24, operates automatically to provide for and maintain such pressure conditions in cylinders 10 and 13 that PA substantially equals P′A′ when the operating member 16 is at rest. In this connection, there is sufficient friction between valves 23 and 24 and their seats or cylinders 21 and 22 to prevent pumping action, that is, the relation of the pressures P and P′ might change a slight amount in either direction without being sufficient to initiate corresponding operating of equalizing movement of valves 23 and 24. The differential value mechanism, however, is made sufficiently sensitive so that the pressure in cylinder 13 is maintained close enough to the value P′ so that the opposing forces acting on pistons 14 and 15 will never become unbalanced to such extent as to place any appreciable strain on the locking or holding means referred to.

Downward movement of operating member 16 is effected by exciting coil 31 where-

upon valve 29 is opened to open cylinder 13 to atmosphere and inlet valve 28 closed to lock out the differential fluid-actuated means and maintain the pressure in cylinder 22 and pipe connections 26 and 42 at substantially the value P'.

When it is desired to arrest downward movement of member 16, coil 31 is deenergized to permit opening of inlet valve 28 and closing of exhaust valve 29, at which time the pressure in cylinder 22 will drop rapidly below the value P' for the reason that at this time the pressure in cylinder 13, with which cylinder 22 is now in communication by way of the open valve 28, is an appreciable amount below the value P', and the valves or pistons 23 and 24 will accordingly move downwardly by reason of the consequent condition of unbalanced forces, valve 23 opening port 43 until the fluid flow from supply 12 to cylinders 13 and 22 by way of pipe connection 42 suffices to cause building up of the pressure in cylinders 13 and 22 to a value slightly in excess of the value P', at which time valves 23 and 24 drift upwardly again to their original intermediate position and port 43 is again closed by valve 23. By successive excitation and deenergization of coil 31, therefore, adjusting step-by-step movement is imparted to operating member 16, it being noted that during such operation excitation of coil 40 is maintained.

For the purpose of imparting upward or return movement to member 16, coil 40 is deenergized to cause opening of inlet valve 37 and closing of exhaust valve 38, whereby fluid under the supply pressure P is permitted to flow to cylinder 13 by way of pipe connection 36, inlet valve 37, ball-check valve 41 and pipe connections 32 and 33, at which time the pressure in cylinder 13 will approach the value P. Simultaneously with the action just described, fluid under the pressure P will flow to cylinder 22 by way of pipe connection 32, the open inlet valve 28 and pipe connection 26, and valves 23 and 24 accordingly moved upwardly to their extreme upper position, it being noted in this connection that although such action will cause valve 24 to open port 44, fluid in cylinder 22, which will now have risen to the pressure P, is prevented from escaping to the atmosphere by way of pipe connection 34 since the exhaust valve 38 at this time is closed. If it is desired to arrest this upward movement of member 16 and its associated pistons, coil 40 is again excited to close inlet valve 37 and open exhaust valve 38, whereupon fluid is permitted to escape to the atmosphere from cylinder 13 by way of pipe connections 33 and 32, the open inlet valve 28, pipe connection 26, cylinder 22, port 44, pipe connection 34, and the open exhaust valve 38 until the pressure in cylinders 13 and 22 drops to a value slightly less than the value P', at which time the valves 23 and 24 drift downwardly again to their original intermediate position whereat valve 24 covers port 44.

The action of the control apparatus might therefore be summarized as follows: During condition of rest of operating member 16, the differential fluid-actuated means automatically provides for and maintains unbalanced pressure conditions in cylinders 10 and 13 such that PA is substantially equal to P'A', at which time coil 31 is deenergized and excitation of coil 40 maintained. To effect downward movement of member 16, coil 31 is excited, it being noted that coil 40 is already excited, and to arrest such downward movement coil 31 only is deenergized. To effect upward movement of member 16, coil 40 is deenergized, it being also noted in this connection that coil 31 is already deenergized, such upward movement of member 16 being arrested by again exciting coil 40 and leaving coil 31 in its deenergized condition.

Coming now to the construction and manner of operation of the locking or holding means, the same comprises the disk 19 provided with suitable notches 45 for receiving the latch or locking member 46 disposed for sliding movement in suitable guides 47 and which is urged at all times into locking relation with disk 19 by a suitable spring 48. The element 49 is pivotally connected intermediate its ends to the outer end of latch 46 and is movable to either of the dotted line positions r and s to cause movement of latch 46 to its dotted line position shown out of locking relation with disk 19. The element 49 is moved to position r upon application of fluid under pressure to the diaphragm motor 50 comprising the diaphragm 51 provided with the stem 52 pivotally connected at 53 to element 49. The valve casing 54 is connected to motor 50, as indicated, and to the fluid supply 12 by way of pipe connections 55 and 56, and contains the inlet valve 57 and the outlet valve 58 carried by the stem 59 which is influenced by the coil 60 connected in series with coil 31, as shown, the arrangement being such that when coil 60 is deenergized inlet valve 57 is closed and exhaust valve 58 is opened by a spring or other suitable means (not shown), while excitation of coil 60 causes opening of inlet valve 57 and closing of exhaust valve 58.

The element 49 is moved to its other position s by a similar diaphragm motor 61 connected, as shown, to the valve casing 62 which is also connected to the fluid supply 12 by pipe connections 55 and 56 and with which is associated the inlet valve 63 and the exhaust valve 64 carried by the stem 65 influenced by the coil 66 connected in series with coil 40, the arrangement, however, being opposite to that of the valve 57—58, that

is, when coil 66 is deenergized inlet valve 63 opens and exhaust valve 64 closes under the action of a spring or other suitable means (not shown), excitation of coil 66 causing inlet valve 63 to close and exhaust valve 64 to open.

The operation of the locking or holding means is therefore as follows: When the operating member 16 is in its condition of rest and coil 40 excited and coil 31 deenergized, coil 66 which is connected in series with coil 40 will also be excited to hold inlet valve 63 closed and exhaust valve 64 open, while coil 60 which is connected in series with coil 31 will be deenergized with the latter to permit closing of inlet valve 57 and opening of exhaust valve 58 under the action of the spring or other suitable means referred to. In exciting coil 31 to effect downward movement of member 16, therefore, coil 60 will be simultaneously excited to effect opening of inlet valve 57 and closing of exhaust valve 58 and consequent operation of diaphragm 50 to cause movement of element 49 to its dotted line position *r* to release latch 46. Upon deenergization of coil 31 to arrest downward movement of member 16, the series-connected coil 60 will also be deenergized to permit closing of inlet valve 57 and opening of exhaust valve 58, whereupon spring 48 becomes effective to move latch 46 into locking relation again with disk 19.

Upon deenergization of coil 40 to effect upward movement of member 16, the coil 66 connected in series with coil 40 will also become deenergized to permit opening of inlet valve 63 and closing of exhaust valve 64 whereupon the diaphragm motor 61 operates to move element 49 to its dotted line position *s* to release latch 46 and permit of such upward movement of member 16. If coil 40 is again excited to arrest such upward movement of member 16, coil 66 is also excited again to close inlet valve 63 and open exhaust valve 64 whereupon spring 48 becomes effective again to move latch 46 into locking relation with disk 19.

The multiple unit system or circuit shown forms no part of the present invention except as it might be used in combination with the control apparatus just described, and has only been disclosed in sufficient detail to enable those skilled in the art to understand in what manner the present control apparatus might be embodied in or combined with such a system or circuit. In this connection, reference is made to Patent #1,229,446 of June 12, 1917, to Hall and Riley, which discloses and describes in detail the system or circuit of which a part has been shown in the drawing. For a better understanding of the arrangement and operation of this system or circuit, therefore, reference may be made to the above patent. In connection with the cooperative action between the improved control apparatus and the system or circuit, it will be sufficient to state that when the reversing control switch 67 is moved to position *w*, and the master switch 68 is in position *a*, control drum 20 is in position *m* and the motors are connected in series across the positive and negative line conductors 69 and 70 with all resistance in, a circuit being established from line conductor 69, trolley 71, conductor 72, contacts 73, conductors 74 and 75, control resistor 76, conductors 77, 78 and 79, contacts 80, conductor 81 and shoe 82 to the negative line conductor 70.

If the master switch 68 is moved from position *a* to position *b*, a circuit is made from the point 83 of resistor 76, through conductors 84 and 85, coil 31 associated with valve 28—29, coil 40 associated with valve 37—38, conductors 86 and 87, coils 60 and 66 respectively, contacts 88 and 89, plates 90 and 91 of the so-called auxiliary or interlocking portion of control drum 20, contacts 92 and 93, conductors 94, 95 and 96, contact 97, plate 98, contact 99, conductors 100 and 101, contacts 80, conductor 81 and shoe 82 to the negative line conductor 70, at which time coils 60 and 66 will both be excited as well as coils 31 and 40, excitation of coil 60 operating to release latch 46. Since both the coils 31 and 40 are excited, downward movement of member 16 and its associated pistons will occur and consequent rotation of pinion 17, shaft 18 and drum 20 until the latter reaches the position *n*, at which time contact 92 leaves plate 90 to open the circuit of the series-connected coils 60 and 31 whereupon latch 46 moves into locking position again under the action of spring 48 and substantially equalized or balanced forces again act upon member 16 for the reason explained above.

Upon further movement of master switch 68 to the positions *c*, *d* and *e*, at which time excitation of the series-connected coils 40 and 66 is maintained, the series-connected coils 31 and 60 will be successively excited and deenergized to effect and permit of forward step-by-step movement of operating member 16 to move control drum 20 to positions *o*, *p* and *q* respectively. Movement of the master switch to position *f* causes deenergization of the series-connected coils 40 and 66 and consequent return movement of control drum 20 to position *n*, at which time contact 93 engages plate 91 to again complete the circuit of coils 40 and 61 to arrest such movement. Further movement of the master switch to the position *g*, as shown in the drawing, completes the circuit of the series-connected coils 31 and 60 while maintaining the circuit of coils 40 and 66, and the control drum 20 is accordingly moved to position *o*, further movement of the master switch to its positions *h* and *i* causing movement of the control drum to the positions *p*

and *g* respectively, in the manner fully explained in the above patent.

The notches 45 in disk 19 are disposed so that a notch will always be in position to receive latch 46 when drum 20 is exactly in any one of its various positions referred to.

From the foregoing it will be seen that control apparatus has been provided which is responsive to unbalanced pressures to effect application to operating member 16 of substantially balanced forces, and wherein such apparatus is responsive to balanced pressures to effect application of unbalanced forces to operating member 16 whereupon the latter is returned to its initial position, the apparatus being responsive to greater unbalancing of the pressures than that existing during condition of rest of member 16 to effect application of such forces to the latter as to cause the same to move forward. Due to the arrangement of the drawing, movement of member 16 and its associated pistons, as well as movement of the pistons or valves 23 and 24, has been referred to as a downward or upward movement, but it is to be understood that such movement would more properly be referred to as a right or left-hand movement, since it is contemplated in actual practice to arrange these various parts in the usual manner, that is, in a substantially horizontal position, such that their weights will have no tendency to impart any movement thereto.

It is further contemplated to form the cylinders or valve seats 21 and 22 in the head of cylinder 13 and to make the diameter of cylinder 21 in the neighborhood of one-half an inch, and the diameter of the various other cylinders of corresponding values. However, in this connection, it is not intended that the invention be limited to any particular values of the diameters of these cylinders since, of course, these will vary in accordance with requirements of practice.

While the present control apparatus has been shown and described in connection with the control drum in a multiple unit control system, it will be understood that the same is adapted for use in controlling other elements or parts. Furthermore, various changes may be made in the size, shape and arrangement of the parts without departing from the spirit of the invention or the scope of the claims.

The invention claimed is:

1. In control apparatus, an operating member movable in a given direction from a rest position or in a direction from said rest position different from said given direction, a piston for imparting movement to said member in said given direction, a cylinder for said piston, means providing for the supply of fluid at substantially constant pressure to said cylinder on one side of said piston during conditions of rest and movement of said member in both said directions, a second piston for imparting movement to said member in said different direction and having a greater diameter than that of said first-named piston, a cylinder for said second piston, valve means for said cylinder comprising differential cylinders and connected pistons operating therein, said valve means being cooperable with said fluid supply means and said two first-named cylinders and operable during the condition of rest of said member to maintain automatically a pressure relation between said two first-named cylinders substantially inversely proportional to the area relation between said two first-named pistons, and means operable independently of said differential fluid-actuated means to effect a change in such pressure relation between said two first-named cylinders.

2. In control apparatus, an operating member movable in a given direction from a rest position or in a direction from said rest position different from said given direction, a piston for imparting movement to said member in said given direction, a cylinder for said piston, means providing for the supply of fluid at substantially constant pressure to said cylinder on one side of said piston during conditions of rest and movement of said member in both said directions, a second piston for imparting movement to said member in said different direction and having a greater diameter than that of said first-named piston, a cylinder for said second piston, valve means for said cylinders comprising differential cylinders and connected pistons operating therein, said valve means being cooperable with said fluid supply means and said two first-named cylinders and operable during the condition of rest of said member to maintain automatically a pressure relation between said cylinders substantially inversely proportional to the area relation between said two first-named pistons, valve means for opening or closing said second-named cylinder to atmosphere, and valve means providing for conditions of communication or non-communication between said second-named cylinder and said fluid supply means.

3. In control apparatus, an operating member supported for movement, and means comprising a locking member in connection with said operating member and a second locking member cooperating with said first-named locking member for holding said operating member in a position of rest and for permitting movement of said operating member from said position in a given direction or in a direction different from said given direction, said means comprising an element pivotally connected to said locking member for moving said second locking member relatively to said first-named lock-

ing member, fluid-actuated means operable to impart movement to said element whereby said operating member is permitted to move in said given direction from a rest position, and fluid-actuated means operable independently of said first-named fluid-actuated means to impart movement to said element whereby said operating member is permitted to move from a rest position in said different direction.

In witness whereof, I hereto affix my signature.

HAROLD D. GREGORY.