Oct. 19, 1926. 1,603,593

J. G. GOODHUE ET AL.

ELECTRICALLY OPERATED VALVE

Filed July 9, 1924 2 Sheets-Sheet 1

Fig. 1.

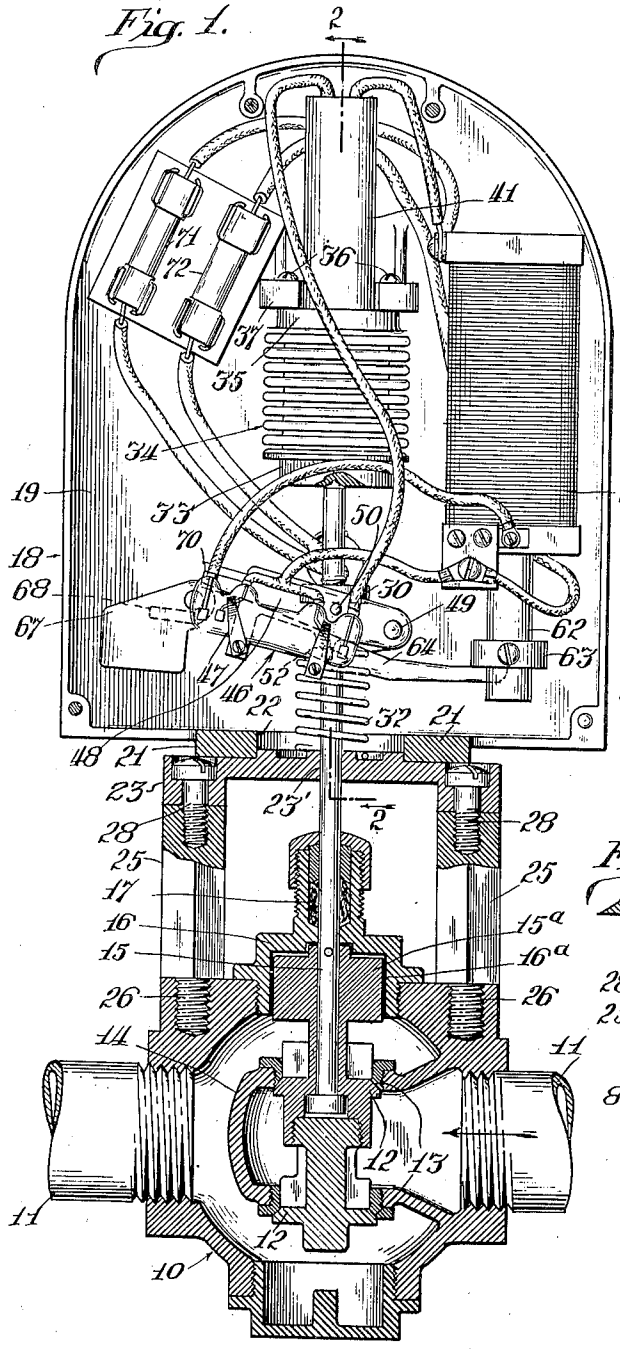


Fig. 2.

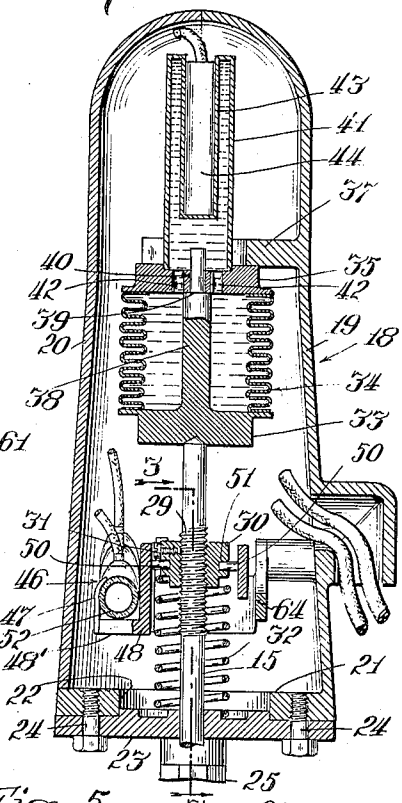
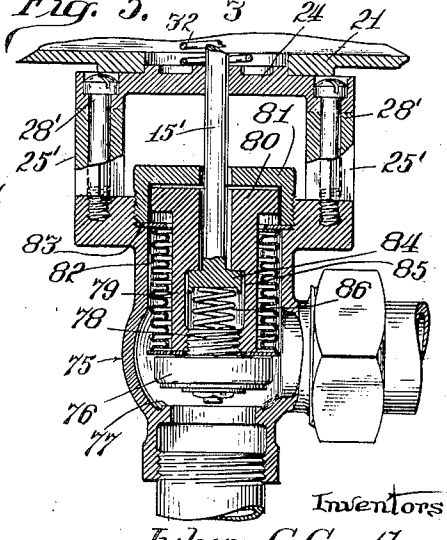


Fig. 5.



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Fig. 5.

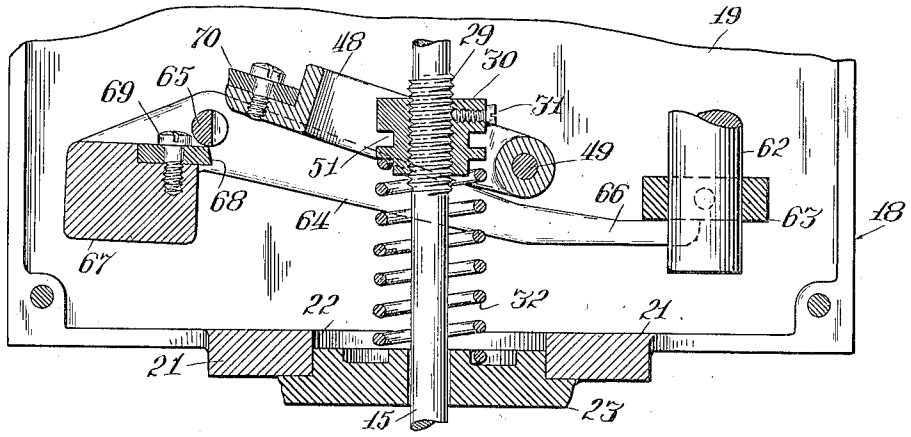


Fig. 4.

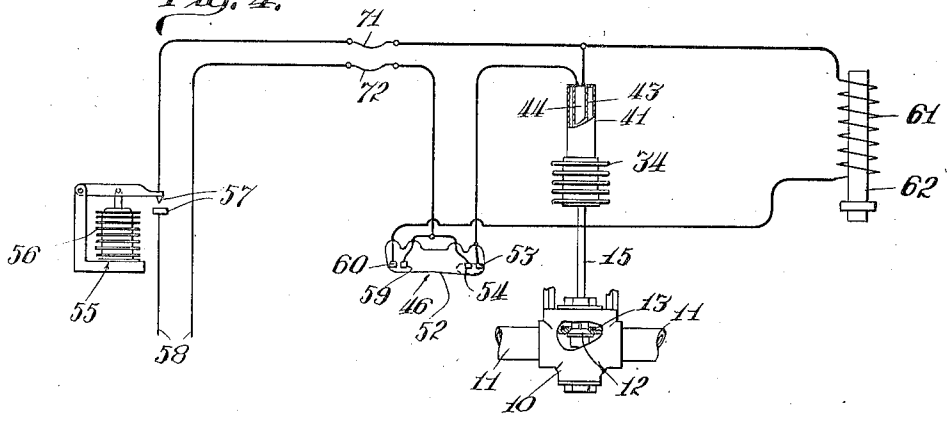
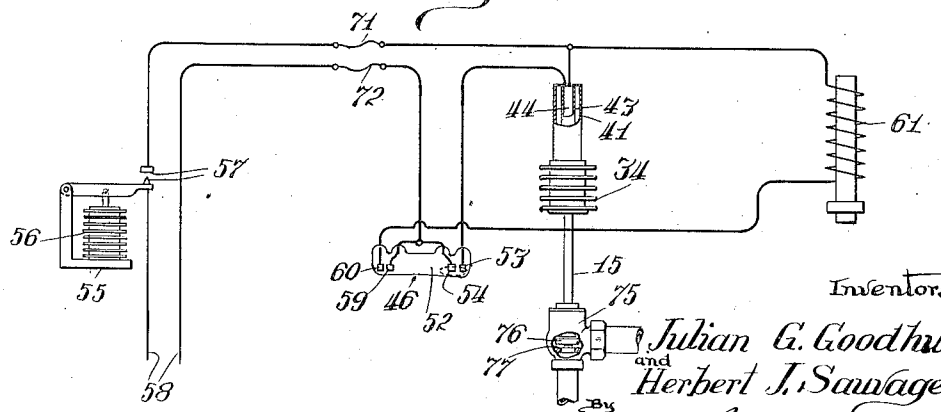


Fig. 6.



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UNITED STATES PATENT OFFICE.

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ELECTRICALLY-OPERATED VALVE.

Application filed July 9, 1924. Serial No. 724,951.

This invention relates to electric and thermostatic controls for steam valves and the like, wherein the operation of the valve responds to the opening or closing of a single control circuit.

It has for its objects to provide electrical means for opening the valve; to provide mechanical means for holding the valve open to economize on the consumption of electrical power; to provide means for disconnecting the electrical valve opening means from the control when the valve is open to reduce the amount of current consumed and to provide a low current consuming device operable when the control circuit is broken for releasing the valve holding means so that the valve is automatically closed in case of failure in the electrical parts. Other objects are to employ an electrically heated expansion motor for operating the valve against a heavy valve closing spring, which motor has a powerful action in proportion to the energy supplied for actuating the same; and mechanically operated means operable directly by the valve for disconnecting the heater from the control circuit as soon as the valve is open.

Figure 1 is a vertical longitudinal section of the valve and valve actuating mechanism embodying our invention;

Figure 2 is a transverse vertical section taken on the line 2—2 of Figure 1;

Figure 3 is a fragmentary section on an enlarged scale taken on the line 3—3 of Figure 2;

Figure 4 is a circuit diagram of the apparatus of Figures 1, 2, and 3;

Figure 5 is a longitudinal vertical section of a modified form of valve; and

Figure 6 is a circuit diagram of the modified apparatus of Figure 5.

The thermostatic control of our invention is shown in the drawings as applied to a valve 10 inserted in a steam line 11. The valve, it will be understood, may control the flow of steam to the radiators of a drying kiln or other room which is to be kept at a constant temperature. To minimize the force necessary to actuate the valve we prefer to employ a balanced valve of the type here shown comprising a pair of valve faces 12 which close against valve seats 13 in the partition 14. The stem 15 of the valve extends upwardly through a bonnet 16 and packing 17 into a casing 18. The valve stem carries a plunger 15^a slidable within a bore 16^a at the lower end of the bonnet to form a dash pot to cushion the closing of the valve.

The casing 18 comprises a back plate 19, which acts as a supporting bracket for the several parts of the device, and a detachable cover 20. At its lower end the back plate 19 of the casing carries an outwardly projecting shelf 21 provided with a circular opening 22. The closure plate 23 for the opening 22 is clamped to the shelf by cap screws 24, the plate 23 being provided with an opening 23′ through which the valve stem 15 extends. In order to reduce the conduction of heat from the steam in the valve to the heat motor (presently to be described) within the casing, we provide spacing posts 25 between the closure plate 23 and the body of the valve 10. The posts 25 are provided with reduced portions 26 threaded into the body of the valve 10 while the upper ends of the posts are secured to the plate 24 by counter-sunk screws 28.

Above the shelf 21 the valve stem 15 is provided with a threaded portion 29 upon which is screwed a threaded annular nut or collar 30 which may be locked at the desired position along the threaded portion by means of a set screw 31. A coil spring 32 inserted between the collar 30 and the closure plate 23 tends to pull the valve to its closed position. The upper end of the valve stem 15 is seated in a suitable depression in the bottom plate 33 of an annular metal bellows or sylphon 34. The top plate 35 of the sylphon is clamped by cap screws 36 to a yoke 37 extending outwardly from the back plate 19 of the casing. The bottom plate 33 of the sylphon has an upwardly extending shank 38 shouldered at 39 adjacent its upper end to limit the collapsing of the sylphon 34 under the upward pressure of the spring 32. The reduced end portion of the shank 38 is reciprocably guided in a bore 40 in the top plate 35.

The plate 35 is brazed or soldered to the lower open end of a cylinder or sleeve 41, formed from any thin metal which is a good conductor of heat, and constituting a vaporizing chamber for the liquid therein.

At its upper end the sleeve 41 is doubled back within itself as a small diameter inner sleeve 43 open at its upper end but closed at its lower end. Between the outer sleeve 41 and the inner sleeve 43 is left a long annular space of small volume as compared with the area of the inner sleeve. Communication between the interior of the sylphon 34 and the interior of the sleeve 41 is afforded by holes 42 through the top plate 35 of the sylphon. An electrical cartridge heater 44 is inserted in the inner sleeve 43, its diameter being sufficient to make a snug fit with the sleeve. The cartridge heater may be of any of the suitable types now in general use.

The sylphon 34 and the sleeve 41 are filled with a suitable liquid such as a mineral oil having a relatively high boiling point and which will not affect the metal of the sleeve and tube. It will be seen that if the alcohol or other liquid within the sleeve 41 is heated to its vaporizing temperature it will quickly expand, forcing the bottom plate 33 of the sylphon downwardly and opening the valve. Heating of the liquid in the sleeve 41 for this purpose is accomplished by sending current through the lead wires 42 of the cartridge heater.

The circuit for the heater 44 is controlled in part by a mercury contact double switch 46 which will now be described. The glass shell of the switch 46 is carried by clips 47 on an L-shaped bracket 48′ attached to the outer side of a lever 48. This lever, which we will refer to as the switch lever, is pivoted upon a pin 49 secured in the back wall 19 of the casing. As shown in Figures 2 and 3, the lever 48 is divided intermediate its ends to form lateral rails or bars which bridge around the valve stem 15 and its collar 30. Each rail of the lever 48 carries a pin 50 which extends radially into an annular groove 51 in the collar 30. The switch lever is thus swung about its pivot 49 by reciprocation of the valve stem 15, and as the switch lever is swung, the switch 46 which it carries is thrown from one position to another. When the switch is in the position shown in the drawings, that is, when the valve is closed, the mercury globule 52 is moved to the lower or right hand end of the glass shell where it connects the contact points 53 and 54.

Referring for a moment to the circuit diagram of Figure 4 we have indicated a thermostat 55 which is placed in the kiln or other room to the temperature of which the thermostatic control is to be responsive. Although any suitable type of thermostat may be used we have here shown a sylphon chamber 56 containing a fluid which at a high temperature will expand the sylphon to hold the contact points 57 open. Conversely, when the temperature falls to a predetermined amount the contacts 57 will be closed, thereby closing an electrical circuit from a suitable source of current 58 through the heater 44 of the heat motor and the contacts 53 and 54 of the switch 46. The heater 44 will soon raise the temperature of the relatively small body of liquid between the inner and outer sleeves to its vaporizing point after which it will rapidly expand, forcing the liquid outwardly at the bottom of the sleeve through the holes 42 into the sylphon 34. The bottom plate 33 of the sylphon, as previously described, will then push the valve stem 15 downwardly to open the valve and permit the flow of steam therethrough. As the valve stem descends the collar 30 will carry the pins 50 on the switch lever downwardly, thereby swinging the lever to its lower position. The mercury globule 52 will then run to the opposite end of the glass shell and close the circuit between the contact points 59 and 60 at the left end of the switch.

The throwing of the switch 46 will open the circuit of the heater 44, permitting the liquid in the sleeve 41 to cool off gradually. The contacts 59 and 60, however, close a second circuit from the power line 58 through the windings of a solenoid 61 and through the contacts 57 of the thermostat. The solenoid 61, as shown in Figure 1, is mounted within the casing 18 and has a downwardly extending core 62 and a collar 63 near the lower end thereof.

A second lever 64, which we shall refer to as the latch lever, is pivotaly mounted on a pin 65 extending from the back plate of the casing, the right hand end of the lever extending as an arm 66 to a position beneath the collar 63 of the solenoid core while the left hand end of the lever carries a counterweight 67. The lever 64 also carries a latch plate 68 secured thereto by a cap screw 69. The left hand end of the switch lever 48 has a similar plate 70. As shown in Fig. 3, the solenoid plunger collar 63 is resting on the end 66 of lever 64, thereby the latch 68 of 64 is rotated clockwise substantially out of the arc of travel of the latch plate 70 in the switch lever 48. Should the end of the plate 68 be positioned in the path of the switch plate 70, the former is cammed aside by the mating beveled surfaces of the plates 68 and 70. But when the valve stem 15 is forced down, rotating the switch lever 48 counter-clockwise, the solenoid 61 will have been energized when the switch lever approaches its lowermost position. When the solenoid 61 is energized, the plunger 62 is drawn upwardly and allows the lever 64 to rotate counter-clockwise under the turning movement of the counterweight 67, and position the end of the plate 68 over the end of the plate 70, so that when the fluid in the bellows 34 contracts in cooling, after the electric heating element 44 has been dis-

connected, the valve closing spring 32 will force the plate 70 into engagement underneath the plate 68. The line of engagement of the two plates is slightly to the right of the center of the pivot 65, therefore the pressure from the heavy valve closing spring is being exerted to rotate the lever 64 counter-clockwise for further engagement of the plates, which rotation would be stopped by the adjacent surfaces of the end of the lever 48 and the counterweight 67 coming into contact.

So long as the contacts 57 of the thermostat remain closed, the solenoid 61 will be energized and the plunger 62 drawn up away from the lever end 66 and the valve will be held locked in its open position by the catch 68. When, however, the temperature in the kiln or room again rises because of the steam or other heating medium admitted through the valve 10 to the radiators, the sylphon 56 of the thermostat will expand and open the contacts 57. The solenoid 61 being thus deenergized, the core 62 will drop permitting the collar 63 to impinge and swing the arm 66 of the latch lever downwardly and consequently release the latch plate 68 to permit the switch lever 48 to be swung upwardly under tension of the spring 32. The relative length of the arm 66 and the movement arm of the contact line of the two latches about the center of rotation 65 is such that the weight alone of the solenoid plunger 62 is sufficient to rotate the lever 64 clockwise when the latch is holding the valve open. The device is thus returned to the normal position shown in the drawings with the steam valve closed and the mercury closing the contacts 53 and 54 of the switch.

If desired a pair of fuses 71 and 72 conveniently mounted within the casing may be inserted in the circuit of the device to protect the windings and the heater thereof.

In those instances where the valve controlled by the device is used in connection with a refrigerating system or if for other reason it is desired that the valve open at a high temperature and close at a low temperature the same apparatus may be used except that the contacts 57 of the thermostat are reversed so that they close at high temperature. By similarly reversing the contacts 57 a normally open or downwardly closing steam valve may be used. Such a valve is shown in Figure 5. The body 75 of the valve is supported by cap screws 28′ passing through spacing sleeves 25′ to the closure plate 24 on the shelf 21, of the casing. A valve head 76 is adapted to close against a seat 77, the head 76 being provided with a boss 78 threaded into the lower end of a sleeve 79. The upper end of the sleeve 79 carries a piston 80 which co-acts with an internal bore of the bonnet 81 to function as a dash pot for the piston head 76. In lieu of packing we employ a sylphon 82 disposed about the sleeve 79, the lower end of the sylphon being clamped between the head 76 and the lower end of the sleeve 79 while the upper end of the sylphon is clamped between the lower end of the screw threaded bonnet 81 and a suitable shoulder 83 on the body of the valve.

The valve head is provided with a valve stem 15′ similar to the valve stem 15 of Figure 1 except that it is slidably journaled in the central bore of the sleeve 79 and that at its end it has a head 84 slidable within a counterbore 85 at the lower end of the sleeve 79. A spring 86 interposed between the boss 78 of the valve head and the head 84 of the valve stem provides a yielding lost motion between the valve head and the stem. The spring 32 normally urges the valve stem 15′ upwardly lifting the valve head 76 from its seat.

As shown in the circuit diagram of Figure 6 the control system, except for the reversal of the thermostat contacts 57, remains the same as that of Figure 4. When the temperature in the kiln or room rises the thermostat 55 will close its contacts 57, establishing a circuit through the coil to the heater 44 of the heat motor and the contacts 53 and 54 of the switch 46. Expansion of the liquid in the sleeve 41 will then force the valve stem 15′ downwardly against the spring 32 to close the valve. Because of the fact that the valve stem will rise slightly as the liquid in the sleeve 41 cools, until the plate 70 contacts the latch plate 68 to lock the valve, it is necessary that the lost motion afforded by the spring 86 be provided for the valve 5. When the valve stem moves downwardly to close the valve the spring 86 will yield sufficiently so that after the valve stem has again been raised a slight distance the spring 86 will still force the valve head 76 against its seat 77.

As soon as the valve closes the switch 46 will be thrown to its alternate position, closing the contact points 59 and 60 to energize the solenoid 61, thus holding the valve closed until the temperature in the room falls sufficiently to open the contacts 57. The parts will then be returned to the normal position indicated in Figure 6.

In many factories and in other industrial plants where attendants are always at hand it is desirable to have the radiators shut off in the event that the electric current fails, since failure of current generally results in a shut down of all work. For such installations the device of Figures 1 to 4 is preferably employed. In homes, however, where the heating apparatus receives no inspection during the night, it is desirable that the radiator valves open when the current fails, so that the water pipes in the house will not freeze. In such cases, we prefer to use the

device shown in Figures 5 and 6 This reversed arrangement of the mechanism is considered within the scope of the claims.

While we have shown these particular embodiments of our invention we contemplate that many changes may be made therein without departing from the spirit or scope of our invention. We claim:

1. The combination of a valve, an electrically actuated expansion motor for operating said valve, catch means for holding said valve when operated by said motor, a thermostatically controlled circuit for said motor, an electro-magnet for releasing said catch means upon being de-energized, and switch means actuated by said motor for substituting said electro-magnet for said motor in said circuit when said motor has operated said valve.

2. In combination with a valve having a stem, electrical valve opening means, a latch for holding the valve open, a solenoid having a plunger which is adapted when the solenoid is de-energized for holding the latch in disengageable relation with said stem and adapted when the solenoid is energized to free said latch, an operating circuit, means operatively connected to the valve stem adapted to connect and disconnect said electrical valve opening means into said circuit when the valve is closed and open respectively, and said means adapted to connect the solenoid into said circuit when the valve is open and to disconnect the solenoid from the circuit when the valve is closed.

3. In combination with a self-closing valve, a heat expansion motor for opening the valve, an electrical heater for the motor, means operatively connected to the valve for electrically connecting and disconnecting the heater, and mechanical means for holding the valve open.

4. In combination with an automatically closing valve having a stem, a heat expansion motor for opening the valve, an electrical heater for the motor, a pivotally mounted switch lever attached to the valve stem, and a mercury switch for said heater mounted on the lever in position to close and open with the valve.

5. In combination with an automatically closing valve having a stem, a heat expansion motor for opening the valve, an electrical heater for the motor, a pivotally mounted switch lever attached to the valve stem, and a mercury switch for said heater mounted on the lever in position to close and open with the valve, a self-operating catch to engage the lever to hold the valve open, and electrically operated means to release said catch.

6. In combination with a self closing valve, having a stem, electrically operated valve opening means, a control circuit, a pivoted switch lever attached to the valve stem, a self operating catch for engaging said lever to hold the valve open, electrically operated means for controlling the catch adapted to disengage the catch when de-energized, and a double mercury switch mounted on the lever and adapted to alternately connect the circuit to the valve opening means when the valve is closed and to the means for controlling the catch when the valve is open.

7. In combination with a self-closing valve, electrically operated valve opening means, a self-operating latch for holding the valve open, a solenoid having a plunger adapted to disengage the latch and hold the latch disengaged when the solenoid is de-energized, and means operatively connected to the valve for electrically connecting the solenoid when the valve is open and adapted to disconnect the solenoid when the valve is closed.

8. In combination with a valve of a thermostatic control therefor, comprising a heat expansion motor for actuating said valve, a spring resistance to said actuation of the valve, a catch for holding the valve against said resistance after the valve has been actuated, an electro-magnet for releasing the catch when said electromagnet is de-energized, an electric circuit including a suitable source of current and a thermostatically controlled switch and a heater for the motor, means actuated by the valve for substituting the electromagnet for the heater in said circuit for holding the electromagnet from releasing the catch while the thermostatic switch is closed and the valve open, said means being adapted to be reversed when the thermostatic switch is opened and the valve closed.

9. In combination with a self-closing valve, a catch self-actuated for holding the valve open, an electrically operated valve opener, a solenoid having a plunger adapted, when released, to move the catch from holding the valve, a circuit including a source of current and including, when the valve is closed, said valve opener, means for closing the circuit, and means operable by the valve for substituting said solenoid in the circuit in place of said valve opener when the valve is open.

In witness whereof, we hereunto subscribe our names this 3 day of July, 1924.

JULIAN G. GOODHUE.
HERBERT J. SAUVAGE.