

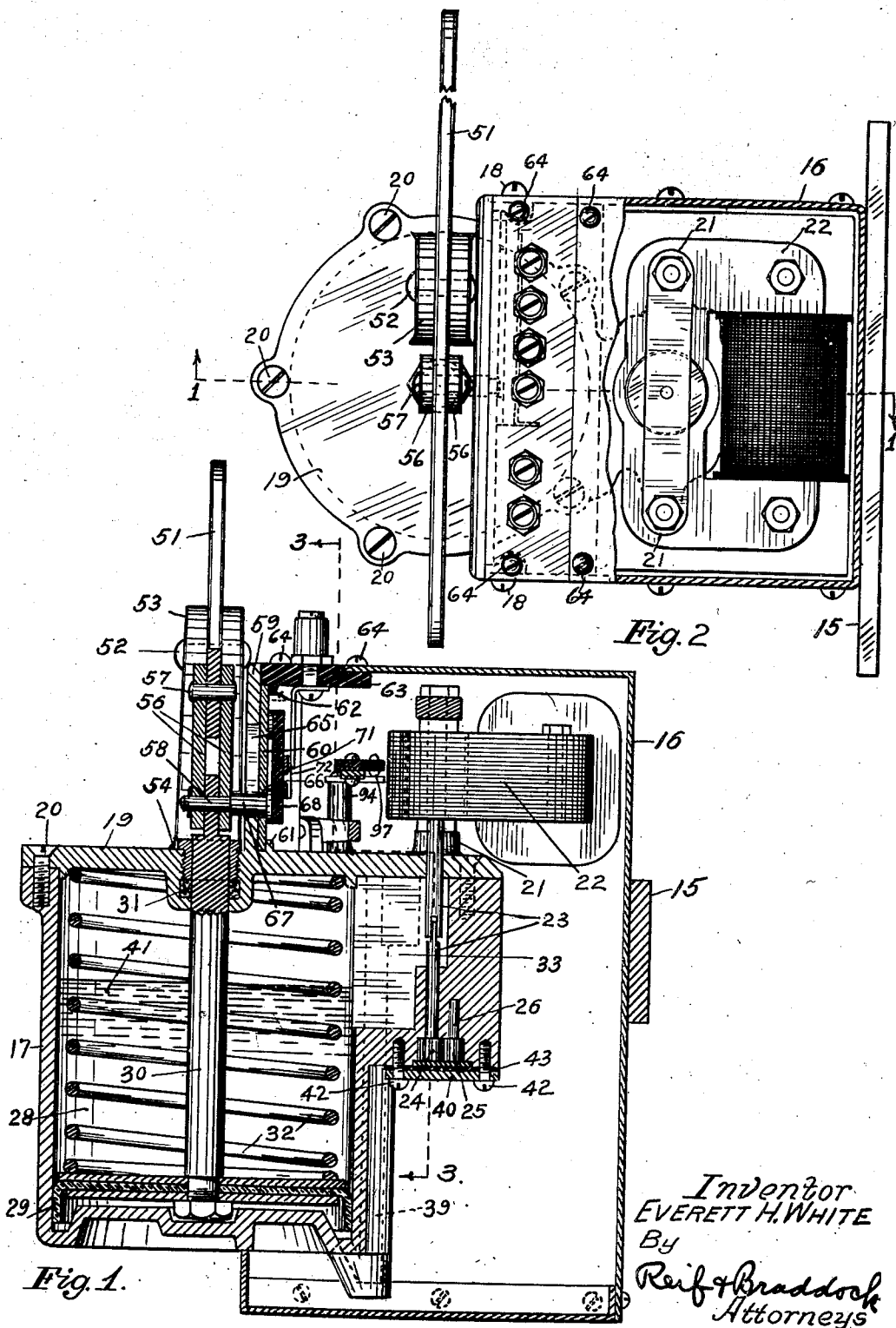
Dec. 18, 1934.

E. H. WHITE
HYDRAULIC REGULATOR

1,984,558

Filed Oct. 2, 1931

4 Sheets-Sheet 1.



Dec. 18, 1934.

E. H. WHITE

1,984,558

HYDRAULIC REGULATOR

Filed Oct. 2, 1931

4 Sheets-Sheet 2

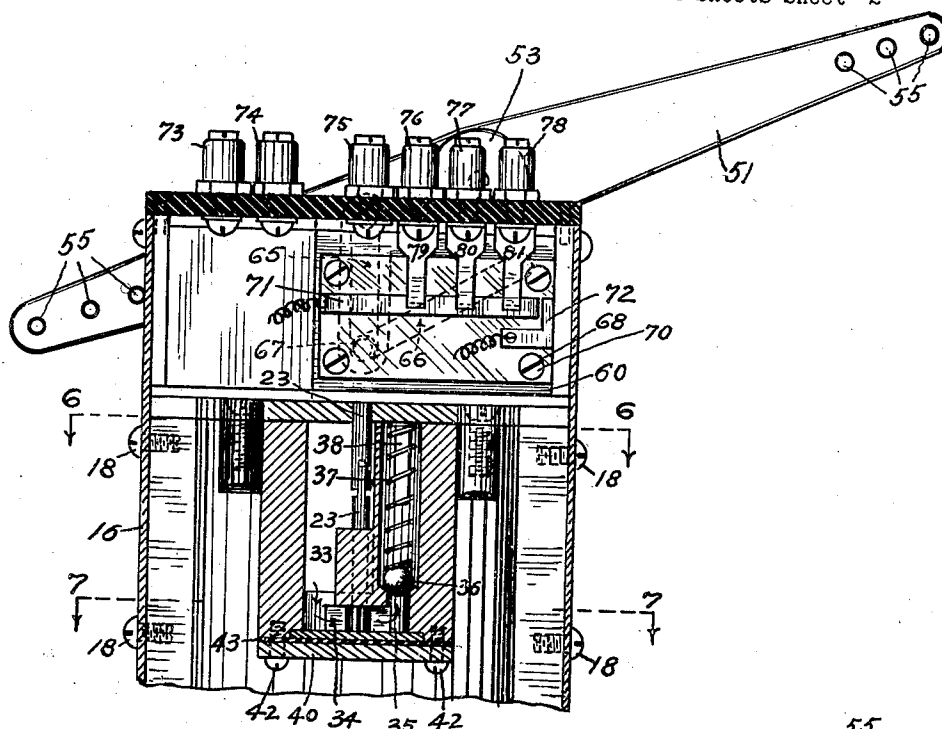


Fig. 3.

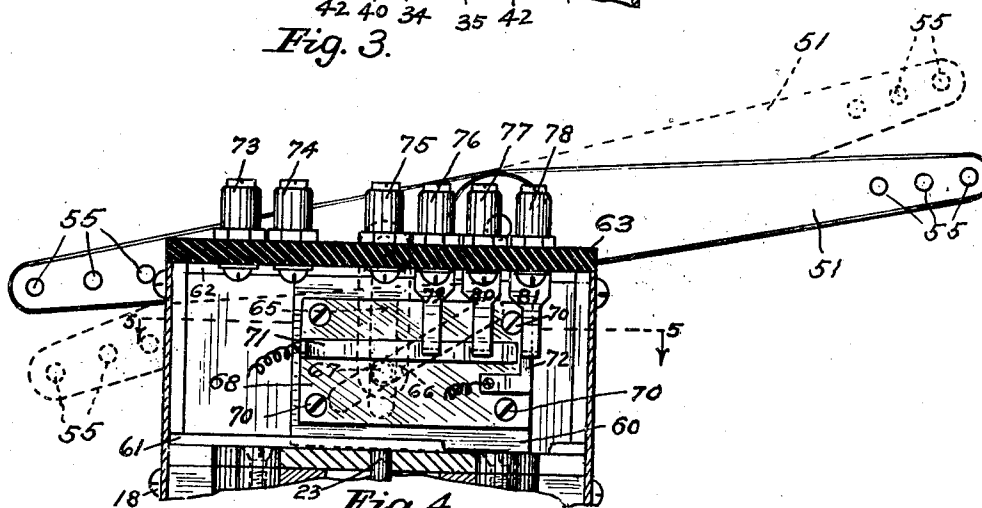


Fig. 4.

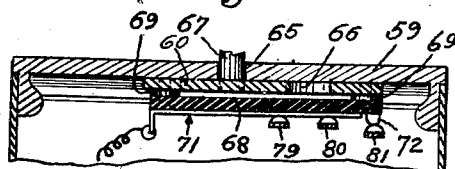


Fig. 5.

Inventor
EVERETT H. WHITE
By
Reif & Braddock
Attorneys

Dec. 18, 1934.

E. H. WHITE

1,984,558

HYDRAULIC REGULATOR

Filed Oct. 2, 1931

4 Sheets-Sheet 3

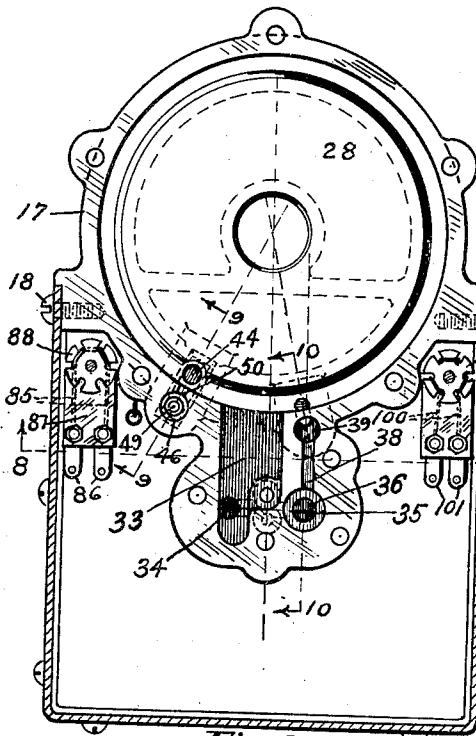


Fig. 6.

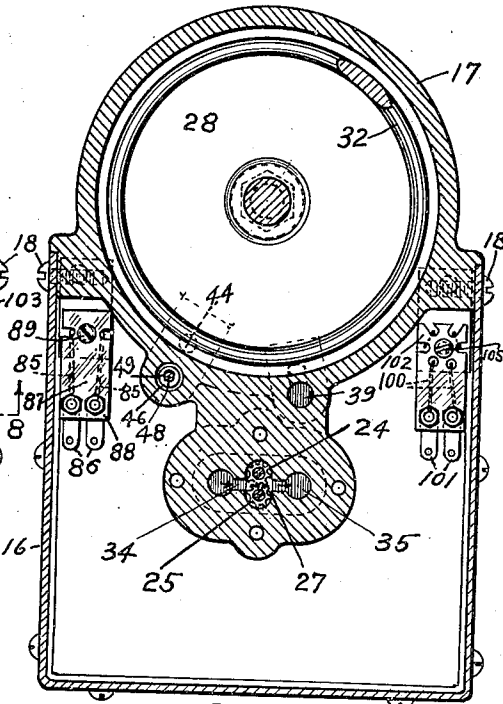


Fig. 7.

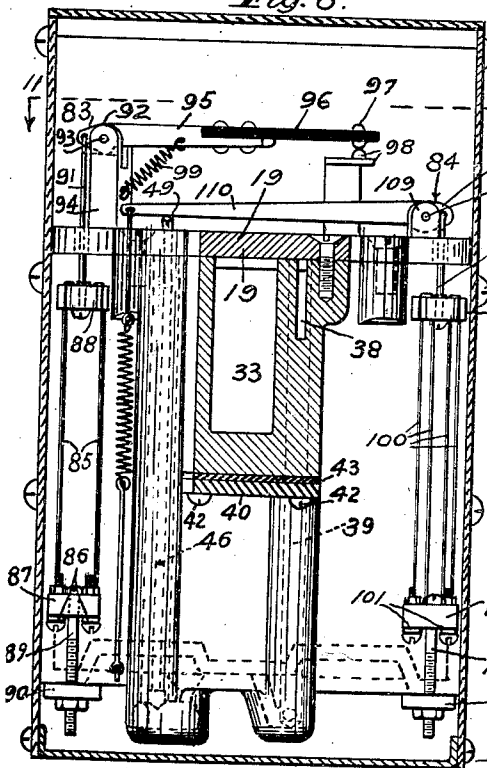


Fig. 8

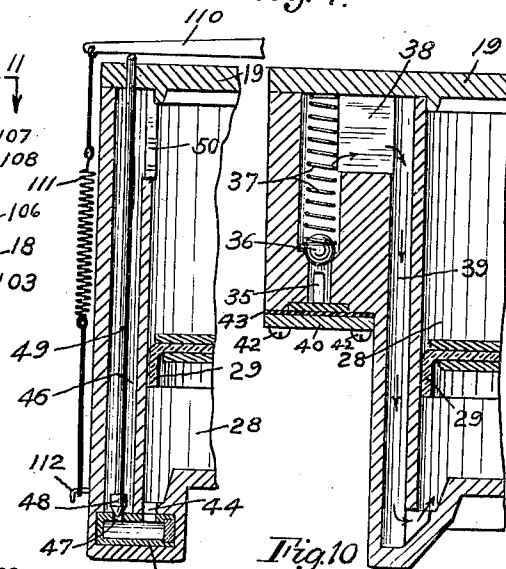


Fig. 9.

Fig. 10

Inventor
EVERETT H. WHITE

By
Reif & Braddock
Attorneys

Dec. 18, 1934.

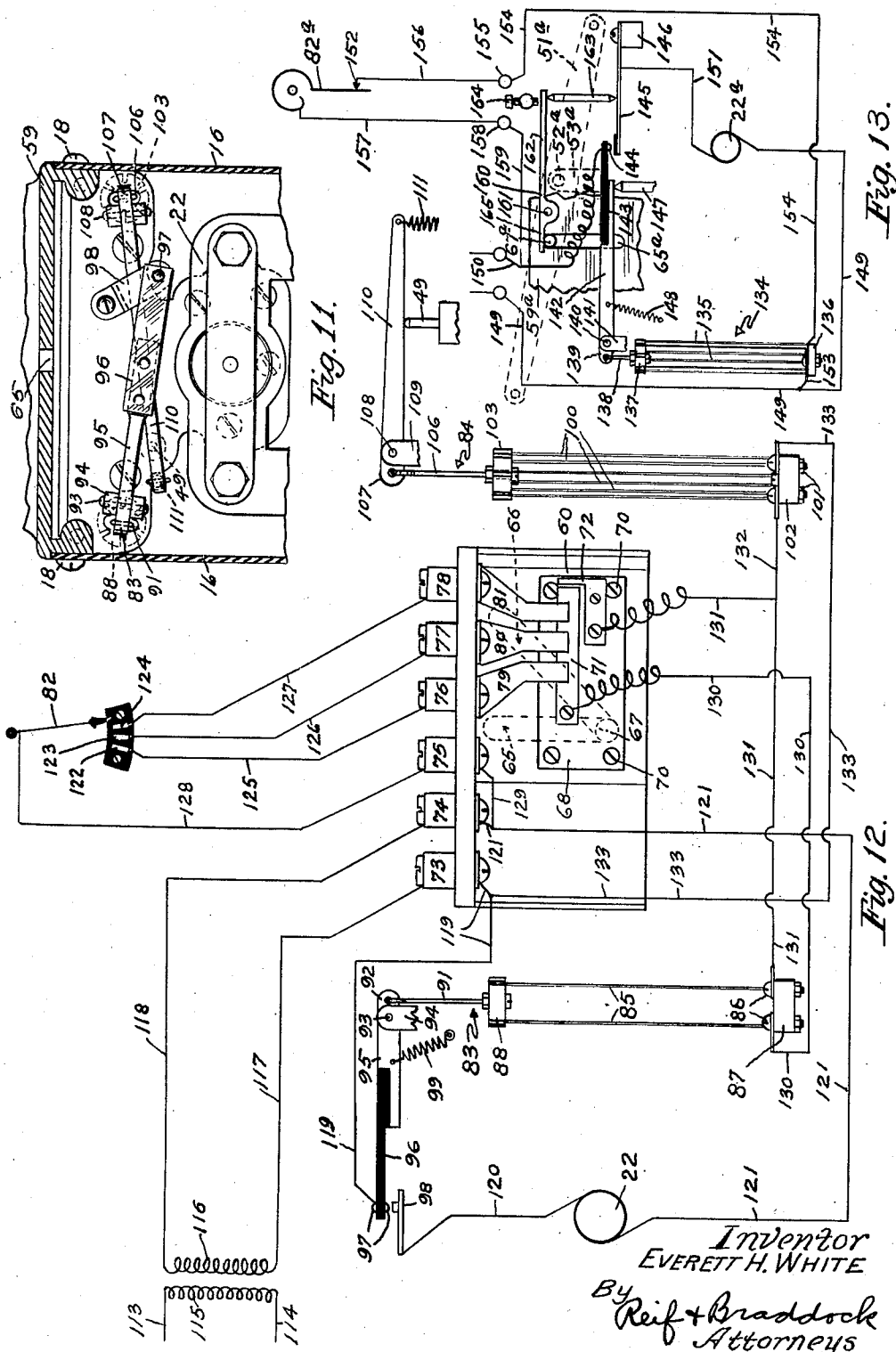
E. H. WHITE

1,984,558

HYDRAULIC REGULATOR

Filed Oct. 2, 1931

4 Sheets-Sheet 4



UNITED STATES PATENT OFFICE

1,984,558

HYDRAULIC REGULATOR

Everett H. White, St. Paul, Minn.

Application October 2, 1931, Serial No. 566,520

23 Claims. (Cl. 60—52)

This invention relates to an hydraulic regulator for the remote control of devices which require motive power to effect their operation, as, for example, heating plant dampers; steam, water, oil, or gas valves; circulating fans or blowers; automatic stokers; intake and mixing valves; etc.

An object of the invention is to provide a regulator for the remote control of devices requiring motive power to effect their operation, which will be hydraulically operated.

A further object is to provide a regulator which will include hydraulically operated and electrically operated mechanisms adapted to cooperate to the accomplishment of the remote control of devices requiring motive power to effect their operation.

A further object is to provide an improved regulator that will supply ample power to operate heavy devices such as heavy dampers, large valves, etc., that require considerable power to effect their operation, and hold them in open positions with a minimum electric current consumption and at the same time cause them to automatically close, or be situated at safety position, in case of current failure from any cause.

Further objects are to provide in the improved regulator, hydraulically operated mechanisms and electrically operated mechanisms which present novel features and characteristics of construction both as individual entities of the regulator and in combination.

With the above objects in view, as well as others which will appear as the specification proceeds, the invention comprises the construction, arrangement and combination of parts as now to be fully described and as hereinafter to be specifically claimed, it being understood that the disclosure herein is merely illustrative and intended in no way in a limiting sense, changes in details of construction and arrangement of parts being permissible as long as within the spirit of the invention and the scope of the claims which follow.

In the accompanying drawings forming a part of this specification,

Fig. 1 is a vertical sectional view of an hydraulic regulator in which the features of the invention are incorporated, taken as on line 1—1 in Fig. 2;

Fig. 2 is a top plan view of the regulator of Fig. 1, partially broken away and partially in section;

Fig. 3 is a detail sectional view taken substantially as on line 3—3 in Fig. 1;

Fig. 4 is a view corresponding generally with

the disclosure of Fig. 3, but showing parts in different positions;

Fig. 5 is a detail sectional view taken as on line 5—5 in Fig. 4;

Fig. 6 is a detail sectional view taken as on line 6—6 in Fig. 3, parts being omitted;

Fig. 7 is a detail sectional view taken as on line 7—7 in Fig. 3;

Fig. 8 is a detail sectional view taken substantially as on line 8—8 in Fig. 6, parts being omitted;

Fig. 9 is a detail sectional view taken as on line 9—9 in Fig. 6;

Fig. 10 is a detail sectional view taken as on line 10—10 in Fig. 6;

Fig. 11 is a detail sectional view taken substantially as on line 11—11 in Fig. 8, parts being omitted;

Fig. 12 is a diagrammatic view of a wiring system which the improved regulator employs, also including additional features of the regulator; and

Fig. 13 is a diagrammatic view of a wiring system employed for a modified form of regulator made according to the invention, the present view also including additional features of the regulator.

With respect to the drawings and the numerals of reference thereon, 15 denotes a support for the regulator upon which the regulator frame or housing 16 can be suitably fastened, as by welding or otherwise.

The frame or housing 16 in turn suitably supports a casing 17 for hydraulically operated mechanisms of the regulator, said casing as shown being positioned partially within and partially without said frame or housing and being secured thereto by screws indicated 18. A cover for the casing 17 is denoted 19, and said cover is attached to the casing by screws 20.

The cover 19 suitably supports, as indicated at 21, a motor 22 which is situated within the frame or housing 16 above said cover. The shaft 23 of said motor 22 extends downwardly through the cover 19 and carries a pumping gear 24 meshing with a pumping gear 25 upon a short shaft 26 mounted in the casing 17, said gears 24 and 25 being situated in a pocket 27 of said casing.

The interior of the casing 17 provides a desirably annular chamber 28 in which a piston or plunger 29 is reciprocable. A connecting rod 30 is attached centrally to the piston or plunger 29 and extends upwardly through the cover 19, numeral 31 designating a packing in said cover and about said connecting rod. A tensile coil spring 32, within the chamber 28 and about the

connecting rod 30, bears at one of its ends against the cover 19 and at its other end against the adjacent face of the piston or plunger 29, to normally hold said piston or plunger at its furthest position from the cover 19, as disclosed in Fig. 1.

A concavity 33 at the side of the chamber 28 adjacent the shaft 23 is open to the upper portion of said chamber 28, and a passage 34 leads first downwardly from said concavity and thence horizontally to the pocket 27, said passage 34 opening to said pocket 27 at one side of the pumping gears 24 and 25 adjacent the location where said gears mesh, as will be more clear from Figs. 3, 6 and 7. At the opposite side of said pumping gears, adjacent the location where they mesh, a passage 35 leads away from the pocket 27, first horizontally and thence upwardly or vertically, the vertical portion of said passage 35 having therein a check valve 36 for the pump including the gears 24 and 25, said check valve 36 being of ball type and being resiliently seated by a coil spring 37 engaging said valve and also engaging the cover 19, as will be more clear from Figs. 3, 6, 7 and 10. The upper portion of the passage 35 communicates with a port or slot 38, which in turn communicates with a passage 39 itself leading to the lower portion of the chamber 28 and opening to the space of said chamber beneath the piston or plunger 29, as will be more clear from Figs. 1, 3, 6, 7, 8, and 10. The lower portion of the pocket 27 is closed by a cover plate 40, and the gears 24 and 25 are disposed in said pocket to pump fluid, indicated 41, from the chamber 28, through the concavity 33, the passage 34, the passage 35, the port or slot 38, and the passage 39 to the space of said chamber 28 beneath the piston or plunger 29, when the motor 22 is in operation. The cover plate 40 is held to the casing 17 by screws 42, and a packing member 43 between the casing and cover plate effectually closes the pocket or pump cylinder 27.

As will be clear from the description already given, the motor 22 is adapted to be driven to force the fluid 41, which may desirably be oil, from the portion of the chamber 28 above the piston or plunger 29 to the portion of said chamber 28 beneath said piston or plunger, to thus cause said piston or plunger to be actuated lengthwise of said chamber, against the action of the coil spring 32, from its position as in Fig. 1 to position closer to the cover 19.

A by-pass for the fluid 41 leads from the space beneath the piston or plunger 29 to the space above said piston or plunger. As disclosed, said by-pass includes a port 44 with which the space beneath the piston or plunger communicates, a small valve box 45 with opening from said port 44 and imbedded in a wall of the casing 17, a passage 46 leading upwardly or vertically from said valve box and with which the interior of said box communicates by a valved outlet 47, a valve 48 for said outlet 47 and carried by a valve stem 49 extending upwardly through the passage 46 and the cover 19, and a port or slot 50 at the upper portion of said passage 46 and affording communication between said passage 46 and the space of the chamber 28 above the piston or plunger 29. See Figs. 6, 7, 8 and 9.

It will be evident that when the valve 48 is in position to close the outlet 47, fluid pumped to the space of the chamber 28 beneath the piston or plunger 29 by operation of the motor 22 and the gear pump will cause said piston or plunger to

be elevated, in the manner as already set forth, but that upon the moving of said valve 48 to open position, the coil spring 32, which was compressed by elevation of the piston or plunger, will act to depress said piston or plunger, in the meantime forcing the fluid from position in the chamber 28 beneath the piston or plunger to position in said chamber 28 above said piston or plunger, said fluid being caused to flow through the port 44, the valve box 45, the outlet 47, the passage 46, and the port or slot 50, constituting said by-pass for the fluid.

A lever 51 is for operating devices which are in remote relation to the improved regulator and which require motive power to effect their operation, examples of such devices being heating plant dampers; steam, water, oil, or gas valves; circulating fans or blowers; automatic stokers; intake and mixing valves; etc. Said lever 51 is, as shown, pivoted at its midlength, by means of a pin 52, between bifurcated portions at the outer or upper end of an upright or post 53 having its inner or lower end suitably supported upon the cover 19 as indicated at 54. The end portions of said lever 51 include openings 55 for attachment of the lever to devices to be operated, although any other convenient arrangement for associating said lever with said devices can be employed. The upright or post 53 is situated adjacent one side of the cover 19, as best shown in Fig. 2, and one end portion of the lever 51 extends outwardly from the casing 17, while the other end portion of said lever 51 extends centrally across said casing above the same to project beyond the casing at the side thereof opposite the upright or post 53, as will be clear from Figs. 2, 3 and 4. Consequently, the portion of the lever 51 which extends across and above the casing 17, passes over the connecting rod 30 in the vertical plane thereof, and said mentioned portion of said lever and said connecting rod are attached to each other by a duplex connecting link 56, a pin 57 affording pivotal connection between said link and said lever, and a pin 58 affording pivotal connection between said link and said connecting rod.

A desirably vertical web or wall 59 is, as disclosed, formed integrally with the cover 19 to extend upwardly therefrom in a plane which is parallel with a vertical plane passed through the lever 51 and arranged lengthwise thereof. A plate 60, desirably of metal, is supported contiguous with or adjacent to the surface of said web or wall 59 opposite the connecting link 56, within the frame or housing 16 and above the casing 17 and to be reciprocable horizontally along said web or wall, by means of a flange 61 integral with the cover 19 and extending upwardly therefrom to engage the lower marginal portion of said plate 60, and a flange 62 integral with and extending downwardly from an insulating block 63 to engage the upper marginal portion of said plate 60, said flanges 61 and 62, together with said cover 19 and said insulating block 63 providing guides for said plate 60. The insulating block 63 is suitably supported upon the frame or housing as at 64.

The web or wall 59 includes a vertical, desirably centrally disposed slot 65, and the plate 60 includes an oblique slot 66 extending in direction from corner toward corner thereof. The pin 58 has an extension 67 thereon which passes through the slots 65 and 66. See Figs. 1 to 5.

It will be apparent that upon upward and downward movement of the piston or plunger 29,

to impart corresponding movement to the pin 58 and its extension 67, said extension 67 will be moved along the slot 65 to cause the plate 60 to be reciprocated horizontally along the web or wall 59, the oblique slot 66, obviously, causing horizontal reciprocation of said plate 60 upon vertical reciprocation of said extension 67. The width of the oblique slot 66 is desirably or preferably a trifle greater than the diameter or width of the extension 67, for a purpose which will be hereinafter set forth.

An insulating block 68 is seated against flat buttons 69 between the plate 60 and said insulating block 68, and screws 70, which desirably pass through said flat buttons, attach said insulating block to said plate.

An elongated, flat contact strip 71 is attached in any suitable manner to the surface of the insulating block 68 which is opposite the plate 60, said contact strip 71 desirably being horizontally disposed. An L-shape contact member is also suitably attached to the insulating block 68 and includes a vertical portion 72 which is arranged adjacent an end of the contact strip 71, the right end as shown in Figs. 3, 4 and 5, in slightly spaced relation to said contact strip. The vertical portion 72 of the contact member is slightly thicker than is the contact strip 71, so that the surface of said vertical portion opposite the insulating block 68 is spaced somewhat farther from said insulating block than is the surface of said contact strip opposite said insulating block, as will be more clear from Fig. 5, and said outer surface of the vertical portion 72 is desirably rounded or curvilinear as shown in said Fig. 5, for a purpose which will hereinafter become evident.

The insulating block 63 suitably supports spaced apart terminals, denoted 73, 74, 75, 76, 77 and 78, respectively, and said terminals 76, 77 and 78 suitably support contact clips, denoted 79, 80 and 81, respectively, each of which contact clips is in conductive engagement with the corresponding supporting terminal. The contact clips 79, 80 and 81 extend downwardly from the insulating block 63 and are adapted to wipe over the contact strip 71 and the vertical portion 72 of the contact member upon the insulating block 68, said contact clips 79, 80 and 81 being resilient to normally engage the contact strip 71 but to ride up over the curved outer surface of the vertical portion 72, when said portion rides under a contact clip, to thus be removed from said contact strip 71, as will be more clear from Figs. 1, 3, 4 and 5. When the vertical portion 72 is removed from the location of a contact clip, said clip assumes its normal position, either that of engagement with the contact strip 71, or a position at the right hand side of said vertical portion as in Figs. 3, 4 and 5, depending upon the working condition of the parts at a particular time and as will be herein later described.

An ordinary thermostatically responsive element 82, such as disclosed in my Patent No. 1,263,497, granted April 23, 1918, in remote relation to the device requiring motive power to effect its operation, as, for instance, in a room to be heated, is disclosed as a means for actuating a switch, as shown a thermal switch 83, for the motor 22, and for actuating a mechanism, as shown a thermal mechanism 84, for controlling the valve 48, but it is to be understood that actuating means other than thermostatic actuating means can be substituted for the thermostatically responsive element 82 illustrated. As

shown, the element 82 is not a thermostat, but is thermostatically actuated, in about the manner as is the equivalent element of my patent which is identified, by a thermostatic device (not shown).

The thermal switch 83 includes a resistor 85 desirably consisting of a single strand of wire having its two end portions connected to terminals 86 upon a lower insulating member 87 and its intermediate portion looped over an upper insulating member 88. The lower insulating member 87 is as disclosed attached, by means of a screw bolt 89, to a bar 90, which bar is suitably attached to the bottom of the casing 17. The upper insulating member 88 is as disclosed attached, by means of a rod 91, to one end of a lever 92 itself pivoted, as at 93, between ears of a bracket 94 suitably supported upon the cover 19. The rod 91 is desirably fixedly secured to said upper insulating member 88 and pivotally secured to said lever 92. The end portion 95 of the lever 92 at the side of the bracket 94 opposite the rod 91 fixedly carries an insulating element 96 itself supporting a contact element 97 which constitutes the movable contact of a switch for the motor 22, said switch also including a fixed contact consisting of the contact element 98 insulatively supported upon said cover 19. A coil spring 99 is attached to the bracket 94 and to the end portion 95 of the lever 92 to urge the movable contact 97 toward the fixed contact 98, and the resistor 85 when contracted holds said contacts apart against the action of said coil spring, but when expanded allows said coil spring to act to move said contacts into engagement. See Figs. 1, 6, 7, 8, 11 and 12.

The thermal mechanism 84 includes a resistor 100 also desirably consisting of a single strand of wire having its two end portions connected to terminals 101 upon a lower insulating member 102 and its intermediate portion looped over an upper insulating member 103 and between said upper and lower insulating members. That is to say, the resistor 100 has one of its ends attached to a terminal on the lower insulating member 102, thence said resistor is looped over the upper insulating member 103, thence said resistor is looped over the lower insulating member 102, thence over the upper insulating member, and so on, and the other end of said resistor is finally attached to the other terminal on said lower insulating member 102. The lower insulating member 102 is as disclosed attached, by means of a screw bolt 104, to a bar 105, which bar is suitably attached to the bottom of the casing 17. The upper insulating member 103 is as disclosed attached, by means of a rod 106, to one end of a lever 107 itself pivoted, as at 108, between ears of a bracket 109 suitably supported upon the cover 19. The rod 106 is desirably fixedly secured to said upper insulating member 103 and pivotally secured to said lever 107. The end portion 110 of the lever 107 at the side of the bracket 109 opposite the rod 106 engages the upper end of the valve stem 49, and a coil spring 111 is for the purpose of urging the portion 110 of the lever 107 toward said valve stem 49. The resistor 100 when contracted holds the portion 111 in receded relation to the valve stem 49, to thus allow the fluid 41 to readily remove the valve 48 from the outlet 47, but when expanded allows the coil spring 111, which is attached between the portion 110 of the lever 107 and a hook 112 upon the wall of the casing 17, to act to move the valve 48 to closed position over the outlet 47, and to hold said valve closed. See Figs. 1, 6, 7, 8, 9, 11 and 12.

The hydraulic regulator and the lever 51 thereof

can be applied to control any devices requiring motive power to effect their operation, as, for example, the draft and check dampers of a furnace; valves controlling flow of steam, water, oil, gas, or other fluid; circulating fans or blowers; automatic stokers; intake and mixing valves or dampers; etc.

When the piston or plunger 29 is positioned as in Figs. 1, 2, 3 and 12, the operating lever 51 is positioned at one of its stationary positions. When the piston or plunger 29 is at the top of its stroke, the position of the lever 51 will be reversed and said lever will be arranged at another of its stationary positions. When the piston or plunger 29 is at location between bottom and top of its stroke, the lever 51 will be situated between the two stationary positions mentioned. In short, when controlling any device requiring motive power to effect its operation, the position of the lever 51, or equivalent, will, obviously, determine the condition of the device being controlled.

Incoming wires 113 and 114 from a source of electrical energy lead to a transformer shown in Fig. 12 and including a primary 115 and a secondary 116. One side of the secondary 116 of said transformer is connected by a lead wire 117 with the terminal 73, and the other side of said secondary is connected by a lead wire 118 with the terminal 74.

A lead wire 119 extends from the terminal 73 to the movable contact 97, a lead wire 120 extends from the fixed contact 98 to the motor 22, and a lead wire 121 extends from said motor 22 to the terminal 74.

As shown very clearly in Fig. 12, the thermostatically responsive element 82 includes a lower portion adapted to wipe over spaced apart terminals, designated 122, 123 and 124, respectively. The terminal 76 is connected to the terminal 122 by a lead wire 125, the terminal 77 is connected to the terminal 123 by a lead wire 126, and the terminal 78 is connected to the terminal 124 by a lead wire 127.

A lead wire 128 connects the thermostatically responsive element 82 with the terminal 75, and a lead wire 129 connects said terminal 75 with the lead wire 121.

A lead wire 130 connects the contact strip 71 with one terminal of the resistor 85, and a lead wire 131 connects the L-shape contact member having the vertical portion 72 with the other terminal of said resistor 85.

A lead wire 132 connects the lead wire 131 with one terminal of the resistor 100, and a lead wire 133 connects the lead wire 119 with the other terminal of said resistor 100.

As shown in Fig. 12, the extension 67 of the pin 58 is at the bottom of the slot 65, and the piston or plunger 29 and the lever 51 are situated as in Figs. 1 to 3. Also, in said Fig. 12, the thermostatically responsive element 82, as, for example, in a room to be heated, is disclosed at the right hand side of the terminal 124, in slightly spaced relation thereto, this being the position of said thermostatically responsive element 82 when the temperature of said room is at or above a desired and predetermined temperature. Also, in said Fig. 12, the plate 60 is situated to locate the contact strip 71 in engagement with the contact clips 79, 80 and 81, and to locate the vertical portion 72 of the L-shape contact member at the right of the contact clip 81. Supposing that the temperature of the room or space having the thermostatically responsive element 82 now falls below said desired predetermined tem-

perature, said thermostatically responsive element comes into engagement with the terminal 124, in a manner which is well known. Upon engagement of said thermostatically responsive element 82 with said terminal 124, an electrical circuit is completed through both the resistor 85 and the resistor 100, said circuit being traced from the secondary 116 of the transformer through the lead wire 117 to the terminal 73, thence through the lead wires 119 and 133 to and through the resistor 100, thence through the lead wires 132 and 131 to and through the resistor 85, thence through the lead wire 130 and the contact strip 71 to the contact clip 81, thence through the terminal 78 and the lead wire 127 to the terminal 124, thence through the thermostatically responsive element 82, the lead wire 128 and the terminal 75, and thence through the lead wires 129 and 121, the terminal 74 and the lead wire 118 back to the secondary of the transformer. Upon the passage of current through said resistors 85 and 100, these are caused to expand longitudinally, in a well known manner, to thus allow the coil spring 111 to act upon the end portion 110 of the lever 107 to effectually move the valve 48 to closed position over the outlet 47, and to allow the coil spring 99 to act upon the end portion 95 of the lever 92 to carry the movable contact 97 into engagement with the fixed contact 98, as already hereinbefore mentioned. Desirably, the resistor 100 is composed of resistance wire of finer grade than the resistance wire composing the resistor 85, to thus insure that the valve 48 will be seated at least as soon as the contacts 97 and 98 are brought into engagement, and preferably an instant previous to the engagement of said contacts 97 and 98. Upon engagement of the contacts 97 and 98, an electrical circuit is completed through the motor 22, said circuit being traced from the secondary 116 through the lead wire 117 to the terminal 73, thence through the lead wire 119 to and through said contacts 97 and 98, thence through the lead wire 120 to said motor 22, thence through the lead wire 121 to the terminal 74, and thence through the lead wire 118 back to the secondary. Upon the resultant operation of the motor 22, the valve 48 being closed as stated, the gear pump forces fluid 41 to travel from position in the chamber 28 above the piston or plunger 29 to position in said chamber below said piston or plunger, in the manner as already set forth, to thus elevate the piston or plunger, or, in other words, to move said piston or plunger toward the cover 19. As said piston or plunger is so moved, the extension 67 upon the pin 58 causes the plate 60 to be slid, from right toward left as shown in Figs. 3, 4, 5 and 12. Naturally, said plate 60 carries the contact strip 71 and the vertical portion 72 of the L-shape contact member along with it, and in due course said vertical portion 72 will ride under the contact clip 81 and thus remove said contact clip 81 from engagement with said contact strip 71. The distance the piston or plunger 29 travels upwardly before causing the contact clip 81 to engage the vertical portion 72 and be removed from the contact strip 71 will obviously depend upon the original setting of the parts 71, 72 and 81 relatively to each other. In the disclosure as made, the contact clip 81 engages the vertical portion 72 and is removed from the contact strip 71 when the lever 51 has reached a position adapted to actuate a device to be controlled a predetermined amount. Upon removal of the contact clip 81

from the contact strip 71, the circuit through the resistor 85, including said contact clip 81 and said contact strip 71, will be broken, and the motor 22 will cease its operation with the lever 51 positioned as set forth, but circuit through the resistor 100 will not be broken for the reason that said contact clip 81 engages the vertical portion 72 before being removed from the contact strip 71 to hold a circuit through said resistor 100 traced from the secondary 116 through the lead wire 117 to the terminal 73, thence through the lead wires 119 and 133 to and through the resistor 100, thence through the lead wires 132 and 131 and the L-shape contact member having the vertical portion 72 to the contact clip 81, thence through the terminal 78 and the lead wire 127 to the terminal 124, thence through the thermostatically responsive element 82, the lead wire 128 and the terminal 75, and thence through the lead wires 129 and 121, the terminal 74 and the lead wire 118 back to said secondary. Hence, when the motor 22 ceases its operation with the piston or plunger 29 so located, the valve 48 will remain closed, and the fluid 41 trapped in the chamber 28 beneath said piston or plunger will cause the piston or plunger to remain in stationary position against the action of the coil spring 32 tending to return said piston or plunger to position as in Fig. 1, as will be understood.

When the thermostatically responsive element 82 is in engagement with the terminal 124, one of two things can happen. Either the temperature of the room or space having said thermostatically responsive element 82 can rise to the desired and predetermined temperature, as in Fig. 12, or the temperature of said room or space can fall to a temperature bringing said thermostatically responsive element into engagement with the terminal 123, said element 82 being adapted to engage said terminal 123 before becoming disengaged from said terminal 124. Supposing that the temperature of the room or space rises to return the thermostatically responsive element 82 from the position as just described to its position as in Fig. 12, the circuit including the resistor 100, and also including the element 82 and the terminal 124, becomes broken to deenergize said resistor 100 and allow it to contract, to thus act upon the portion 110 of the lever 107 against the action of the coil spring 111 and allow the valve 48 to be removed from its seat over the outlet 47. Immediately, the coil spring 32 acts to return the piston or plunger 29 to position as in Fig. 1, the fluid 41 which was beneath said piston or plunger being by-passed to the space of the chamber 28 above the piston or plunger through the port 44, the valve box 45, the outlet 47, the passage 46 and the port or slot 50 constituting the by-pass. Supposing, instead, that the temperature of the room or space falls to a temperature bringing the thermostatically responsive element 82 into engagement with the terminal 123, of course before becoming disengaged from the terminal 124, circuit is continued through the resistor 100 and is remade through the resistor 85 over the route as described when the thermostatically responsive element 82 first came into engagement with the terminal 124, except that the present circuit is through the contact clip 80, the terminal 77, the lead wire 126, and the terminal 123 instead of through the contact clip 81, the terminal 78, the lead wire 127 and the terminal 124 as before described. The resistor 100 remains expanded, and the resistor 85 is caused to again expand to allow the coil

spring 99 to close the contacts 97 and 98 as before. Upon engagement of the contacts 97 and 98, the electrical circuit through the motor 22 is again completed, and the resultant operation of said motor forces more fluid 41 into the space of the chamber 28 below the piston or plunger 29, to thus further elevate said piston or plunger and slide the plate 60 still further toward the left in Figs. 3, 4, 5 and 12. In due course the vertical portion 72 will ride under the contact clip 80 and remove it from engagement with the contact strip 71. As before, the distance the piston or plunger 29 travels to accomplish the operation, will depend upon the distance at which the contact clip 80 is originally set from the vertical portion 72. In the disclosure as made, the contact clip 80 engages the vertical portion 72 and is removed from the contact strip 71 when the lever 51 has reached a position adapted to still further actuate a device to be controlled an additional predetermined amount. Upon removal of the contact clip 80 from the contact strip 71, the circuit through the resistor 85 is broken, as before stated, and the motor 22 ceases its operation with the lever 51 situated at the new position, but circuit through the resistor 100 will not be broken because of engagement between the contact clip 80 and the vertical portion 72, holding a circuit through said resistor 100 traced through the route as before described, except that the present circuit is through the contact clip 80, the terminal 77, the lead wire 126, and the terminal 123 instead of through the contact clip 81, the terminal 78, the lead wire 127, and the terminal 124. As before, when the motor 22 ceases its operation with the piston or plunger 29 so located, the valve 48 will remain closed to trap the fluid 41 beneath the piston or plunger to cause said piston or plunger to remain stationary against the action of the coil spring 32.

When the thermostatically responsive element 82 is thus in engagement with the terminal 123, the temperature of the room or space can rise to return said thermostatically responsive element to position out of engagement with said terminal 123 and again in engagement with the terminal 124, or the temperature of said room or space can fall to a temperature bringing said thermostatically responsive element into engagement with the terminal 122, said element 82 being adapted to engage said terminal 122 before becoming disengaged from said terminal 123. Supposing that the temperature rises to carry the thermostatically responsive element 82 from position where it engages the terminal 123 to position where it engages the terminal 124 and is out of engagement with said terminal 123, the circuit including the resistor 100, and also including the element 82 and the terminal 123, becomes broken to deenergize said resistor 100 and allow it to contract, to thus act upon the portion 110 of the lever 107 against the action of the coil spring 111 and allow the valve 48 to be removed from its seat over the outlet 47. The contact clip 81 being at the time mentioned to the right of the vertical portion 72 in spaced relation to said vertical portion, there will be no circuit through said resistor 100 by the route before described including said contact clip 81, even though the thermostatically responsive element 82 and the terminal 124 are in engagement, as will be evident. Immediately, the coil spring 32 acts to return the piston or plunger 29 toward the position as in Fig. 1, the fluid being by-passed to the space of the chamber 28 above the piston

or plunger. When, however, the vertical portion 72 is moved a sufficient distance upon its return toward normal position to engage the contact clip 81, the circuit through the resistor 100 and including said vertical portion 72, contact clip 81, terminal 124 and thermostatically responsive element 82 will be remade, to allow the valve 48 to be immediately moved to closed position, to thus locate the piston or plunger 29 and the lever 51 in the positions which these assume when the thermostatically responsive element 82 moves from its position as in Fig. 12 to its position of engagement with the terminal 124, and as already fully described. Thereafter, should the thermostatically responsive element 82 move from its position of engagement with the terminal 124 to the position as in Fig. 12, or to position again engaging the terminal 123, the action as hereinbefore described will be repeated. Supposing, instead, that the temperature of the room or space falls to a temperature bringing the thermostatically responsive element 82 into engagement with the terminal 122, of course before becoming disengaged from the terminal 123, circuit is continued through the resistor 100 and is remade through the resistor 85 through the route as described when the thermostatically responsive element 82 first came into engagement with the terminal 124, except that the present circuit is through the contact clip 79, the terminal 76, the lead wire 125, and the terminal 122 instead of through the contact clip 81, the terminal 78, the lead wire 127 and the terminal 124 as before described. The resistor 100 remains expanded and the resistor 85 is caused to again expand to allow the coil spring 99 to close the contacts 97 and 98 as before. Upon engagement of the contacts 97 and 98, the electrical circuit through the motor 22 is again completed, and the resultant operation of said motor forces more fluid 41 into the space of the chamber 28 below the piston or plunger 29, to thus further elevate said piston or plunger and slide the plate 60 still further toward the left in Figs. 3, 4, 5 and 12. In due course, the vertical portion 72 will ride under the contact clip 79 and remove it from engagement with the contact strip 71. As before, the distance the piston or plunger 29 travels to accomplish the operation as just described will depend upon the distance at which the contact clip 79 is originally set from the vertical portion 72. In the disclosure as made, the contact clip 79 engages the vertical portion 72 and is removed from the contact strip 71 when the lever 51 has reached reverse to that in Figs. 1, 2, 3 and 12, with the piston or plunger 29 at the top of its stroke. Upon removal of the contact clip 79 from the contact strip 71, the circuit through the resistor 85 is broken, as before stated, and the motor 22 ceases its operation with the lever 51 situated at the new position, but circuit through the resistor 100 will not be broken because of engagement between the contact clip 79 and the vertical portion 72, holding a circuit through said resistor 100 traced through the route as before described, except that the present circuit is through the contact clip 79, the terminal 76, the lead wire 125, and the terminal 122. As before, when the motor 22 ceases its operation with the piston or plunger 29 so located, the valve 48 will remain closed to trap the fluid 41 beneath the piston or plunger to cause said piston or plunger to remain stationary, against the action of the coil spring 32.

When the thermostatically responsive element 82 is thus in engagement with the terminal 122 and the temperature rises to carry said element from position where it engages said terminal 122 to position where it engages the terminal 123 and is out of engagement with said terminal 122, the circuit including the resistor 100, and also including the element 82 and the terminal 122, becomes broken to de-energize said resistor 100 and allow it to contract, to thus act upon the portion 110 of the lever 107 against the action of the coil spring 111 and allow the valve 48 to be removed from its seat over the outlet 47. The contact clip 80 being at the time mentioned to the right of the vertical portion 72 in spaced relation to said vertical portion, there will be no circuit through said resistor 100 by the route before described including said contact clip 80, even though the thermostatically responsive element 82 and the terminal 123 are in engagement, as will be evident. Immediately, the coil spring 32 acts to return the piston or plunger 29 toward the position as in Fig. 1, the fluid being by-passed to the space of the chamber 28 above the piston or plunger. When the vertical portion 72 is moved a sufficient distance toward normal position to engage the contact clip 80, the circuit through the resistor 100 and including said vertical portion 72, contact clip 80, terminal 123 and thermostatic element 82 will be remade, to allow the valve 48 to be immediately moved to closed position, to thus locate the piston or plunger 29 and the lever 51 in the positions which these assume when the thermostatically responsive element 82 moves from its position of engagement with the terminal 124 to its position of engagement with the terminal 123, and as already described. Thereafter, should the thermostatically responsive element 82 move from its position of engagement with the terminal 123 to its position of engagement with the terminal 124 and out of engagement with the terminal 123, or to position again engaging the terminal 122, the action as hereinbefore described will be repeated.

The arrangement is such that engagement of the thermostatically responsive element 82 with the terminal 122 provides the maximum heat producing condition of a device to be operated; that is when the piston or plunger 29 is at the top of its stroke and the lever 51 is in corresponding position. It is evident that the present regulator can operate a device requiring motive power to effect its operation in a greater or less number of stages than illustrated and described, merely by increasing or decreasing the number of contact clips such as 79, 80 and 81 and the number of terminals such as 122, 123 and 124.

In the disclosure as made, the lever 51 is capable of assuming four different and predetermined stationary positions.

Hereinbefore it has been stated that the width of the oblique slot 66 in the plate 60 is a trifle greater than the diameter or width of the extension 67 on the pin 58 which rides in said oblique slot 66. The obvious purpose of this feature is to allow lost motion in the operation of said plate 60. Upon the movement of the plate 60 from right toward left in Figs. 3, 4, 5 and 12, during the upstroke of the piston or plunger 29, the various stationary positions of said piston or plunger, other than the position as in Fig. 1, are dependent upon the locations at which the vertical portion 72 of the L-shape contact member rides under one side of each of the contact clips 79, 80 and 81, respectively, to remove said clips

from the contact strip 71, whereas upon the movement of said plate 60 from left toward right in said Figs. 3, 4, 5 and 12, during the downstroke of the piston or plunger 29, the various stationary positions of said piston or plunger, other than the position as in Fig. 1, are dependent upon the locations at which said vertical portion 72 engages the opposite side of each of said contact clips 79, 80 and 81. By the provision of the lost motion in the operation of the plate 60 as set forth, the arrangement can be such that the piston or plunger 29 can be stopped at exactly the same locations upon the downstroke thereof as upon the upstroke, as will be obvious. Any other convenient arrangement for accomplishing this result can be substituted.

Attention is called to the fact that when the resistor 85 is out of circuit, and the motor 22 is inoperative, while the resistor 100 is energized and the valve 48 is closed, the current supplied to said resistor 100 is greater than when the current passes through said resistor 85, and the motor 22 is operative, as well as through said resistor 100. Thus, when the piston or plunger 29 is in any one of its stationary, elevated positions, the resistor 100 is constantly energized to sufficient extent to assure that there will be no interference with the action of the coil spring 111 in holding the valve 48 tightly closed, as will be understood.

In Fig. 13 I have illustrated a modified type of hydraulic regulator made according to the invention. As there shown, a lever 51a, similar to the lever 51, is capable of assuming two different and predetermined stationary positions, corresponding to those in which the piston or plunger 29 is at the limit of its downstroke as in Figs. 1 and 12, and at the limit of its upstroke.

With reference to said Fig. 13, 67a denotes an extension, similar to the extension 67 and similarly supported, ridable in a vertical slot 65a in a web or wall 59a, which web or wall 59a may be similar to the web or wall 59. The lever 51a is as shown pivoted at 52a upon an upright or post 53a which may be supported in the same manner as is the upright or post 53.

The present form of the invention includes a single thermal device 134 which replaces both the thermal switch 83 and the thermal mechanism 84 of the form of the invention as hereinbefore described. The thermal device 134 includes a resistor 135 carried by lower and upper insulating members, denoted 136 and 137, in substantially the manner as before set forth in connection with both the resistor 85 and the resistor 100. The lower insulating member 136 may be anchored in any suitable way (not shown), and the upper insulating member 137 is secured by a rod 138 to one end of a lever 139, the connection between said rod and lever desirably being, as disclosed, a pivotal connection. The lever 139 is pivotally supported, as at 140, upon a bracket 141 itself fixedly mounted in any convenient manner. The end portion 142 of the lever 139 at the side of the pivot 140 opposite the rod 138, carries an insulating element 143 upon which is arranged a contact element 144 constituting the movable contact of a switch also including a flexible contact consisting of a contact element 145 suitably and insulatively supported in any convenient way, as at 146. The contact element 145 is a resilient strip of conducting material. A valve stem 147, which may be similar to the valve stem 49 and for a similar purpose, is provided, and the end of said valve stem 147 spaced from its valve is adapted to be engaged, as

shown in Fig. 13, in about the manner in which said valve stem 49 is engaged by the portion 110 of the lever 107, by the portion 142 of the lever 139. A coil spring 148 is attached to the portion 142 of said lever 139 and to a fixed part to be capable of urging said portion 142 against the valve stem 147 and the movable contact 144 toward the flexible contact 145.

The arrangement is such that when the resistor 135 is contracted, the end portion 142 of the lever 139 is held in receded position, against the action of the coil spring 148, both to allow the valve carried by the stem 147 to freely open, and to cause the movable contact 144 to be free of the fixed contact 145. When, however, the resistor 135 is expanded, the coil spring 148 is allowed to act to hold the stem 147 in position closing its valve, and to hold the movable contact 144 in engagement with the flexible contact 145, provided said flexible contact is in its normal or unsprung condition.

The circuit for the hydraulic regulator of Fig. 13 includes incoming lead wires 149 and 150, which may correspond to the lead wires 117 and 118 of Fig. 12.

The lead wire 149 extends to the motor 22a, corresponding to the motor 22 and similarly operating a piston or plunger (not shown) controlling the extension 67a. A lead wire 151 extends from said motor 22a to the resilient contact 145, and the lead wire 150 connects with the movable contact 144.

A thermostatic element 82a, which may be similar or equivalent to the element 82 already described, is adapted to engage a terminal 152 when the room or space having said element 82a is calling for heat, and to be disengaged from said terminal when said room or space reaches a desired and predetermined temperature, as will be understood. A lead wire 153 connects the lead wire 149 with one terminal of the resistor 135, a lead wire 154 connects the other terminal of said resistor with a terminal 155, and a lead wire 156 connects said terminal 155 with the terminal 152. A lead wire 157 connects the thermostatic element 82a with a terminal 158, and a lead wire 159 connects said terminal 158 with the lead wire 150.

Supposing the piston or plunger, such as 29, to be positioned as in Fig. 1, so that the extension 67a is at the lower end of the slot 65a instead of at the upper end of said slot, as said extension 67a is shown in Fig. 13, and the lever 51a is correspondingly positioned when the room or space calls for heat and the thermostatic element 82a as a consequence engages the terminal 152. Upon the coming into engagement of said element and terminal, a circuit is set up through the resistor 135, said circuit being traced from the incoming lead wire 149 to the lead wire 153, thence through the resistor 135, thence through the lead wire 154, the terminal 155 and the lead wire 156 to the terminal 152, and thence through the thermostatic element 82a, the lead wire 157, the terminal 158, and the lead wire 159 to the incoming lead wire 150. Thus the resistor 135 is energized and caused to expand longitudinally to allow the coil spring 148 to act both to close the valve (corresponding to the valve 48 of Fig. 9) carried by the stem 147, and to cause the movable contact 144 to engage the flexible or resilient contact 145, said contacts 144 and 145 coming into engagement preferably no sooner than said valve is actually seated.

Upon the coming into engagement of the contacts 144 and 145, the motor 22a is energized, and

operates to elevate the piston or plunger, such as 29, so that the extension 67a is moved from position at the lower end of the slot 65a to position at the upper end of said slot and the lever 51a is correspondingly positioned, as in said Fig. 13.

Mechanism for breaking the motor circuit at the switch consisting of the contacts 144 and 145 when the extension 67a approaches the limit of its upstroke includes a lever 160 which as shown is pivoted on the web or wall 59a at 161. The longer leg 162 of said lever 160 engages one end of a link 163, the opposite end of said link engaging the flexible or resilient contact element 145 which normally causes said leg 162 to engage an adjustable stop 164, at the side of said leg 162 opposite the link 163, to thus hold the shorter leg 165 of said lever 160 in the path of movement of the extension 67a.

In Fig. 13, the thermostatic element 82a has engaged the terminal 152 in response to a call for heat by the room or space, the motor 22a and the resistor 135 have been actuated to elevate the piston or plunger, and the extension 67a, movable with the plunger, has reached its upstroke and has pushed the shorter leg 165 upwardly to swing the longer leg 162 downwardly, and thus removed the contact 145 from the contact 144 to break the motor circuit. As is evident, the circuit through the resistor 135 remains made to keep said resistor energized, and as a consequence the valve (not shown) carried by the stem 147 remains closed to cause the piston or plunger and the extension 67a to remain elevated, as said extension 67a is shown in Fig. 13, the lever 51a being in position to correspond. The parts will, obviously remain in the positions as illustrated and described as long as the room or space is calling for heat and the thermostatic element 82a is in engagement with the terminal 152, the motor 22a of course being idle.

When the room or space reaches the desired and predetermined temperature, and the thermostatic element 82a resultantly becomes removed from the terminal 152, to break the circuit having the resistor 135, said resistor becomes de-energized and as a consequence contracts to move the portion 142 of the lever 139 to receded position allowing the valve carried by the stem 147 to freely open, and causing the contact element 144 to be moved upwardly a slight distance. Upon the receding movement of the portion 142 of the lever 139, the coil spring (not shown), such as 32, acts to push the piston or plunger, and with it the extension 67a, outwardly or downwardly, the lever 51a having movement to correspond, while the fluid is bypassed, in the manner as hereinbefore described, from the space beneath the piston or plunger to the space above said piston or plunger. Upon downward movement of the extension 67a, this clears the shorter leg 165 of the lever 160, and immediately the contact 145, by reason of its resiliency, moves toward the contact 144, pushing the longer leg 162 against the adjustable stop 164. But in view of the fact that the movable contact 144 has been caused to recede by reason of the contraction of the resistor 135, as already described, the contacts 144 and 145 are out of engagement when the piston or plunger is positioned as in Fig. 1, to correspondingly situate the extension 67a and the lever 51a.

Evidently, when the parts are situated as in Fig. 13, and contact is then broken at the thermostatic element 82a and the terminal 152, the piston or plunger is moved by the coil spring to

its furthest outward or downward position, as in Fig. 1, and the extension 67a is moved to the end of the slot 65a opposite the end at which said extension is shown in said Fig. 13, while the lever 51a is positioned as in Fig. 1.

Attention is called to the fact that the hydraulic regulator of Fig. 13 can, generally speaking, remotely control devices requiring motive power to effect their operation in the various manners as described in connection with Figs. 1 to 12.

It will be appreciated that the employment of thermal elements, such as 83, 84 and 134, directly responsive in their operation to expanding and contracting action of resistance elements, such as 85, 100 and 135, themselves expanding and contracting immediately upon receiving flow of current, makes provision for efficient operation of the regulator, the switch for the motor 22 or 22a and the by-pass valve closing practically instantaneously with the closing of the circuits controlling said resistance elements, and opening practically instantaneously with the breaking of said circuits. Employment of the non-inductive resistance elements allows operation of the hydraulic regulator by controlling circuits therefor which can incorporate delicate and fine electrical contacts, especially those engaged by the element 82 or 82a, for the reason that the operating current required by said resistance elements to accomplish their efficient operation in the regulator does not have to exceed more than a few watts, which, flowing through a non-inductive circuit, causes practically no arcing whatever at the controlling instrument contacts. The arrangement as herein disclosed and described is a great and valuable improvement over arrangements heretofore in vogue for such work as temperature regulation and humidity control, and my present arrangement is also invaluable for a variety of other uses.

One of the many valuable features of the present hydraulic regulator is that its mechanical arrangement is such that by adding or removing circuit breaker clips and control or regulator circuit terminals, the number of different positions of manipulating mechanisms, such as the lever 51, can be increased or decreased without necessity for material changes in the general mechanism.

Especial attention is called to the fact that the present hydraulic regulator is so constructed that should the electrical operating current therefor fail, the parts of said regulator can automatically situate themselves at the safety position of a device to be operated. That is to say, and referring to the disclosures of both forms of the invention as described, upon failure of the operating current, all of the resistors 85, 100 and 135 will of course be de-energized, to obviously allow the piston or plunger 29 to be situated at the minimum heat producing condition of the levers 51 and 51a, as in Figs. 1, 2, 3 and 12.

What I claim is:

1. In a regulator for the remote control of a device requiring motive power to effect its operation, hydraulically operated mechanism comprising a fluid containing cylinder, a piston therein, a pump for forcing fluid into one end portion of said cylinder to move said piston longitudinally of the cylinder toward the opposite end portion thereof, means in said opposite end portion of the cylinder for urging said piston longitudinally of said cylinder in direction opposite that in which the piston is moved by said fluid, a motor for actuating said pump, an operating

electrical circuit for said motor, a plurality of remotely controlled electrical circuits, means operatively connecting said piston with said device, a by-pass for allowing flow of fluid from said end portion of said cylinder and past said piston into said opposite end portion of the cylinder, a valve for controlling said by-pass, means controlled by each of said remotely controlled electrical circuits for making said motor operating circuit and for concurrently causing said valve to be closed when the corresponding remotely controlled electrical circuit is made, and means actuated by said piston for breaking said motor operating circuit as made by each of said remotely controlled electrical circuits while leaving said valve closed, said means controlled by each of said remotely controlled electrical circuits being adapted to cause said valve to open when the corresponding remotely controlled electrical circuit is broken.

2. The combination as specified in claim 1, wherein said means actuated by said piston for breaking said motor operating circuit as made by each of said remotely controlled electrical circuits while leaving said valve closed includes a plurality of spaced apart contact clips, one for each of said remotely controlled electrical circuits, a contact strip adapted to be situated in each of said remotely controlled electrical circuits and to wipe said contact clips, and a contact element also adapted to be situated in each of said remotely controlled electrical circuits and to wipe said contact clips and to remove them from said contact strip, said contact element being connected in series with said means for controlling said valve and in parallel with said means for making said motor operating circuit, and said contact strip being connected in series with both said means for controlling said valve and said means for making said motor operating circuit.

3. In a regulator for the remote control of a device requiring motive power to effect its operation, the combination with an hydraulically operated mechanism including a pump and means actuated by said mechanism and operative upon said device, of a motor for driving said pump to actuate said mechanism, an operating electrical circuit for said motor, a remotely controlled electrical circuit, means in said remotely controlled electrical circuit for making said motor operating circuit, and means responsive to said hydraulically operated mechanism for breaking said motor operating circuit when said mechanism is situated in any predetermined one of a plurality of different stationary positions said mechanism is capable of assuming.

4. In a regulator for the remote control of a device requiring motive power to effect its operation, the combination with an hydraulically operated member and means actuated by said member and operative upon said device, of a pump adapted to force fluid to actuate said member in one direction, a motor for driving said pump, means independent of said pump for actuating said member in opposite direction, a valve for trapping fluid at a side of said member to thus preclude operation of the member by said independent means, an operating electrical circuit for said motor, a remotely controlled electrical circuit for making said motor operating circuit, means responsive to actuation of said hydraulically operated member for breaking said motor operating circuit, and means controlled by

said remotely controlled electrical circuit for controlling said valve, said motor operating circuit being made only while said valve is in closed position.

5. In a regulator for the remote control of a device requiring motive power to effect its operation, the combination with an hydraulically operated member and means actuated by said member and operative upon said device, of a pump adapted to force fluid to actuate said member in one direction, a motor for driving said pump, means independent of said pump for actuating said member in opposite direction, a valve for trapping fluid at a side of said member to thus preclude operation of the member by said independent means, an operating electrical circuit for said motor, a remotely controlled electrical circuit, means in said remotely controlled electrical circuit for making said motor operating circuit, means responsive to actuation of said hydraulically operated member for breaking said motor operating circuit, means for controlling said valve, and a device controlled by said remotely controlled electrical circuit for controlling said last mentioned means, said valve being in closed position at all times while said motor operating circuit is made.

6. In a regulator for the remote control of a device requiring motive power to effect its operation, the combination with an hydraulically operated member and means actuated by said member and operative upon said device, of a pump adapted to force fluid to actuate said member in one direction, a motor for driving said pump, means independent of said motor and pump for actuating said member in opposite direction, a valve for trapping fluid at a side of said member to preclude operation of the member by said independent means, an operating electrical circuit for said motor, means for controlling said valve, a remotely controlled electrical circuit, means in said remotely controlled electrical circuit for making said motor operating circuit and for concurrently causing said valve to become closed, and means responsive to actuation of said hydraulically operated member for breaking said motor operating circuit while allowing said valve to remain closed, said valve being adapted to become opened upon the breaking of the remotely controlled electrical circuit which caused said valve to become closed.

7. In a regulator for the remote control of a device requiring motive power to effect its operation, the combination with an hydraulically operated member and means actuated by said member and operative upon said device, of a pump adapted to force fluid to actuate said member in one direction, a motor for driving said pump, means independent of said motor and pump for actuating said member in opposite direction, a valve for trapping fluid at a side of said member to preclude operation of the member by said independent means, an operating electrical circuit for said motor, means for controlling said valve, remotely controlled electrical circuits, means in said remotely controlled electrical circuits for making said motor operating circuit and for concurrently causing said valve to become closed, means responsive to actuation of said hydraulically operated member for breaking said motor operating circuit while allowing said valve to remain closed, said valve being adapted to become opened upon the breaking of the remotely controlled electrical circuit which caused said valve to become closed, whereby to

permit actuation of said hydraulically operated member by said independent means, and means for causing said valve to again become closed responsively to actuation of said member by said independent means.

8. In a regulator for the remote control of a device requiring motive power to effect its operation, the combination with an hydraulically operated member and means actuated by said member and operative upon said device, of a pump adapted to force fluid to actuate said member in one direction, a motor for driving said pump, means independent of said motor and pump for actuating said member in opposite direction, a valve for trapping fluid at a side of said member to preclude operation of the member by said independent means, an operating electrical circuit for said motor, means for controlling said valve, remotely controlled electrical circuits, means in said remotely controlled electrical circuits for making said motor operating circuit and for concurrently causing said valve to become closed, means responsive to actuation of said hydraulically operated member when actuated by said motor and pump for breaking said motor operating circuit while allowing said valve to remain closed, said valve being adapted to become opened upon the breaking of the remotely controlled electrical circuit which caused said valve to become closed, whereby to permit actuation of said hydraulically operated member by said independent means, and means for causing said valve to again become closed responsively to actuation of said member by said independent means.

9. In a regulator for the remote control of a device requiring motive power to effect its operation, the combination with an hydraulically operated member and means actuated by said member and operative upon said device, of a pump adapted to force fluid to actuate said member in one direction, a motor for driving said pump, means independent of said motor and pump for actuating said member in opposite direction, a valve for trapping fluid at a side of said member to preclude operation of the member by said independent means, an operating electrical circuit for said motor, means for controlling said valve, remotely controlled electrical circuits, means in said remotely controlled electrical circuits for making said motor operating circuit and for concurrently causing said valve to become closed, means responsive to actuation of said hydraulically operated member when actuated to a predetermined position by said motor and pump for breaking said motor operating circuit while allowing said valve to remain closed, said valve being adapted to become opened upon the breaking of the remotely controlled electrical circuit which caused said valve to become closed, whereby to permit actuation of said hydraulically operated member by said independent means, and means for causing said valve to again become closed responsively to actuation of said member by said independent means.

10. In a regulator for the remote control of a device requiring motive power to effect its operation, the combination with an hydraulically operated member and means actuated by said member and operative upon said device, of a pump adapted to force fluid to actuate said member in one direction, a motor for driving said pump, means independent of said motor and pump for actuating said member in opposite direction, a valve for trapping fluid at a side of

said member to preclude operation of the member by said independent means, an operating electrical circuit for said motor, means for controlling said valve, remotely controlled electrical circuits, a fixed contact member in each of said remotely controlled electrical circuits, a movable contact member common to all of said remotely controlled electrical circuits for successively engaging said fixed contact members to each time make said motor operating circuit and cause said valve to become closed, means responsive to actuation of said hydraulically operated member when actuated to a predetermined position by said motor and pump for breaking said motor operating circuit while allowing said valve to remain closed, whereby said motor and pump can actuate said hydraulically operated member in step by step movements in said one direction by successive engagement of said movable contact member with said fixed contact members, said valve being adapted to become opened upon the breaking of the remotely controlled electrical circuit which caused said valve to become closed, except when said movable contact member is engaging a fixed contact member in the series to make said motor operating circuit, and means for causing said valve to again become closed responsively to actuation of said member by said independent means.

11. In a regulator for the remote control of a device requiring motive power to effect its operation, a member, a pump for actuating said member in one direction, a motor for actuating said pump, means for actuating said member in opposite direction, a valve for precluding operation of said member by said last mentioned means, an operating electrical circuit for said motor, remotely controlled electrical circuits, means in each of said remotely controlled electrical circuits for making said motor operating circuit and for simultaneously closing said valve, means actuated by said member when driven by said pump for breaking said motor operating circuit while leaving said valve closed, and means operative upon the breaking of the remotely controlled electrical circuit which caused said valve to be closed for opening said valve, to thus allow said member to be actuated in said opposite direction.

12. In a regulator for the remote control of a device requiring motive power to effect its operation, a member, a pump for actuating said member in one direction, a motor for actuating said pump, means for actuating said member in opposite direction, a valve for precluding operation of said member by said last mentioned means, an operating electrical circuit for said motor, remotely controlled electrical circuits, means in each of said remotely controlled electrical circuits for making said motor operating circuit and for simultaneously closing said valve, means actuated by said member when driven by said pump for breaking said motor operating circuit while leaving said valve closed, means operative upon the breaking of the remotely controlled electrical circuit which caused said valve to be closed for opening said valve, to thus allow said member to be actuated in said opposite direction, and means for again closing said valve when said member has moved in said opposite direction a predetermined extent.

13. In a regulator for the remote control of a device requiring motive power to effect its operation, hydraulically operated mechanism comprising a fluid containing cylinder, a piston therein, a pump for forcing fluid into one end portion of said cylinder to move said piston longitudinally of the

cylinder toward the opposite end portion thereof, means in said cylinder for urging said piston longitudinally of said cylinder in direction opposite that in which the piston is moved by said fluid, a motor for actuating said pump, an operating electrical circuit for said motor, remotely controlled electrical circuits, means in each of said remotely controlled electrical circuits for closing said motor operating circuit, a by-pass for allowing flow of fluid from said end portion of said cylinder and past said piston into the opposite end portion of the cylinder, a valve for controlling said by-pass, and means in each of said remotely controlled electrical circuits for controlling said valve, said valve being in closed position at all times while said motor operating circuit is closed.

14. In a regulator for the remote control of a device requiring motive power to effect its operation, a member for actuating said device, a pump for actuating said member in one direction; a motor for actuating said pump, means for actuating said member in opposite direction, an operating electrical circuit for said motor, remotely controlled electrical circuits each adapted to be closed to close said motor operating circuit, said motor operating circuit being adapted to be successively closed by the closing in a predetermined succession of said remotely controlled circuits whereby to actuate said member in said one direction in a plurality of step by step movements, means operative under certain conditions to preclude actuation of said member in direction opposite that in which the member is actuated by said pump, and means operative under other conditions for allowing said member to be actuated in said opposite direction in step by step movements the reverse of the step by step movements first mentioned.

15. In a regulator for the remote control of a device requiring motive power to effect its operation, a member for actuating said device, a pump for forcing fluid to actuate said member in one direction, a motor for actuating said pump, means for actuating said member in opposite direction, an operating electrical circuit for said motor, remotely controlled electrical circuits each adapted to be closed to close said motor operating circuit, said motor operating circuit being adapted to be successively closed by the closing in a predetermined succession of said remotely controlled circuits whereby to actuate said member in said one direction in a plurality of step by step movements, a valve operative under certain conditions to trap fluid at a side of said member to thus preclude actuation of said member in direction opposite that in which the member is actuated by said pump, and means for actuating said valve under other conditions to allow said member to be actuated in said opposite direction in reverse step by step movements substantially equal to the step by step movements first mentioned.

16. In a regulator for the remote control of a device requiring motive power to effect its operation, a member for actuating said device, a pump for forcing fluid to actuate said member in one direction, a motor for actuating said pump, means for actuating said member in opposite direction, an operating electrical circuit for said motor, a remotely controlled electrical circuit for controlling said motor operating circuit, a valve adapted to be closed under certain conditions to preclude actuation of said member in direction opposite that in which the member is actuated by said pump, and means for opening said valve

under other conditions to allow said member to be actuated in said opposite direction to a predetermined extent, said valve being closed at all times while said motor is operating.

17. In a regulator for the remote control of a device requiring motive power to effect its operation, a member for actuating said device, a pump for forcing fluid to actuate said member in one direction, a motor for actuating said pump, means for actuating said member in opposite direction, an operating electrical circuit for said motor, a remotely controlled electrical circuit for closing said motor operating circuit, means actuated by said member for opening said motor operating circuit, a valve adapted to be closed under certain conditions to preclude actuation of said member in direction opposite that in which the member is actuated by said pump, and means for opening said valve under other conditions to allow said member to be actuated in said opposite direction, said valve being closed at all times while said motor is operating.

18. In a regulator for the remote control of a device requiring motive power to effect its operation, the combination with mechanism for moving said device both to an operating and to a safety position, of a motor for actuating said mechanism to move said device to said operating position, means independent of said motor for actuating said mechanism to move said device to said safety position, a member for controlling the operations of said mechanism by both said motor and said independent means, an operating electrical circuit for said motor, a remotely controlled electrical circuit, means in said remotely controlled electrical circuit actuatable when said circuit is closed to energize said motor to position said member so that said motor can actuate said mechanism to move said device to said operating position and so that said member can thereafter cause the device to remain in said operating position as long as said remotely controlled electrical circuit remains closed, said last mentioned means being actuatable when said remotely controlled electrical circuit is deenergized to position said member so that said independent means can actuate said mechanism to move said device to said safety position, and means for breaking said motor operating circuit when said mechanism has moved said device to said operating position.

19. In a regulator for the remote control of a device requiring motive power to effect its operation, the combination with mechanism for moving said device both to an operating and to a safety position, of a motor for actuating said mechanism to move said device to said operating position, means independent of said motor for actuating said mechanism to move said device to said safety position, a member for controlling the operations of said mechanism by both said motor and said independent means, an operating electrical circuit for said motor, a remotely controlled electrical circuit, means in said remotely controlled electrical circuit actuatable to position said member so that said motor can actuate said mechanism to move said device to said operating position to be there retained by said member, said last mentioned means also being actuatable to position said member so that said independent means can actuate said mechanism to move said device to said safety position, and means for breaking said motor operating circuit when said mechanism has moved said device to said operating position.

20. In a regulator for the remote control of a

device requiring motive power to effect its operation, the combination with hydraulically operated mechanism for moving said device both to an operating and to a safety position, said hydraulically operated mechanism including a pump, of a motor for driving said pump to actuate said mechanism to move said device to said operating position, means independent of said motor and pump for actuating said mechanism to move said device to said safety position, a valve for controlling the operations of said mechanism by both said pump and said independent means, an operating electrical circuit for said motor, a remotely controlled electrical circuit, means in said remotely controlled electrical circuit actuable to position said valve so that said pump can actuate said mechanism to move said device to said operating position to be there retained by said valve, said last mentioned means also being actuable to position said valve so that said independent means can actuate said mechanism to move said device to said safety position, and means for breaking said motor operating circuit when said mechanism has moved said device to said operating position.

21. In a regulator for the remote control of a device requiring motive power to effect its operation, the combination with hydraulically operated mechanism for moving said device both to an operating and to a safety position, said hydraulically operated mechanism including a pump, of a motor for driving said pump to actuate said mechanism to move said device to said operating position, means independent of said motor and pump for actuating said mechanism to move said device to said safety position, a valve for controlling the operations of said mechanism by both said pump and said independent means, an operating electrical circuit for said motor, a remotely controlled electrical circuit, means in said remotely controlled electrical circuit actuable when said circuit is closed to energize said motor to position said valve so that said pump can actuate said mechanism to move said device to said operating position and so that said valve can retain the device in said operating position as long as said remotely controlled electrical circuit remains energized, said last mentioned means being actuable when said remotely controlled electrical circuit is deenergized to position said valve so that said independent means can actuate said mechanism to move said device to said safety position, and means for breaking said motor operating circuit when said mechanism has moved said device to said operating position.

22. In a regulator for the remote control of a device requiring motive power to effect its operation, the combination with mechanism for moving said device both to a plurality of different operating positions and to a safety position, of a motor for actuating said mechanism to move said device from said safety position successively to each of said operating positions, means independent

of said motor for actuating said mechanism to move said device successively from one of said operating positions to another and to said safety position, a member for controlling the operations of said mechanism by both said motor and said independent means, an operating electrical circuit for said motor, a plurality of remotely controlled electrical circuits, including a remotely controlled electrical circuit for each of said operating positions, means in each remotely controlled electrical circuit actuable when the corresponding remotely controlled circuit is closed to energize said motor to position said member so that said motor can actuate said mechanism to move said device to the corresponding operating position and so that said member can cause said device to be there retained, said last mentioned means being actuable when all of said remotely controlled electrical circuits are deenergized to position said member so that said independent means can actuate said device to said safety position, and means for breaking said motor operating circuit when said mechanism is moved by said motor to position said device in an operating position.

23. In a regulator for the remote control of a device requiring motive power to effect its operation, the combination with hydraulically operated mechanism for moving said device both to a plurality of different operating positions and to a safety position, said hydraulically operated mechanism including a pump, of a motor for driving said pump to actuate said mechanism to move said device from said safety position successively to each of said operating positions, means independent of said motor and pump for actuating said mechanism to move said device successively from one of said operating positions to another and to said safety position, a valve for controlling the operations of said mechanism by both said pump and said independent means, an operating electrical circuit for said motor, a plurality of remotely controlled electrical circuits, including a remotely controlled electrical circuit for each of said operating positions, means in each remotely controlled electrical circuit actuable when the corresponding remotely controlled circuit is closed to energize said motor to position said valve so that said pump can actuate said mechanism to move said device to the corresponding operating position and so that said valve can retain the device in said mentioned operating position as long as said corresponding remotely controlled circuit remains energized, said last mentioned means being actuable when all of said remotely controlled circuits are deenergized to position said valve so that said independent means can actuate said device to said safety position, and means for breaking said motor operating circuit when said mechanism is moved by said motor to position said device in an operating position.

EVERETT H. WHITE.