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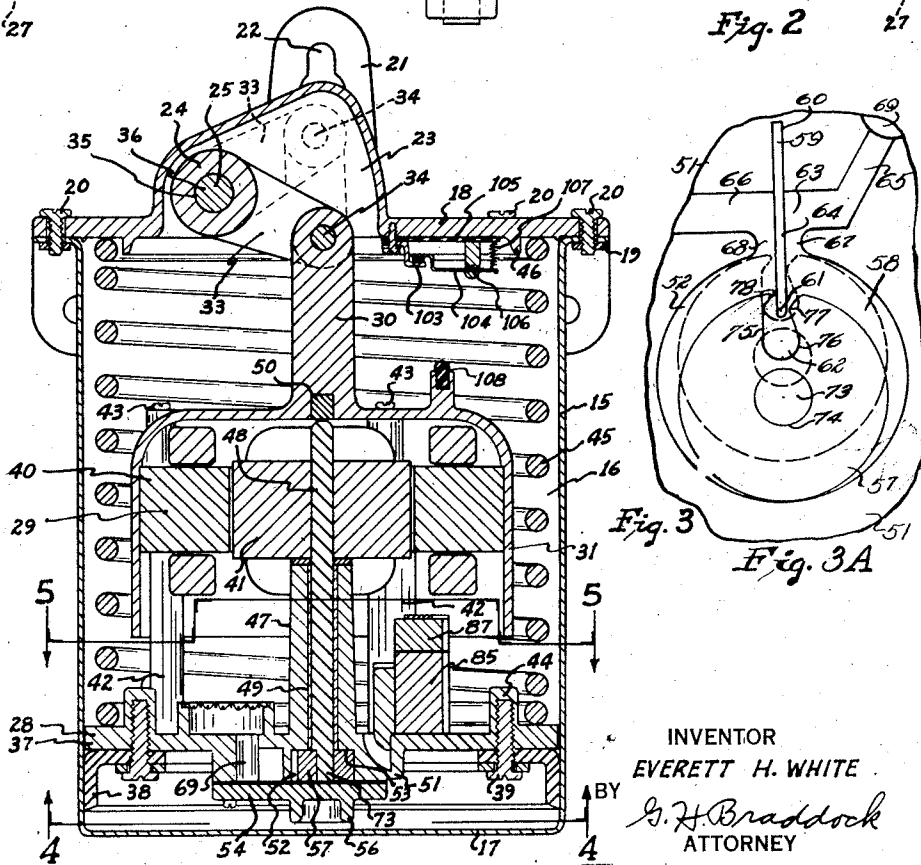
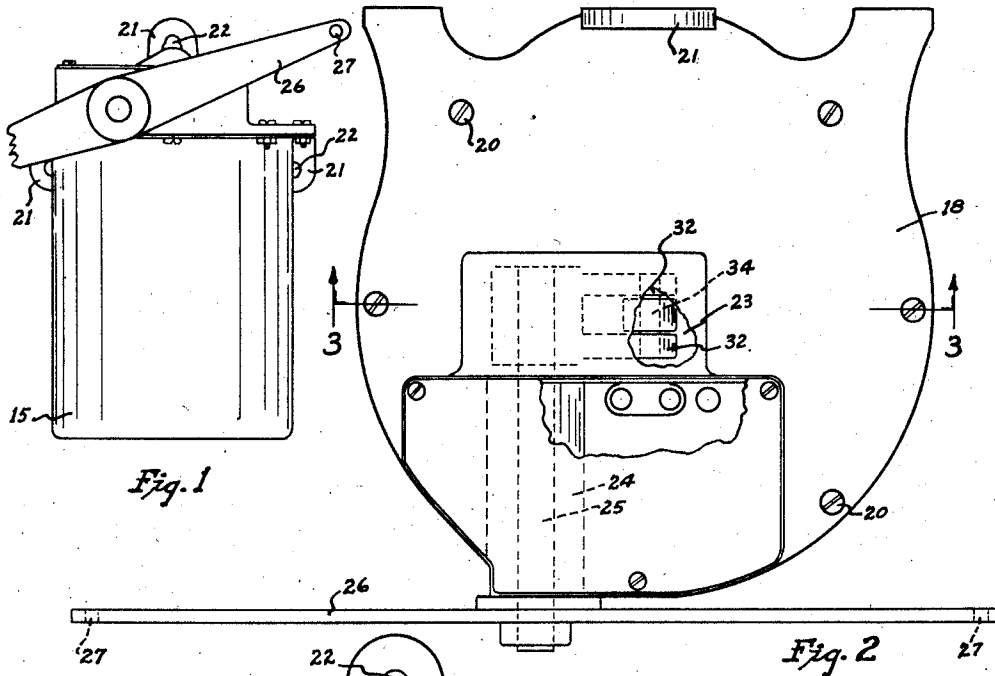
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2,308,731

HYDRAULIC REGULATOR

Filed Dec. 11, 1939

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

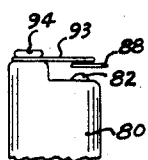
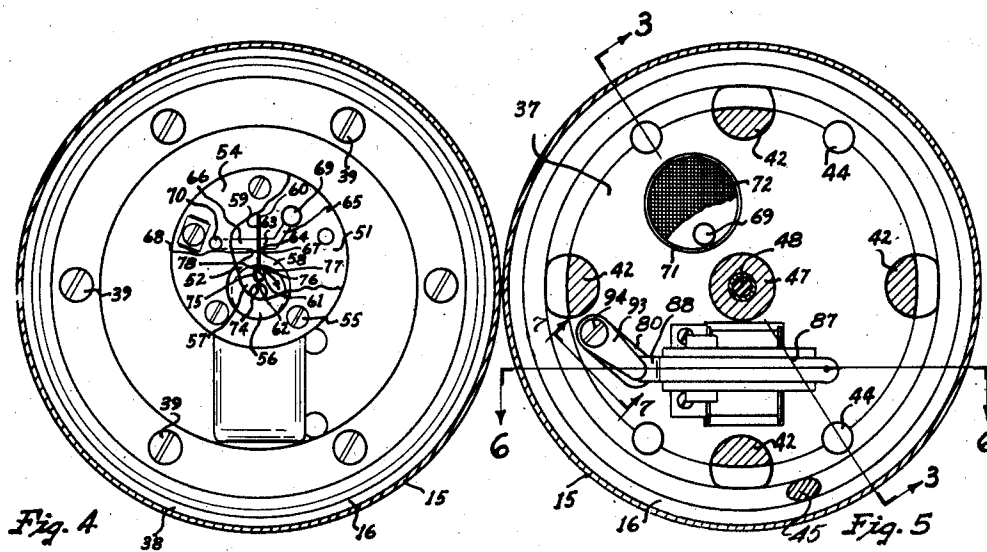


Fig. 7

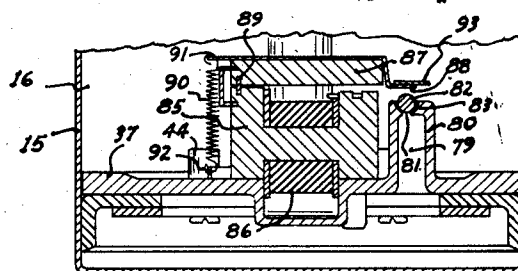
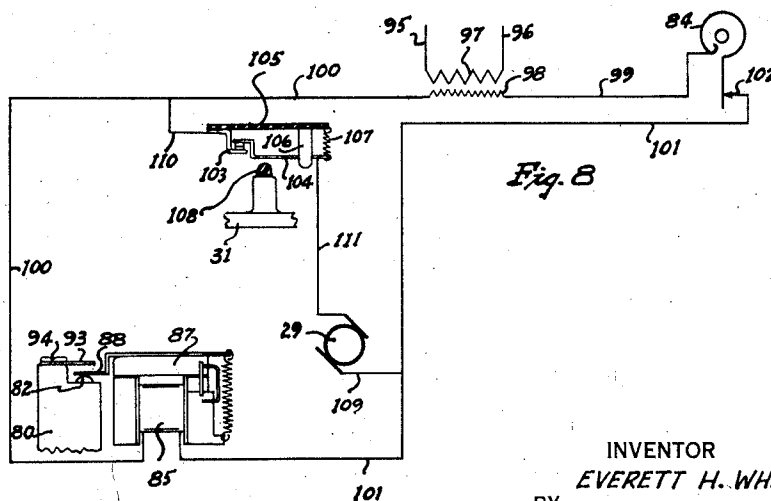


Fig. 6



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3 Sheets-Sheet 3

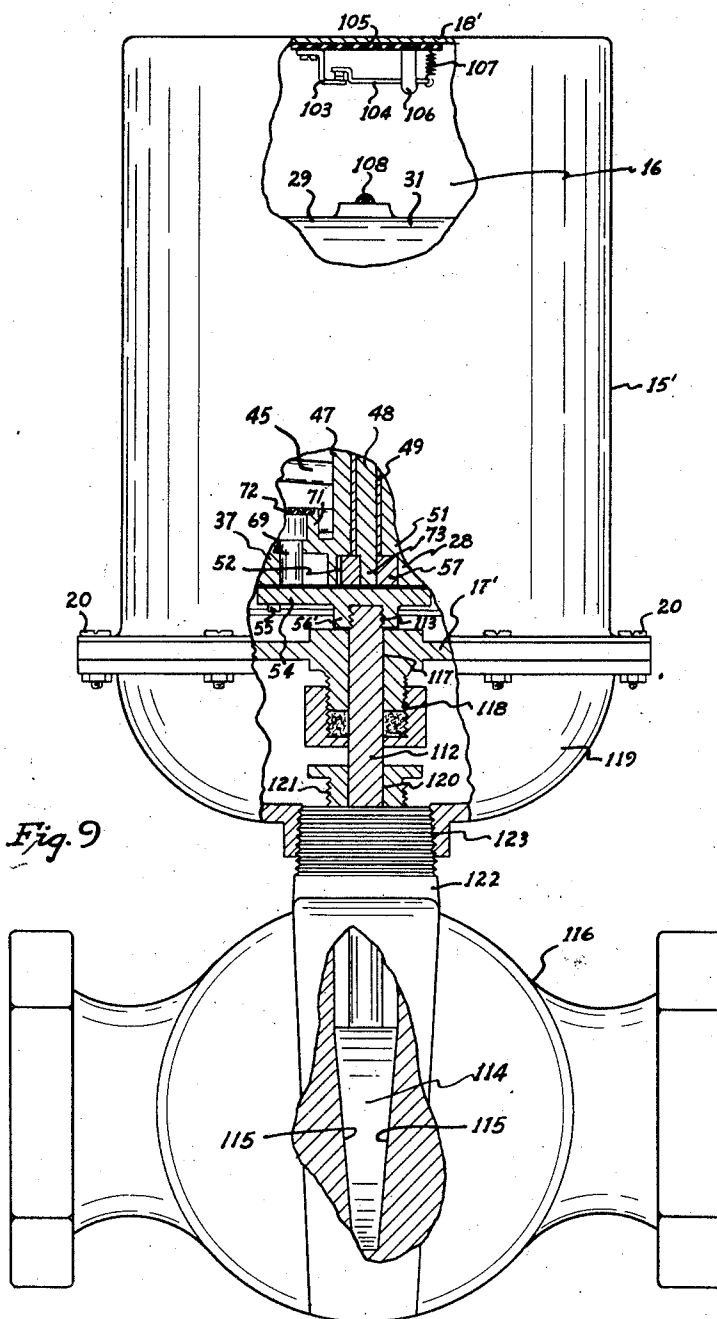


Fig. 9

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UNITED STATES PATENT OFFICE

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HYDRAULIC REGULATOR

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10 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.

The purpose of the invention is to provide an hydraulic regulator of the character as illustrated, described and claimed in my Patent No. 1,984,558, for Hydraulic regulator, granted December 18, 1934, and which will include various novel and improved features and characteristics of construction designed with the end in view of rendering the present hydraulic regulator an improvement generally over the hydraulic regulator disclosed in said mentioned patent.

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 include hydraulically actuated mechanism novel and improved construction.

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

A further object is to provide a novel and improved hydraulic regulator which can supply ample power to operate heavy devices, such as heavy dampers, large valves, etc., that require considerable power to effect their operation, and hold the services in open, or operative, positions, and at the same time cause the devices automatically to close, or be situated at safety positions, in case of current failure for any cause.

Further objects are to provide in the regulator, hydraulically and electrically actuated mechanisms which will present improved features and characteristics of construction novel both as individual entities of said regulator and in combination with each other.

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 so 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 an elevational view, partially broken away, of an hydraulic regulator made according to the invention;

Fig. 2 is an enlarged top plan view, partially broken away, of the hydraulic regulator of Fig. 1;

Fig. 3 is a vertical sectional view, taken substantially on line 3—3 in Fig. 2, or substantially as on line 3—3 in Fig. 5;

Fig. 3A is a detail view corresponding generally with the disclosure of Fig. 4;

Fig. 4 is a horizontal sectional view, taken substantially as on line 4—4 in Fig. 3, and disclosing broken away parts;

Fig. 5 is a horizontal sectional view, taken substantially as on line 5—5 in Fig. 3, with parts omitted;

Fig. 6 is a detail sectional view, taken substantially as on line 6—6 of Fig. 5;

Fig. 7 is a detail elevational view, taken substantially on line 7—7 in Fig. 5;

Fig. 8 is a diagrammatic view of a wiring system which the regulator employs, additionally disclosing other features of said regulator; and

Fig. 9 is an elevational view, partially in section and partially broken away, of an hydraulic regulator of modified construction made according to the invention.

A casing or housing 15 of the hydraulic regulator provides a desirably annular chamber 16 defined or bounded as to its diameter by the cylindrical side wall of said casing or housing and defined or bounded as to its length by opposite end walls 17 and 18 of said casing or housing. The end wall 17 as disclosed is constituted as a permanent closure member of the casing or housing 15, and the end wall 18 is constituted as a removable upper closure member or cover for said casing or housing. The upper end of said cylindrical side wall of the casing or housing 15 includes an outwardly extending, annular flange 19, and the upper closure member or cover 18 is fastened down against said annular flange in any suitable and convenient manner, as by headed and nutted bolts 20.

The upper closure member or cover 18 integrally carries spaced apart bracket elements 21, three as shown, all in a single plane at a side of the casing or housing 15, and each bracket member 21 includes an opening 22 to receive means, such for example as a nail or screw, for the purpose of stably securing said casing or housing upon a suitable support therefor. That is, means assembled with the bracket members

or elements 21 are adapted to be secured in or to any suitable and convenient support (not shown) for the hydraulic regulator.

The upper closure member or cover 18 includes a concavity 23 thereof at the side of the body of said upper closure member or cover opposite the annular chamber 13, and in the disclosure as made said concavity 23 is disposed substantially axially of the cylindrical side wall of the casing or housing 15. Also, the upper closure member or cover 13 includes a bearing 24, which is horizontally disposed in the disclosure as made, for a shaft 25. A lever 26 fixed upon an end portion of the shaft 25 is for the purpose of actuating devices which are in remote relation to the hydraulic regulator and 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. The opposite end portions of the lever 23 include openings 27 for attachment of the lever to devices to be operated, although any other suitable and convenient arrangement for associating said lever with said devices can be employed. The lever 26 is arranged substantially horizontally and is situated at the outer side of the upper portion of the casing or housing 15 in adjacent relation to said casing or housing.

A piston or plunger 28 is reciprocally mounted within the casing or housing 15. More explicitly, the piston or plunger 28 is mounted to be slidably movable longitudinally of said casing or housing over the interior surface of its cylindrical side wall. An electric motor 29 is rigid with the piston or plunger 28, above said piston or plunger as disclosed, and the construction and arrangement are such that when said piston or plunger is reciprocated, said electric motor reciprocates, or moves, with the piston or plunger. Stated otherwise, said piston or plunger and said electric motor are built as a unitary structure capable of having reciprocatory movement within the casing or housing 15.

A rod 30 integral with the shell 31 of the electric motor 29, at the side of said motor opposite the piston or plunger 28, which is the upper side of the electric motor in the disclosure as made, is disposed axially or centrally of said piston or plunger to in effect constitute a connecting rod for the piston or plunger. The free or upper end portion of said rod or connecting rod 30 is disposed between spaced apart arms 32 of a bifurcated lever 33, and is oscillatably mounted upon a cross pin 34 situated in said spaced apart arms 32. The bifurcated lever 33 is situated in the concavity 23 of the upper closure member or cover 18, and the end portion of said bifurcated lever opposite the cross pin 34 is fixed, as at 35, upon a portion 36 of the horizontal shaft 25 situated within said concavity 23.

The piston or plunger 28 includes a disc frame 37 and a usual annular working element or leather 38 made rigid with said disc frame, as by screw bolts 39. The motor shell 31 rigidly supports the usual elements of an electric motor, including its stator 40 and its rotor or armature 41. Upstanding, spaced apart posts 42, four as shown, arranged at ninety degrees apart, and at the side of the disc frame 37 opposite the annular working element or leather 38, are integral with said disc frame and are disposed within said motor shell 31 in engaging relation with the interior surface of its side wall, as will be clear from Figs. 3 and 5. The outer or upper end portion of each post 42

includes a threaded opening, and screws 43 pass through holes in bosses upon the base of the motor shell 31 and enter the threaded openings in said posts to make the motor shell, and its appurtenances, rigid with the disc frame of the piston or plunger. That is, the posts 42 locate the electric motor 29 and the piston or plunger 28 against relative sidewise movement, and said posts and the screws 43 in cooperation with each other locate said electric motor and said piston or plunger against relative longitudinal movement. The disc frame 37 as disclosed has four spaced apart bosses 44 thereon, including a boss 44 between each pair of adjacent posts 42, and all of the bosses 44 and posts 42 are disposed in a single circumference. See Fig. 5. As shown more clearly in Fig. 3, the inner portions of the screw bolts 39, which secure the disc frame 37 and the annular working element or leather 38 to each other, are situated within the bosses 44.

A compression coil spring 45, within the annular chamber 16 and about the electric motor 29, bears at one of its ends against the upper closure member or cover 18 and at its other end against the adjacent face of the disc frame 37 of the piston or plunger 28. An annular rib 46 extending inwardly or downwardly from the closure member or cover 18 is within the adjacent or upper end portion of the compression coil spring 45 thus to locate this mentioned end portion of said compression coil spring, and the opposite or lower end portion of the compression coil spring is in surrounding relation to the posts 42 and the bosses 44 thus to be located. Said compression coil spring 45 is adapted normally to cause the piston or plunger 28 to be situated at its furthest position from the closure member or cover 18, about as disclosed in Fig. 3, adjacent to or against the closure member 17.

A bearing member 47 integral with and situated centrally of the disc frame 37 extends perpendicularly from the side of said disc frame which is opposite the annular working element or leather 38, or upwardly, and the shaft 48 of the electric motor 29, which shaft is rigid with the rotor or armature 41, is rotatably mounted in a bushing 49 suitably and conveniently fixed in said bearing member 47. The inner or upper end of the motor shaft 43 engages a thrust receiving element 50 arranged centrally of the base of the motor shell 31 at the inner surface of said shell, and the rod or connecting rod 30, said thrust receiving element 50 and the motor shaft 48 are in alignment with each other in direction longitudinally of the casing or housing 15.

The disc frame 37 includes a central portion or pump casing 51 which is offset in direction toward the lower closure member 17, or downwardly, and said offset portion or pump casing 51 is hollowed out or cut away to provide an annular pump chamber 52 of a rotary type pump of the hydraulic regulator. The inner or upper end portion of the pump chamber 52 is closed by an end wall constituted as an annular shoulder 53 of the disc frame 37 in surrounding relation to the outer or lower end of the bearing for the motor shaft 48 provided by the bearing member 47, and the outer or lower end portion of said pump chamber is closed by a cap 54 secured, as by screws 55, up against the surface of the central offset portion 51 of said disc frame 37 which is adjacent the closure member 17. A stop member 56, annular as shown, integral with the outer or lower surface of the cap 54 is adapted to come into engagement with the inner surface of the

closure member 17 to limit the movement of the piston or plunger 28, and its appurtenances, in direction away from the closure member or cover 18.

A cylindrical impeller 57 is eccentrically situated within the annular pump chamber 52 with its external cylindrical wall in engagement with the internal cylindrical wall of said pump chamber. The external cylindrical wall of the impeller has diameter less than that of the internal cylindrical wall of the pump chamber, and said impeller and pump chamber together provide a crescent shape cavity 58 at the side of the impeller and pump chamber opposite the point or location of engagement between the external cylindrical wall of said impeller and the internal cylindrical wall of said pump chamber. The impeller has dimension in direction axially thereof equal to the depth of the pump chamber 52. Evidently, the crescent shape cavity 58 has depth equal to the width or thickness of the impeller, as well as equal to the depth of the pump chamber.

An abutment 59 is associated with the impeller 57 and with the pump casing 51 to the purpose of separating or shutting-off the high pressure side of the pump from the low pressure side of said pump. Said abutment 59 is constituted as a rectilinear strip of desirably rigid material. The outer end portion 60 of the abutment or strip 59 is fixedly secured in the pump casing 51 and the inner end portion 61 of said abutment or strip is arranged, more or less freely, in a radially disposed slot or groove 62 at the circumference of the impeller 57 and extending the full width or thickness of said impeller perpendicularly thereto. The rectilinear strip which constitutes the abutment 59 has width equal to the depth of the pump chamber 52, and the opposite side, or upper and lower, edges of said abutment or strip 59 terminate flush with the opposite, or upper and lower, surfaces of the impeller 57. In the direction of its length the abutment or strip 59 is disposed radially of the pump chamber 52, and in the direction of its width said abutment or strip is disposed perpendicularly to the pump casing 51 and the impeller 57.

The central offset portion of the pump casing 51 includes a well 63 at the side of the pump chamber 52 adjacent the abutment 59, and an intermediate portion 64 of said abutment extends across or through said well. The abutment divides the well 63 into an inlet chamber 65 at the low pressure side of the pump and an outlet chamber 66 at the high pressure side of said pump. The inlet chamber 65 communicates with the pump chamber 52 through an elongated passageway 67 at said low pressure side of the pump and directly adjacent the abutment, and said pump chamber communicates with the outlet chamber 66 through an elongated passageway 68 at said high pressure side of said pump and directly adjacent said abutment. An inlet port 69 extends through the disc frame 37 and leads from the space of the annular chamber 16 which is at the electric motor side of said disc frame, the upper side of the disc frame as illustrated, to the inlet chamber 65, and an outlet port 70 extends through the cap 54 and leads from the outlet chamber 66 to the space of said annular chamber 16 which is at the side of the disc frame opposite said electric motor, the lower side of the disc frame as illustrated. A small annular element 71 integral with the disc frame 37 at the side of said disc frame adjacent the

electric motor 29 is in surrounding relation to the adjacent end of the inlet port 69, and a small screen 72 in covering relation to the outer or upper end of said small annular element 71 is for the purpose of insuring that no solid particles or foreign matter will enter the pump chamber 52 by way of said inlet port 69.

The pump includes means for causing the external cylindrical wall of the impeller 57 to be rolled, slid or frictionally moved progressively over the internal cylindrical wall of the pump chamber 52. The motor shaft 48 fixedly carries a crank or eccentric 73 adapted to the purpose of accomplishing rotative movement of the axis of the impeller 57 and its external cylindrical wall. The crank or eccentric 73 is rotatably mounted in a centrally arranged opening 74 through the impeller 57. Rotation of the motor shaft 48 causes the crank or eccentric 73 to revolve and thus accomplish rotative movement, or movement in a circle, of the axis for the impeller 57 and its external cylindrical wall in the direction of the arrow in Fig. 4. Such movement of the impeller axis causes said impeller to be moved in direction toward and away from the abutment 59 so that the inner end portion 61 of said abutment becomes situated at variable depths in the slot or groove 62 as said axis for the impeller is rotated or moved in a circle. The construction and arrangement are such that said abutment is never removed from said slot or groove. Rotative movement of the axis for the impeller 57 also causes the external cylindrical wall of said impeller to be rolled, slid or frictionally moved or advanced over the internal cylindrical wall of the pump chamber 52, thus to accomplish the pumping operation. As the pump operates, the crescent shape cavity 58 decreases in size as it is moved in direction from the low pressure side toward the high pressure side of the abutment and increases in size as it is moved from the high pressure side toward the low pressure side of said abutment. During each revolution of the impeller axis, suction is created in the crescent shape cavity at the low pressure side of the pump, due to increasing space of the low pressure area or section of said crescent shape cavity, thus to cause fluid to enter the crescent shape cavity from the inlet chamber 65, and pressure is created in said crescent shape cavity at the high pressure side of the pump, due to decreasing space of the high pressure area or section of the crescent shape cavity, thus to cause fluid to be compressed out of said crescent shape cavity and delivered to the outlet chamber 66.

The slot or groove 62 is constructed to provide a side wall 75 thereof at the side of the abutment 59 adjacent the pump outlet which will have larger surface area than does a side wall 76 of said slot or groove at the side of said abutment adjacent the pump inlet, no matter what may be the relative positions of the abutment 59 and the slot or groove 62 during operation of the pump. In the disclosure as made, the side wall 76 includes an elongated rib 77 which is well within the perimeter of the cylindrical impeller 57, is parallel with the abutment 59 and extends toward said abutment, while the side wall 75 includes a similar elongated rib 79, but disposed at the perimeter of said cylindrical impeller. The side wall 76 is cut away or back at the outer side of the elongated rib 77. The construction and arrangement are such that pressure of the high pressure side of the pump will be applied against an area of the side wall 75 of the slot

or groove 62 at the adjacent side of the abutment which is of greater magnitude than is the area of the side wall 76 against which said pressure is applied at the opposite side of said abutment. Stated differently, the elongated rib 77 constantly will be held in pressing engagement with or against the abutment 59 at the low pressure side of said abutment and of the pump, by reason of the fact that pressure at the high pressure side of said pump is exerted over a larger area of the side wall 75 than of the portion of the side wall 76 which is between the base of the slot or groove 62 and said elongated rib 77. The cut-back portion of the side wall 76, at the outer side of the elongated rib 77, will be subjected only to low pressure at the low pressure side of the abutment and of the pump. Thus, differential in pressure between the high pressure side and the low pressure side of the pump is operative to the accomplishment of an effective separation or shut-off between said high pressure side and said low pressure side of said pump, said separation or shut-off of course being provided by the abutment 59 in cooperation with the elongated closure element or rib 77 retained in pressing engagement against said abutment under pressure of fluid at the high pressure side of the pump in excess of the pressure of fluid at the low pressure side of said pump.

As the external cylindrical wall of the impeller 57 is caused to roll, slide or frictionally move or advance over the internal cylindrical wall of the pump chamber 52, there will be a retardation of the forward movement of said external wall of said impeller due to the fact that the cylindrical wall of the impeller has circumference less than that of the cylindrical wall of the pump chamber. Such retardation of movement of said impeller will cause the closure element or elongated rib 77 of the impeller constantly to pressingly engage the low pressure side of the abutment to accomplish effective separation or shut-off between the high pressure side and the low pressure side of the pump. In fact, save for the abutment 59 itself and the engagement of the closure element or elongated rib 77 of the impeller 57 therewith, said impeller would rotate in direction opposite that in which bodily moved during the operation of the pump. This for the reason that the frictional movement or advancement of the smaller external surface of the impeller over the larger internal surface of the pump chamber exerts a force upon said impeller which tends to rotate it on the crank or eccentric 73 in direction counter to that in which the impeller is moved. The engagement between the abutment 59 and the closure element or elongated rib 77 of the impeller resists the tendency of said impeller to rotate in direction opposite that in which it is forced to travel bodily, and the frictional force exerted against the impeller tending to rotate it in reverse direction is the measure of the pressure under which the separation or shut-off between the high pressure side and the low pressure side of the pump is accomplished.

It will of course be understood that each of the two constructions and arrangements as hereinbefore described for accomplishing or providing separation or shut-off between the high pressure side and the low pressure side of a rotary type pump of the nature as set forth is operative in and of itself to the production of its intended service, although both of the constructions and arrangements are incorporated in the pump illustrated in the drawings. One of said two con-

structions and arrangements depends for its effectiveness upon differential in pressure between the high pressure side and low pressure side of the pump, and the other depends for its effectiveness upon retardation of movement of the impeller as it advances.

The annular chamber 16 provided by the casing or housing 15 is adapted to contain fluid, such as oil, for example, and the electric motor 29 is adapted to be driven to actuate the rotary pump to cause fluid to be forced from the portion of the annular chamber 16 adjacent said electric motor, or above the piston or plunger 28, to the portion of said annular chamber adjacent the closure member 17, or beneath said piston or plunger, thus to cause the piston or plunger to be actuated lengthwise of the annular chamber 16, against the resilient action of the compression coil spring 45, from the position of said piston or plunger as in Fig. 3 to position closer to the closure member or cover 13.

A by-pass 79 for the fluid leads from the space of the annular chamber 16 at the side of the disc frame 37 adjacent the closure member 17, or beneath the piston or plunger 28, upwardly through a valve cage 80 integral with said disc frame and extending therefrom in direction toward the electric motor 29, or upwardly, to the space of said annular chamber at the side of the disc frame adjacent said electric motor, or above said piston or plunger. The by-pass 79 includes a port 81 through the outer or upper end of the valve cage 80 controlled by a ball valve 82 adapted to be pressingly engaged against a part-spherical valve seat 83 at the outer side of and surrounding the port 81 to preclude passage of fluid through said port, or to be removed from pressing engagement against said valve seat to permit passage of fluid through the port. It will be evident that when the ball valve 82 is in position to close the port 81, fluid pumped to the space of the annular chamber 16 at the side of the piston or plunger 28 opposite the electric motor 29, or beneath said piston or plunger, by operation of said electric motor and the rotary pump actuated thereby, will cause the piston or plunger to be moved toward the closure member or cover 13, or elevated, but that upon the actuation of said ball valve 82 to open position, the compression coil spring, which is compressed by movement of the piston or plunger toward said closure member or cover 13, or elevation of said piston or plunger, will act to move the piston or plunger toward the cover member 17, or depress said piston or plunger, in the meantime forcing fluid to flow from position in the annular chamber 16 at the closure member 17 side of the piston or plunger, or beneath said piston or plunger, through the by-pass 79 and its port 81 to position in said annular chamber at the closure member or cover 13 side of the piston or plunger, or above said piston or plunger.

An ordinary thermostatically responsive element 84, 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 controlling a circuit for the electric motor 29, as well as a means for controlling a circuit for an electro-magnet 85, including a usual coil and core, suitably and conveniently fixedly supported, as at 86, upon a surface and in a concavity of the disc frame 37 which are adjacent the ball valve 82. An armature 37 for the electro-magnet 85 includes an extension portion 88 of said armature for causing said ball valve 82

to be pressingly engaged against the part-spherical valve seat 83 in closing relation to the port 81, or to be released from pressing engagement against said valve seat. More explicitly, the end portion of the armature 87 which is opposite the extension portion 88 of said armature is pivotally supported, as at 89, upon the electro-magnet 85, and a coil spring 90, having one of its ends 91 fastened to the end of the armature opposite its extension portion and its other end 92 fastened to the disc frame 37, is adapted to urge the armature in direction away from the electro-magnet. A stop or limit piece 93, secured upon the upper end of the valve cage 80, as by a screw 94, and situated at the side of the extension portion 88 of the armature opposite the ball valve 82, is for the purpose of limiting the extent of movement of the armature 87 in direction away from the electro-magnet 85. The construction and arrangement are such that when the electro-magnet 85 is de-energized, the coil spring 90 causes the armature 87 to be at its furthest distance away from the electro-magnet 85 and the extension portion 88 to be withdrawn from the ball valve 82, against the stop or limit piece 93, so that said ball valve is released from the part-spherical valve seat 83, and when said electro-magnet is energized, said armature is drawn up against the electro-magnet, counter to the action of said coil spring 90, to cause said extension portion 88 to pressingly engage the ball valve 82 and cause it to be pressingly engaged against said valve seat 83 in closing relation to said port 81.

The hydraulic regulator and its lever 26 can be applied to control any device or devices which require 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 fluids; circulating fans or blowers; automatic stokers, intake and mixing valves or dampers; etc. Desirably, the construction and arrangement will be such that when the lever 26 is situated to correspond with the position of the piston or plunger 28 as in Fig. 3, the device or devices to be operated will be situated at the safety position of said device or devices.

Incoming wires 95 and 96 from a source of electrical energy lead to a transformer, shown in Fig. 8, including a primary 97 of said transformer and a secondary 98 of the transformer. One side of the secondary 98 is connected by a lead wire 99 with the thermostatically responsive element 84, and the other side of said secondary is connected by a lead wire 100 with one terminal of the electro-magnet 85. A lead wire 101 extends from a fixed terminal 102, adapted to be engaged by the thermostatically responsive element 84, to the other terminal of said electro-magnet 85.

A controller for the circuit of the electric motor 29 is situated inside the annular chamber 16 as disclosed, and includes a fixed contact element 103 and a movable contact element 104, both insulatively mounted, as at 105, upon the closure member or cover 18. A pivot for the movable contact element 104 is denoted 106, and a coil spring 107 is adapted to the purpose of retaining the movable contact element 104 normally in engagement with the fixed contact element 103. Means for causing said fixed contact element 103 and movable contact element 104 to become disengaged consists, in the disclosure as made, of an insulating finger 108 upon the base

of the motor shell 31 adapted to engage the movable contact element 104 upon movement of the piston or plunger 28 with electric motor 29 in direction toward and adjacent to the closure member or cover 18 and cause said movable contact element to be pushed away, upwardly as shown, from the fixed contact member. Stated differently, the insulating finger 108 causes the contact elements 103 and 104 to be separated when the piston or plunger 28 approaches or reaches the limit of its upstroke.

A lead wire 109 extends from the lead wire 101 to one terminal of the electric motor 29, a lead wire 110 extends from the lead wire 100 to the fixed contact element 103, and a lead wire 111 is connected between the other terminal of said electric motor and the movable contact element 104.

Supposing the piston or plunger 28 to be situated as in Fig. 3, with the lever 26 in position to correspond, when a room or space to be warmed calls for heat and the thermostatically responsive element 84 as a consequence engages the fixed terminal 102, upon the coming into engagement of said element 84 and terminal 102 a circuit is set up through the electro-magnet 85, and a different circuit is set up through the electric motor 29. The circuit through said electro-magnet 85 is traced from the secondary 98 through the lead wire 99 to said element 84, thence through the terminal 102 and the lead wire 101 to the electro-magnet and thence through the lead wire 100 back to the secondary, and a circuit through said electric motor 29 is traced from the secondary 98 through the lead wire 99 to said element 84, thence through the terminal 102 and the lead wires 101 and 109 to the electric motor and thence through the lead wire 111, the movable contact element 104, the fixed contact element 103 and the lead wires 110 and 100 back to the secondary.

In Fig. 8 the thermostatically responsive element 84 has engaged the fixed terminal 102 in response to a call for heat by the room or space, and the electric motor 29 has operated to elevate the piston or plunger 28, with said electric motor and the insulating finger 108, to position where said insulating finger is spaced but a slight distance from the movable contact element 104. When said element 84 and terminal 102 became engaged as in Fig. 8 both the electric motor 29 and the electro-magnet 85 became energized. As a consequence, said electro-magnet immediately caused the ball valve 82 to be seated in closing relation to the port 81, in the manner as hereinbefore set forth, and said electric motor immediately commenced to operate the rotary pump of the hydraulic regulator thus to cause the piston or plunger to have movement longitudinally of the casing or housing 15, also in the manner as before described. As is evident, by continued movement of the insulating finger 108 from its position as in Fig. 8 toward and to the movable contact element 104, supported upon the closure member or cover 18, said movable contact element will be separated from the fixed contact element 103 thus to break the circuit including the electric motor 29. With breaking of the motor circuit said electric motor will cease operation and the piston or plunger 28, with appurtenances, will remain at the position adjacent the closure member or cover 18 to which carried by actuation of said electric motor. Obviously, the circuit including the electro-magnet 85 will remain made as long as the room or space

continues its call for heat and the element 84 and terminal 102 as a consequence remain engaged, and the ball valve 22 will remain seated to preclude operation of the piston or plunger in direction opposite that in which said piston or plunger was caused to be moved by the electric motor until the occasion of the breaking of the circuit including said electro-magnet 85 by separation of the element 84 from the terminal 102.

When the room or space reaches the desired and predetermined temperature, and the thermostatically responsive element 84 resultantly becomes removed from the fixed terminal 102, to break the circuit including the electro-magnet 85, the ball valve 22 is released from the partitioned seat 33 about the port 81. Upon release of said ball valve 22 the compression coil spring 45 acts to push the piston or plunger 28, with appurtenances, in direction toward the closure member 17, or downwardly, while fluid is bypassed, as hereinbefore set forth, from the space at the closure member 17 side to the space at the closure member or cover 18 side of said piston or plunger. Evidently, when the piston or plunger 28 is at the limit of its stroke which takes it nearest the closure member or cover 18 and contact is then broken at the thermostatically responsive element 84 and the terminal 102, said piston or plunger is moved by the compression coil spring 45 to its position as in Fig. 3, at or adjacent to the closure member 17.

Especial attention is called to the fact that the present hydraulic regulator is so constructed that should the electrical operating current fail, the parts of said regulator automatically can situate themselves at the safety position of a device or devices to be operated. That is to say, upon failure of the operating current, the electric motor 29 and the electro-magnet 85 will of course be de-energized, obviously to allow the piston or plunger 28 to be situated at the minimum heat producing condition of the lever 26.

It will be evident that the present regulator could be modified to operate a device or devices requiring motive power to effect their operation in a greater number of stages than as illustrated and described.

The thermostatically responsive element 84 could be replaced by actuating means for the hydraulic regulator of entirely different type, as, for example, by mechanically propelled elements of a mechanism for accomplishing some operation or sequence of operations.

In Fig. 9 there is disclosed an hydraulic regulator of modified construction made according to the invention. In many respects the hydraulic regulator of Fig. 9 is of the same construction as the hydraulic regulator hereinbefore described in connection with Figs. 1 to 7, and parts in said Fig. 9 which are the same as equivalent parts in said Figs. 1 to 7 bear similar reference numerals.

More explicitly, the novel and improved hydraulic regulator of the invention is disclosed in Fig. 9 as when set up to control, or open and close, a valve by substantially direct operation of said valve, instead of through the instrumentality of a lever such as 26 in Figs. 1 and 2.

The casing or housing 15', equivalent to the casing or housing 15, is inverted, and includes end closure members 17' and 18' which are equivalent to the end closure members 17 and 18 and for the same purpose. An annular stop member 56', equivalent to the annular stop member 56, limits the extent of movement of the piston or plunger 28 in direction away from the closure member 18'

by coming into engagement with the closure member 17', precisely as before set forth.

The rod or connecting rod 30 of the disclosure as in Fig. 3 is omitted from the disclosure as in Fig. 9, and is replaced by a valve stem connecting rod 112 having one of its end portions threaded, as at 113, into the annular stop member 56'. A valve 114 is rigidly supported upon the end of said valve stem connecting rod 112 spaced from or opposite said annular stop member 56', and said valve 114 is adapted to be in the closed position of valve seats 115 of a fitting 115 when the piston or plunger 28 is situated as in Fig. 9, or adjacent the closure member 17', and in the open position of said valve seats 115 when said piston or plunger 28 is situated adjacent the closure member 18', as set forth in connection with the disclosure of Figs. 1 to 7.

A portion of the length of the valve stem connecting rod 112 which is adjacent the closure member 17' is slidably arranged, as at 117, in said mentioned closure member, and a stuffing box 118 is for precluding the passage of fluid out of the annular chamber 16 by way of the opening in the closure member 17' through which said valve stem connecting rod passes. A dome-shape member 119 is secured in any suitable and convenient manner against the outer surface of the closure member 17' and is situated in surrounding relation to the stuffing box 118. A portion of the length of said valve stem connecting rod 112 adjacent the fitting 116 is slidably arranged, as at 120, in a second stuffing box 121 situated within the dome-shape member 119 and assembled with the adjacent end of a tubular connecting member 122 which leads to said fitting 115. The end portion of the tubular connecting member 122 which has the stuffing box 121 is threaded, as at 123, in an opening through a central portion of said dome-shape member spaced from the closure member 17', and the dome-shape member 119 is in surrounding relation to said stuffing box 121. The end portion of the valve stem connecting rod 112 adjacent the valve 114 is freely movable longitudinally in the tubular connecting member 122.

The hydraulic regulator of Fig. 9 operates in about the manner as before described, and can include or employ a wiring system as disclosed in Fig. 8.

Supposing the piston or plunger 28 of the hydraulic regulator as illustrated in Fig. 9 to be situated as there shown, against the closure member 17', with the valve 114 in closing relation to the valve seats 115, when a room or space to be warmed calls for heat and a thermostatically responsive element, such as the element 84 in a wiring system as disclosed in Fig. 8, as a consequence engages a fixed terminal, such as 102 in said Fig. 8, upon the coming into engagement of said element 84 and terminal 102 separate circuits are set up through the electro-magnet 85 and the electric motor 29, as hereinbefore set forth, each circuit including the thermostatically responsive element 84 and the fixed terminal 102, and said electro-magnet and said electric motor become energized. Immediately upon energization of the electro-magnet this causes the ball valve, such as 82, to be seated, and immediately upon energization of the electric motor this commences to operate the rotary pump of Fig. 9 to cause the piston or plunger to have movement longitudinally of the casing or housing 15' and thus cause the valve stem connecting rod 112 to be slid in its bearings, inwardly of said casing or housing 15', and the valve

114 to be moved to open position. When said valve 114 is fully opened, or opened to an extent which was predetermined, the insulating finger 108 of Fig. 9 is adapted to engage the movable contact element 104 and cause it to be separated from the fixed contact element 103, thus to break the motor circuit and cause the electric motor to cease its operation. The piston or plunger 28, with appurtenances, will remain at the position adjacent the closure member 13' to which carried by actuation of the electric motor when the motor circuit is broken, by reason of the fact that the electro-magnet remains energized until the element 84 and terminal 102 are separated, as before explained.

When the room or space reaches the desired and predetermined temperature, and thus causes the thermostatically responsive element 84 and the fixed terminal 102 to become separated, the electro-magnet circuit is broken and the ball valve is released from the port of the by-pass. The compression coil spring 45, seated between the closure member 13' and the piston or plunger 28, acts to push said piston or plunger, with appurtenances, back to the position in which disclosed in Fig. 9, when the electro-magnet circuit is broken, and concurrently with the just mentioned movement of said piston and plunger, the valve 114 will become engaged against the valve seats 115, in closing relation to said valve seats. Obviously, upon failure of current said valve 114 will be moved to its closed condition by the tensile coil spring 45.

The motor shell 31 is of cup-like configuration, and the elements, including the stator and rotor or armature, of the electric motor are supported within said motor shell in spaced relation to its open or lower side. The base and side wall of the motor shell are constituted as an integral structure, and the locations of jointure, accomplished by the screws 43, between the base of said motor shell and the posts 42 are made fluid-tight in any suitable and convenient manner. Thus, the fluid in the annular chamber 16 is kept substantially clear of the electric motor elements within the motor shell. More explicitly, upon elevation of the piston or plunger, with the electric motor, the open or lower side of the motor shell will reach elevation above the level of fluid or oil in the annular chamber 16 so that atmospheric air will fill the interior space of said motor shell, and upon depression of said piston or plunger, with said electric motor, the air will be compressed somewhat within the motor shell by the fluid or oil, but will, in turn, prevent the fluid or oil from reaching the electric motor elements.

What is claimed is:

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

responsive to actuation of said hydraulically operated piston for breaking said motor operating circuit, and means controlled by said remotely controlled electrical circuit for causing said valve to be in closed condition when the remotely controlled electrical circuit is made and in open condition when said remotely controlled electrical circuit is broken.

2. 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 assembled with the member for forcing fluid to actuate the member in one direction, a motor for actuating said pump, means for actuating said member in the opposite direction, an operating electrical circuit for said motor, a remotely controlled electrical circuit, means for closing each of said electrical circuits, a valve adapted to be closed during the time said motor operating circuit is closed to enable the building up of pressure for operating said member and to preclude actuation of said member in direction opposite that in which the member is actuated by said pump and to be open when the remotely controlled electrical circuit is broken to allow said member to be actuated in said opposite direction, and means responsive to actuation of said member by fluid forced by said pump for breaking said motor operating circuit.

3. 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 assembled with said member for forcing fluid to actuate the member in one direction, a motor for actuating said pump, means for actuating said member in the opposite direction, an operating electrical circuit for said motor, a remotely controlled electrical circuit, means for closing each of said electrical circuits, a valve adapted to be closed during the time said motor operating circuit is closed to enable the building up of pressure for operating said member and to preclude actuation of said member in direction opposite that in which the member is actuated by said pump and to be open when the remotely controlled electrical circuit is broken to allow said member to be actuated in said opposite direction, means assembled with said member for controlling said valve, and means responsive to actuation of said member by fluid forced by said pump for breaking said motor operating circuit.

4. 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 assembled with said member for forcing fluid to actuate the member in one direction, a motor assembled with said member for actuating said pump, means for actuating said member in the opposite direction, an operating electrical circuit for said motor, a remotely controlled electrical circuit, means for closing each of said electrical circuits, a valve adapted to be closed during the time said motor operating circuit is closed to enable the building up of pressure for operating said member and to preclude actuation of said member in direction opposite that in which the member is actuated by said pump and to be open when the remotely controlled electrical circuit is open to allow said member to be actuated in said opposite direction, means including an electro-magnet in said remotely controlled electrical circuit and assembled with said member for controlling said valve, and means responsive to actuation of said member by fluid forced by

said pump for breaking said motor operating circuit.

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

6. In a regulator for the remote control of a device requiring motive power to effect its operation, the combination with mechanism including a piston for moving said device both to an operating and to a safety position and a pump assembled with said piston, of a motor for actuating said pump to cause said mechanism and its piston to move said device to said operating position, means independent of said motor and pump for actuating said mechanism and its piston to move said device to said safety position, a valve for controlling the operations of said mechanism and its piston by both said motor and said independent means, an operating electrical circuit for said motor, a remotely controlled electrical circuit adapted to be closed when said motor circuit is closed, means constituted as an electro-magnet in said remotely controlled electrical circuit and assembled with said piston actuatable when the remotely controlled electrical circuit is closed to position said valve so that said motor and pump can cause said mechanism and its piston to move said device to said operating position and so that said valve thereafter can cause the device to remain in said operating position as long as said remote control electrical circuit remains closed, said last mentioned means being actuatable when said remotely controlled electrical circuit is broken to position said valve so that said independent means can actuate said mechanism and its piston to move said device to said safety position, and means for breaking said motor operating circuit when said mechanism and its piston have moved said device to said operating position.

7. 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 assembled with said piston 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 remotely controlled electrical circuit, 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 in said remotely controlled electrical circuit for causing said motor operating circuit to be made and for concurrently causing said valve to be closed, and means actuated by said piston for breaking said motor operating circuit while leaving said valve closed, said remotely controlled circuit being adapted to be broken to cause said valve to be open.

8. 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 assembled with said piston 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 remotely controlled electrical circuit, means operatively connecting said piston with said device, a by-pass through said piston 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 in said remotely controlled electrical circuit for causing said motor operating circuit to be made and for concurrently causing said valve to be closed, and means actuated by said piston for breaking said motor operating circuit while leaving said valve closed.

9. 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 assembled with said piston for forcing fluid into one end portion of said cylinder to move said piston longitudinally of the cylinder toward the opposite end portion of the cylinder, means for urging said piston longitudinally of said cylinder in direction opposite that in which the piston is moved by said fluid, a motor assembled with said piston for actuating said pump, an operating electrical circuit for said motor, a remotely controlled electrical circuit, means operatively connecting said piston with said device, a by-pass through said piston 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 constituted as an electro-magnet in said remotely controlled electrical circuit including an armature for causing said valve to be closed, said electro-magnet being supported upon said piston, means for closing said operating electrical circuit for said motor and said remotely controlled electrical circuit, and means actuated by said piston for

breaking said motor operating circuit while leaving said remotely controlled electrical circuit and said valve closed.

10. In an hydraulic regulator, a fluid containing cylinder, a piston therein, means for causing said piston to be moved to and fro within said cylinder, and an electric motor rigid with

said piston and situated in said cylinder, said electric motor including a cup-like shell having an open side within said cylinder and adjacent said piston but otherwise closed and motor elements situated within said cup-like shell substantially clear of fluid in said cylinder.

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