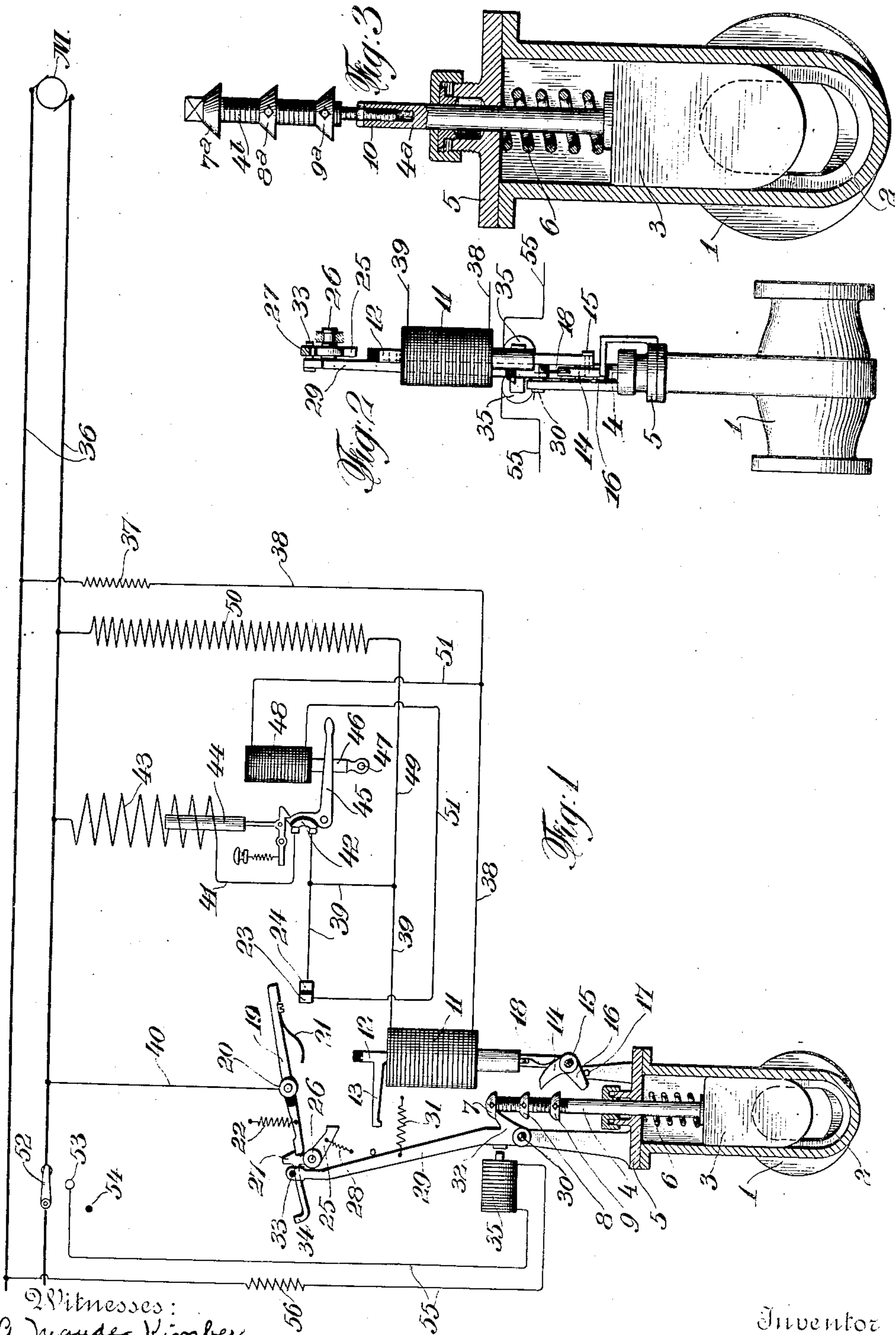


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ELECTRIC WATER VALVE.  
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Patented Dec. 15, 1908.



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# UNITED STATES PATENT OFFICE.

GEORGE P. CARROLL, OF BRIDGEPORT, CONNECTICUT.

## ELECTRIC WATER-VALVE.

No. 906,509.

Specification of Letters Patent.

Patented Dec. 15, 1908.

Application filed March 25, 1907. Serial No. 364,418.

*To all whom it may concern:*

Be it known that I, GEORGE P. CARROLL, residing at Bridgeport, in the county of Fairfield and State of Connecticut, have invented a new and useful Electric Water-Valve, of which the following is a specification.

My invention relates to valves which are automatically opened when power is applied to operate some other mechanism and are automatically closed when such power is turned off from said other mechanism; and it especially relates to water valves, in the water pipes leading to the condensers and water jackets in compression refrigerating systems, which are made to open and close simultaneously with the starting and stopping of the compressor.

The means employed are automatic means whereby, at the time the compressor or other mechanism is started or stopped, the valve, by the application of electric power, is opened or closed; also automatic means whereby, while the compressor or other mechanism is in operation, the valve is locked in an open position so that it will remain open without the further employment of power until the compressor or other mechanism is to be stopped; and also automatic means whereby, if additional power becomes requisite to operate said compressor or other mechanism, while such condition continues, an increased supply of fluid will be permitted to pass through the valve.

In the drawings Figure 1 is a vertical cross section of the valve and its operative electrical connections shown diagrammatic in part. Fig. 2 is a side elevation of the valve and of parts of its connections as seen from the right of the preceding figure. Fig. 3 is a vertical cross section of the valve with a valve stem of an alternative construction.

A casing 1 has an oblong port 2 with its longer axis vertical. A gate valve 3 is adapted to partially or wholly open the port according to its position of elevation. A valve stem 4 is secured at its lower end to the top of the valve and passes up and out through a detachable cap 5 closing the casing 1 and being provided with a suitable stuffing box. A spring 6 coiled about the valve stem and abutting against the inside of the cap and the valve keeps the valve closed when not opposed by a greater force. The valve stem 4 above the cap 5 is provided with, say three, collar heads 7, 8 and 9, which should be longitudinally adjustable.

In Fig. 1 the stem 4 is shown as threaded and all three collar heads are correspondingly threaded and are kept in any desired position by set screws.

In the alternative construction shown in Fig. 3 the valve stem consists of a lower valve stem 4<sup>a</sup>, having a threaded socket 10, and an upper valve stem 4<sup>b</sup> correspondingly threaded at its lower end for longitudinal adjustment in the socket 10. In this latter construction only the lower collar heads 8<sup>a</sup> and 9<sup>a</sup> are threaded and provided with set screws; and the upper valve stem 4<sup>b</sup> and the collar head 7<sup>a</sup> receive their proper longitudinal position by a proper adjustment in the socket 10.

A solenoid 11 has a core 12 insulated at its top and provided with an arm 13 projecting at right angles from the core above the solenoid and below the insulated top. The outer end of the arm 13 has a vertical face. A dog 14, pivoted at 15 on an extension of the lower end of the core 12, has a lower arm 16, which when the core 12 is in its lowest position, rests on a pin 17, supported by an extension of the cap 5, so as to keep the dog away from the valve stem. But when the core is elevated, a flat spring 18, attached at one end to the core 12, presses the dog against the valve stem or against one of its collar heads if one of these is adjacent.

A double switch arm 19, pivoted at the left of its center at 20, has an insulated flat spring 21 on its under side at the right of the pivot 20, and a coiled spring 22, attached to its upper side at the left of the pivot 20 and tending to keep in an elevated position the left end of the double switch arm. The arm is insulated between the pivot 20 and the spring 22. The right end of the arm beyond the flat spring 21 has a contact surface adapted to close a circuit on contact points 23 and 24, which are insulated from each other.

A double locking arm 25 pivoted at 26 by means of a tooth 27 projecting from the upper member of the locking arm, is adapted to engage the left end of the switch arm 19 from above, so as to hold the right end of the switch arm elevated away from the contact points 23 and 24. A coiled spring 28, attached to the lower member of the locking arm, tends to pull that member to the left so as to force the upper member and the tooth 27 to the right. When out of engagement the left end of the switch arm 19 rests on the



inclined upper face of the tooth 27. When the tooth 27 is engaged as shown with the left end of the switch arm 19 and also when that end rests on the inclined upper face of the tooth, the outer face of the lower member of the locking arm 25 is in a vertical plane just a trifle to the left of the arm 13.

A detent lever 29, pivoted at 30 on an extension of the cap 5, is normally kept in nearly a vertical position by a coiled spring 31 tending to pull it to the right. Just above the pivot 30 the detent lever 29 has a detent 32 adapted to engage from beneath and to lock in an elevated position whichever one of the adjacent collar heads it may be under. The extreme top of the detent lever 29 has a pin 33 adapted on occasion to engage and keep in position a lock extension 34 extending to the left from the upper member of the double locking arm 25. An electro-magnet 35 is operative when energized to pull the detent lever 29 to the left in opposition to the spring 31.

Electric mains 36 lead to and from a motor M. From the mains, through a resistance 37, a branch line 38 leads to the solenoid 11. From the solenoid a line 39 leads to the contact point 24. A line 40 leads from the pivot 20 back to the mains 36 on the further side of the motor M. A line 41 leads from the line 39 to a circuit breaker 42, of the usual kind, and thence through a resistance 43 having a core 44 back to the mains 36 also on the further side of the motor M. The resistance 43 operates on the core 44 so as, by opening the circuit breaker, to break the circuit when the current exceeds a predetermined limit. The circuit breaker 42 is provided with a suitable arm 45, which serves the double purpose of being a hand lever for closing when lifted the circuit and also is adapted to be lifted with like effect by the elevation of a core 46 having a pin 47 for engaging the arm 45 when a solenoid 48 containing the core 46 is energized. A line 49 leads from the line 39 through a resistance 50 back to the mains 36 also on the further side of the motor M. A branch line 51 leads to and through the solenoid 48 from the branch line 38 to the contact point 23. A switch 52 is adapted to close the circuit as shown when it is desired to start the motor M. The switch makes an intermediate contact at 53 for an instant on its downward drop to the insulated pin 54 when the motor is to be stopped. When contact is made at 53 a slight current passes from the mains 36 through a branch line 55, provided with a resistance 56, to and through the solenoid 35 back to the mains 36 also on the farther side of the motor M, and thus energizes the electro-magnet for an instant when the current is turned off from the motor. The effect is to move the detent lever 29 and the detent 32 to the left and thus release the detent

from engagement with whichever collar head on the stem 4 it may be under. The relative resistances are such that a greater current is required to pass through the resistance 50 than through the resistance 43. These relative resistances may be graduated as desired.

The method of operation is as follows: The valve casing 1 is intended to be connected as an integral part of the water supply pipe leading to the condenser and water jacket of a refrigerating system. And the motor M is intended to operate the compressor of the system, which may be of any of the many well known types. Of course, however, the motor may be employed to operate any other mechanism where it is desired to have a valve open and close simultaneously with the starting and stopping of the mechanism. And instead of operating a motor the mains 36 may be employed to turn on power to an electric heater, or for any other purpose in connection with which electric power is useful, simultaneously with the opening of a valve; in which connection also the valve would be closed when the power was turned off. In any of these applications, until the current is to be turned on to the motor M or is to be otherwise employed, the gate valve 3 is in its lowest position, entirely closing the port 2; also the top collar head 7 is below the detent 32, the under side of the detent resting on the collar head; also the left end of the double switch arm 19 rests on top of the tooth 27; and also the right end of the double switch arm rests on the contact points 23 and 24. When, to start the compressor, taking from henceforward a refrigeration system as a type for the employment of my invention, the current is turned on to the motor M, as by closing the switch 52, as shown, a small current passes from the mains 36 through the resistance 37, the branch line 38, the solenoid 11, the line 39, the contact point 24, the double switch arm 19, the pivot 20, and the line 40 back to the mains. A part of the current from the branch line 38 also passes through the line 51, the solenoid 48, the contact point 23, and thence to the double switch arm 19; but has no effect at present on the operation of the valve. The passing of the current through the solenoid 11 lifts the core 12 and the dog 14. As the dog is lifted, its lower arm 16 is raised from off the pin 17 so that the flat spring 18 then presses the dog against the valve stem 4 under the collar head 7. The continued elevation of the core 12 lifts the collar head 7 and through it forces the detent 32 and the detent lever 29 to the left, overcoming the coiled spring 31 in so doing. Just as soon as the collar head 7 passes the detent 32, the coiled spring 31 forces the detent 32 against the stem under the collar head 7, thus locking the valve stem and the valve in a par-



tially open position as shown. As the core 12 is being elevated and before the detent lever is forced to the left, its insulated top strikes the insulated flat spring 21 and thereby tends to break the contact of the double switch arm 19 with the contact points 23 and 24. But at the instant of striking, the face of the arm 13 is just opposite the face of the lower member of the double locking arm 25 and thereby holds the tooth 27 so that the left end of the double switch arm cannot drop below the tooth. An instant later, however, the arm 13 has passed above the lower member of the double locking arm 25 and the core 12 has fully compressed the flat spring 21 so that the current through the contact points 23 and 24 will be completely broken as soon as the tooth 27 can be forced to the left. The tooth is so forced to the left an instant later by the down pressure upon it of the left end of the double switch arm 19 and especially by the movement to the left of the pin 33 along the lock extension so as to depress the lock extension as the detent lever 29 rotates to the left on its pivot 30. This rotation takes place, as just stated, while the collar head 7 is passing the detent 32. The breaking of the current deenergizes the solenoid 11 so that the core 12 and its dog 14 resume their original position. All the parts are now in the position shown in Fig. 1. The effect of this entire operation is to leave the collar head 7 locked by the detent 32, the valve partially open and the current through the line 40 broken. Therefore no current is employed to keep the valve open while the motor is running. It is assumed that the collar head 7 has been adjusted on its stem so that a sufficient supply of water can pass through the port 2 to satisfy the normal requirements of the condenser and water jacket when the valve is thus partially open. If at any time it is found that too much or too little water is flowing through for the normal requirements of the system, a proper adjustment of the collar head up or down the stem 4 will remedy the difficulty. The structure in Fig. 3 differs from that in Fig. 1 only in that in the former the adjustment will be made by turning the upper stem 4<sup>b</sup> up or down in the socket 10.

When it is desired to stop the motor, the switch 52 is dropped to the insulated pin 54. The instantaneous intermediate contact at 53 sends a current through the branch line 55 and thus energizes the electro-magnet 35 so as to draw the detent lever 29 to the left and thus to disengage the detent 32 from the collar head 7. This disengagement permits the coiled spring 6 to depress and close the valve 3, thus shutting off the supply of water at the same time power is turned off from the mains 36. As this shutting down of the valve occurs whenever the power is turned off, irrespective of which collar head has been there-

before engaged, the precise method need not be repeated. Simultaneously with the release of any collar head, the rotation of the detent lever 29, through its pin 33 acting on the lock extension 34, moves the tooth 27 to the left. The double switch arm 19 is then acted upon by the coiled spring 22 so that it again makes contact with the contact points 23 and 24; but as the switch 52 is now open no current passes through the line 40.

Sometimes it happens that the current required to drive the motor M increases beyond what would be sufficient to pass through the resistance 37 alone and becomes sufficient to pass through the branch line 38, the solenoid 11, the line 39, the line 41, the circuit breaker 42 and the resistance 43 back to the mains. This would occur in a refrigeration system while the motor M was running and when the supply of water passing into the condenser, by reason of becoming heated in its source of supply, had become insufficient to remove enough of the heat of compression for the economical operation of the plant. In other words this would occur when, as indicated by the high pressure gage, the supply of water was insufficient to keep down the head pressure to the point of economical operation. The effect of a current passing through the resistance 43 is to again energize the solenoid 11, to lift the core 12, to engage the dog 14 with the collar head 8 so as to lift the stem 4 still higher until the collar head 8 gets above the detent 32 and is held by it in a locked position. At this time the only action of the core 12 on the flat spring 21 is to keep the double switch arm 19 from off the contact points 23 and 24 until the detent 32 locks the collar head 8 on its under side, when the tooth 27 again becomes operative to lock the double switch arm. As the valve 3 is lifted up to a position corresponding to that of the collar head 8 over the detent 32, the supply of water to the condenser is correspondingly increased. The normal effect of such an increased supply of condensing water is to decrease the power required to operate the motor M. Consequently, when this point is reached, the current no longer passes through the resistance 43; and the valve remains locked in its secondary lifted position, and without the expenditure of power, until the current is shut off from the motor and the valve is closed in the manner previously explained. But should it happen, from the continued heating of the water in its source of supply or from any other reason, that this increased supply of water is insufficient to reduce the power operating the motor and the power required continues to increase, the current passing through the resistance 43 will soon lift the core 44 so as to act on the circuit breaker 42 and thereby break the current flowing through the resistance. By this ac-



tion the arm 45 drops on the pin 47. Under these circumstances, also, the valve remains locked in its secondary lifted position, and without the expenditure of power, until the  
 5 current is shut off from the motor and the valve is closed. In other words this further opening of the valve either brings the power back to normal and so prevents power from being used to hold open the valve; or, if the  
 10 power is not brought back to normal, the power is automatically shut off so as no longer to be employed in holding the valve open.

Should the power required to operate the  
 15 motor continue to increase beyond the point sufficient to open the circuit breaker 42, a branch current will eventually pass through the branch line 38, the solenoid 11, the line 39, the line 49 and the resistance 50 back  
 20 to the mains. The energization of the solenoid 11 again lifts the core 12 and in consequence the dog 14 engages the collar head 9 and lifts the stem 4 to its highest elevation until the collar head 9 gets above the  
 25 detent 32 and is held by it in a locked position. Here again the only effect of the core 12 on the flat spring 21 is to keep the double switch arm 19 from off the contact points 23 and 24 until the tooth 27 again interlocks  
 30 with it. It will be observed that, under the circumstances, while some current continues to pass through the resistance 50, no current is employed in holding the valve lifted to this its highest position. And if the in-  
 35 creased flow of water is normally operative to decrease the current required to operate the water, the current will cease to flow through the resistance 50. If on the other hand, the current through the resistance  
 40 should continue to increase, such a fact is proof that the difficulty does not lie with any insufficiency of water supply; but that something more serious is responsible. When, under these latter conditions of the highest  
 45 elevation of the valve, the current is turned off, the valve drops to its closed position and the double switch arm 19 again makes contact with the contact points 23 and 24 as before. When again the current is turned  
 50 on to the motor, at the same time, as before explained, that the solenoid 11 is first energized by a current passing through the contact point 24, a current also passes through the line 51, the solenoid 48, and  
 55 the contact point 23 to the double switch arm 19, there uniting with the current passing through the contact point 24. This energization of the solenoid 48 lifts the core 46 and the pin 47 and thereby lifts the  
 60 arm 45 so that the circuit breaker 42 is again put in operative position.

All the foregoing appliances constitute a three stage valve. It is obvious that, if desired, the collar head 9, the line 49, the  
 65 resistance 50, the line 51, the solenoid 48,

the core 46, the pin 47 and the contact point 23 may be dispensed with. When an excess current passing through the resistance 43 opens the circuit breaker 42, the arm 45 will then be useful to subsequently close  
 70 the circuit breaker by hand. Under these circumstances the valve has two stages and only two collar heads are necessary. It is also obvious that by the insertion of more collar heads, intermediate resistances, cir-  
 75 cuit breakers, solenoids and their connections, the number of stages of the valve may be increased above three. On the other hand, by the omission of the collar head 9, the line 41, the circuit breaker 42, the arm  
 80 45, the resistance 43, the line 51, the solenoid 48, the core 46, the pin 47 and the contact point 23, the valve is of a very simple two stage type. It is further obvious that the stem 4 and all the appliances for lift-  
 85 ing and depressing it may be employed for other purposes than to actuate a valve. Again by omitting collar heads 8 and 9, the contact point 23 and all parts numbered from 41 to 51 inclusive, the valve is of the  
 90 one stage type. When so used the arrangement of parts can be slightly altered so that the stem 4 will come under the core 12 and the means connecting the stem and the core may then consist in making them both of  
 95 one piece with the collar head 7 in an intermediate position.

I claim:

1. In combination a casing having a port, means adapted to open or close said port,  
 100 automatic means for opening said port by the application of electric power to said former means when such power is also applied for other purposes and for closing said  
 105 port through said former means when the electric power is turned off from being used for said other purposes, and automatic means operative when the power used for said other purposes exceeds a predetermined  
 110 limit to further open said port.

2. In combination a casing having a port, means adapted to open or close said port,  
 115 automatic means for opening said port by the application of electric power to said former means when such power is also applied for other purposes and for closing said  
 120 port by again applying electric power to said former means when the electric power is turned off from being used for said other purposes, and automatic means operative  
 125 when the power used for said other purposes exceeds a predetermined limit to further open said port.

3. In combination a casing having a port, means adapted to open or close said port,  
 130 automatic means for opening said port by the application of electric power to said former means when such power is also applied for other purposes, for keeping said  
 135 port open and shutting off the power ap-



plied in connection therewith, and for closing said port through said former means when the electric power is turned off from being used for said other purposes, and automatic means operative when the power used for said other purposes exceeds a predetermined limit to further open said port.

4. In combination a casing having a port, means adapted to open or close said port, automatic means for opening said port by the application of electric power to said former means when such power is also applied for other purposes, for keeping said port open and shutting off the power applied in connection therewith, and for closing said port by again applying electric power to said former means when the electric power is turned off from being used for said other purposes, and automatic means operative when the power used for said other purposes exceeds a predetermined limit to further open said port.

5. In combination a casing having a port, a valve adapted to open or close said port, automatic means for opening said port by the application of power to said valve when such power is also applied for other purposes and for closing said port when such power is turned off from being used for said other purposes, and automatic means operative when the power used for said other purposes exceeds a predetermined limit to further open said port and without the further employment of power to keep it so further open until such power is so turned off.

6. In combination a casing having a port, means adapted to open or close said port, automatic means for opening said port by the application of electric power to said former means when such power is also applied for other purposes and for closing said port through said former means when the electric power is turned off from being used for said other purposes, and automatic means operative when the power used for said other purposes exceeds a predetermined limit to further open said port and without the further employment of power to keep it so further open until such power is so turned off.

7. In combination a casing having a port, means adapted to open or close said port, automatic means for opening said port by the application of electric power to said former means when such power is also applied for other purposes and for closing said port by again applying electric power to said former means when the electric power is turned off from being used for said other purposes, and automatic means operative when the power used for said other purposes exceeds a predetermined limit to further open said port and without the further employment of power to keep it so further open until such power is so turned off.

8. In combination a casing having a port, a valve adapted to open or close said port, automatic means for opening said port by the application of power to said valve when such power is also applied for other purposes, for keeping said port open without the further employment of power, and for closing said port when such power is turned off from being used for said other purposes, and automatic means operative when the power used for said other purposes exceeds a predetermined limit to further open said port and without the further employment of power to keep it so further open until such power is so turned off.

9. In combination a casing having a port, means adapted to open or close said port, automatic means for opening said port by the application of electric power to said former means when such power is also applied for other purposes, for keeping said port open and shutting off the power applied in connection therewith, and for closing said port through said former means when the electric power is turned off from being used for said other purposes, and automatic means operative when the power used for said other purposes exceeds a predetermined limit to further open said port and without the further employment of power to keep it so further open until such power is so turned off.

10. In combination a casing having a port, means adapted to open or close said port, automatic means for opening said port by the application of electric power to said former means when such power is also applied for other purposes, for keeping said port open and shutting off the power applied in connection therewith, and for closing said port by again applying electric power to said former means when the electric power is turned off from being used for said other purposes, and automatic means operative when the power used for said other purposes exceeds a predetermined limit to further open said port and without the further employment of power to keep it so further open until such power is so turned off.

11. In combination a stem, automatic means for lifting said stem by the application of power when such power is also applied for other purposes and for dropping said stem when such power is turned off from being used for said other purposes, and automatic means operative when the power used for said other purposes exceeds a predetermined limit to further lift said stem.

12. In combination a stem, automatic means for lifting said stem by the application of electric power when such power is also applied for other purposes and for dropping said stem when the electric power is turned off from being used for said other purposes, and automatic means operative when the power used for said other purposes



exceeds a predetermined limit to further lift said stem.

13. In combination a stem, automatic means for lifting said stem by the application  
5 of electric power when such power is also applied for other purposes and for dropping said stem by again applying electric power in connection therewith when the electric power is turned off from being used for said  
10 other purposes, and automatic means operative when the power used for said other purposes exceeds a predetermined limit to further lift said stem.

14. In combination a stem, automatic  
15 means for lifting said stem by the application of power when such power is also applied for other purposes, for locking said stem in such lifted position, and for dropping said stem when such power is turned off from being  
20 used for said other purposes, and automatic means operative when the power used for said other purposes exceeds a predetermined limit to further lift said stem.

15. In combination a stem, automatic  
25 means for lifting said stem by the application of electric power when such power is also applied for other purposes, for locking said stem in such lifted position, and for dropping said stem when the electric power is turned  
30 off from being used for said other purposes, and automatic means operative when the power used for said other purposes exceeds a predetermined limit to further lift said stem.

35 16. In combination a stem, automatic means for lifting said stem by the application of electric power when such power is also applied for other purposes, for locking said stem in such lifted position, and for  
40 dropping said stem by again applying electric power in connection therewith when the electric power is turned off from being used for said other purposes, and automatic means operative when the power  
45 used for said other purposes exceeds a predetermined limit to further lift said stem.

17. In combination a stem, automatic means for lifting said stem by the application of power when such power is also applied for other purposes and for dropping  
50 said stem when such power is turned off from being used for said other purposes, and automatic means operative when the power used for said other purposes exceeds a predetermined limit to further lift said stem and to  
55 hold it in such latter position without the further employment of power.

18. In combination a stem, automatic means for lifting said stem by the application of electric power when such power is also applied for other purposes and for dropping  
60 said stem when the electric power is turned off from being used for said other purposes, and automatic means operative when the power used for said other purposes exceeds a  
65

predetermined limit to further lift said stem and to hold it in such latter position without the further employment of power.

19. In combination a stem, automatic means for lifting said stem by the applica- 70  
tion of electric power when such power is also applied for other purposes and for dropping said stem by again applying electric power in connection therewith when the electric power is turned off from being used for said 75  
other purposes, and automatic means operative when the power used for said other purposes exceeds a predetermined limit to further lift said stem and to hold it in such latter position without the further employment 80  
of power.

20. In combination a stem, automatic means for lifting said stem by the application of power when such power is also applied for other purposes, for locking said stem in 85  
such lifted position, and for dropping said stem when such power is turned off from being used for said other purposes, and automatic means operative when the power used for said other purposes exceeds a predeter- 90  
mined limit to further lift said stem and to hold it in such latter position without the further employment of power.

21. In combination a stem, automatic means for lifting said stem by the applica- 95  
tion of electric power when such power is also applied for other purposes, for locking said stem in such lifted position, and for dropping said stem when the electric power is turned off from being used for said other purposes, 100  
and automatic means operative when the power used for said other purposes exceeds a predetermined limit to further lift said stem and to hold it in such latter position without the further employment of power. 105

22. In combination a stem, automatic means for lifting said stem by the application of electric power when such power is also applied for other purposes, for locking said stem in such lifted position, and for dropping 110  
said stem by again applying electric power in connection therewith when the electric power is turned off from being used for said other purposes, and automatic means operative when the power used for said other purposes exceeds a predetermined limit to further lift said stem and to hold it in such latter position without the further employment of power. 115

23. In combination a casing having a port, 120  
a valve positionable in different positions so as to permit of no fluid or of varying quantities of fluid passing through said port, a stem attached to said valve and itself positionable to position said valve in any one of such possible positions, a plurality of engagement catches on said stem and corresponding to varying conditions exterior to said valve and operative to act on that one of said catches corresponding to a special exterior condition 130



so as to position said stem in a corresponding predetermined position, and a locking device operative after each action of said means to hold in position the particular catch last acted upon until another predetermined exterior condition becomes existent.

24. In combination mains adapted to conduct varying quantities of current per unit of time, a casing having a port, a valve positionable in different positions so as to permit of no fluid or of varying quantities of fluid passing through said port, a stem attached to said valve and itself positionable to position said valve in any one of such possible positions, a plurality of engagement catches on said stem and corresponding to the varying quantities of current conducted by said mains, means responsive to predetermined conditions of such current and operative to act on that one of said catches corresponding to a predetermined condition of such current so as to position said stem in a corresponding predetermined position, and a locking device operative after each action of said means to hold in position the particular catch last acted upon until the condition of such current becomes as predetermined.

25. In combination mains adapted to conduct varying quantities of current per unit of time, a casing having a port, a valve positionable in different positions so as to permit of no fluid or of varying quantities of fluid passing through said port, a stem attached to said valve and itself positionable to position said valve in any one of such possible positions, a plurality of engagement catches on said stem and corresponding to the varying quantities of current conducted by said mains, means responsive to predetermined conditions of such current and operative to act on that one of said catches corresponding to a predetermined condition of such current so as to position said stem in a corresponding predetermined position, a locking device operative after each action of said means to hold in position the particular catch last acted upon until the quantity of such current increases or decreases according to predetermined conditions, and means operative after the turning of such current to close said valve.

26. In combination mains adapted to conduct varying quantities of current per unit of time, a casing having a port, a valve positionable in different positions so as to permit of no fluid or of increasing quantities of fluid passing through said port, a stem attached to said valve and itself positionable to position said valve in any one of such possible positions, a plurality of engagement catches on said stem and corresponding to the varying quantities of current conducted by said mains, means responsive to predetermined conditions of such current and operative to make engagement with that one of said

catches corresponding to the passage of a predetermined quantity of such current so as to position said stem in a corresponding predetermined position, a locking device operative after each action of said means to hold in position the particular catch last acted upon until said means shall again act upon the next catch or until such current shall be turned off, and means operative in such latter case to close said valve.

27. In combination a casing having a port, a valve positionable in different positions so as to permit of no fluid or of increasing quantities of fluid passing through said port, a stem attached to said valve and itself positionable to position said valve in any one of such possible positions, a plurality of collars secured to said stem, a dog adapted to engage any of said collars temporarily adjacent and to position said stem in some one of such possible positions, means for applying power to said dog so as to bring it into engagement with such adjacent collar, means for intermittently applying power to said former means to cause the same so to act, and a locking device operative after each such engagement to hold in position the collar last engaged until the next collar is engaged by said dog or until power is applied to close said valve.

28. In combination mains adapted to conduct varying quantities of electric current per unit of time, a casing having a port, a valve positionable in different positions so as to permit of no fluid or of increasing quantities of fluid passing through said port, a stem attached to said valve and itself positionable to position said valve in any one of such possible positions, a plurality of collars secured to said stem, a dog adapted to engage any of said collars temporarily adjacent and to position said stem in some one of such possible positions, means responsive to predetermined increases in the current conducted by said mains and operative to bring said dog into temporary engagement with an adjacent collar and thereby to permit of some fluid or of more fluid as the case may be passing through said port, means for intermittently applying electric power to said former means to cause the same so to act, a locking device operative after each such engagement to hold in position the collar last engaged until the next collar is engaged by said dog or until the electric power is turned off from said mains, and means operative in such latter case to close said valve.

29. In combination a stem movable into different positions, a plurality of engagement catches on said stem and corresponding to varying exterior conditions, means responsive to such exterior conditions and operative to act on that one of said catches corresponding to a special exterior condition so as to position said stem in a corresponding predetermined position, and a locking device



operative after each action of said means to hold in position the particular catch last acted upon until another predetermined exterior condition becomes existent.

5 30. In combination mains adapted to conduct varying quantities of current per unit of time, a stem movable into different positions, a plurality of engagement catches on said stem and corresponding to the varying quantities of current conducted by said mains, means responsive to predetermined conditions of such current and operative to act on that one of said catches corresponding to a predetermined condition of such current so as to position said stem in a corresponding predetermined position, and a locking device operative after each action of said means to hold in position the particular catch last acted upon until the condition of such current becomes as predetermined.

31. In combination mains adapted to conduct varying quantities of current per unit of time, a stem movable into different positions, a plurality of engagement catches on said stem and corresponding to the varying quantities of current conducted by said mains, means responsive to predetermined conditions of such current and operative to act on that one of said catches corresponding to a predetermined condition of such current so as to position said stem in a corresponding predetermined position, a locking device operative after each action of said means to hold in position the particular catch last acted upon until the quantity of such current increases or decreases according to predetermined conditions, and means operative after the turning of such current to restore said stem to its original position.

40 32. In combination mains adapted to conduct varying quantities of current per unit of time, a stem movable into different positions, a plurality of engagement catches on said stem and corresponding to the varying quantities of current conducted by said mains, means responsive to predetermined conditions of such current and operative to make engagement with that one of said catches corresponding to the passage of a predetermined quantity of such current so as to position said stem in a corresponding predetermined position, a locking device operative after each action of said means to hold in position the particular catch last acted upon until said means shall again act upon the next catch or until such electric current shall be turned off, and means operative in such latter case to restore said stem to its original position.

60 33. In combination a stem movable into different positions, a plurality of collars secured to said stem, a dog adapted to engage any of said collars temporarily adjacent and to position said stem in some one of such possible positions, means for applying power to

said dog so as to bring it into temporary engagement with such adjacent collar, means for intermittently applying power to said former means to cause the same so to act, and a locking device operative after each such engagement to hold in position the collar last engaged until the next collar is engaged by said dog or until power is applied to said means tending to restore said stem to its original position.

75 34. In combination mains adapted to conduct varying quantities of electric current per unit of time, a stem movable into different positions, a plurality of collars secured to said stem, a dog adapted to engage any of said collars temporarily adjacent and to position said stem in some one of such possible positions, means responsive to predetermined increases in the current conducted by said mains and operative to bring said dog into temporary engagement with an adjacent collar and thereby to position said stem in a corresponding position, means for intermittently applying electric power to said former means to cause the same so to act, a locking device operative after each such engagement to hold in position the collar last engaged until the next collar is engaged by said dog or until the electric power is turned off from said mains, and means operative in such latter case to restore said stem to its original position.

35. In combination a stem, a solenoid, a core in said solenoid such that when said solenoid is energized said core is lifted, means connecting said stem and core and operative to lift said stem when said solenoid is energized, means operative to lock said stem in such lifted position after each such lifting, a line leading to and from said solenoid, ending in a contact point and adapted for the passage of an electric current to energize said solenoid, a switch adapted to be connected with said contact point, means whereby after said core has been energized and said stem has been so lifted and locked the connection between said switch and contact point is broken, and means for subsequently releasing and dropping said stem.

115 36. In combination electric mains, a stem, a solenoid, a core in said solenoid such that when said solenoid is energized said core is lifted, means connecting said stem and core and operative to lift said stem when said solenoid is energized, means operative to lock said stem in such lifted position after each such lifting, branching from said mains a line leading to and from said solenoid, ending in a contact point and adapted for the passage of an electric current to energize said solenoid, a switch adapted to be connected with said contact point, means whereby after said core has been energized and said stem has been so lifted and locked the connection between said switch and contact



point is broken, and means for releasing and dropping said stem actuated by the passage of a current at approximately the time when the current through said mains is turned off.

37. In combination a stem normally depressed, a collar on said stem, a solenoid, a core in said solenoid having a top extending above said solenoid and a projecting arm 13 so that when said solenoid is energized all the parts of said core are lifted, means connecting said collar and core and operative to lift said collar when said solenoid is energized, a detent 32 and a detent lever 29 with a pin 33 normally pulled to the right, a line leading to and from said solenoid, ending in a contact point and adapted for the passage of an electric current to energize said solenoid, a switch 19 provided with a spring 21 and normally depressed on said contact point, a double locking arm 25 having a tooth 27 normally pulled to the right and a lock extension 34, and means subsequently operative on said detent after said core has been energized, after said stem has been lifted and locked, and after the connection between said switch and contact point has been broken to release said collar.

38. In combination electric mains, a stem normally depressed, a collar on said stem, a solenoid, a core in said solenoid having a top extending above said solenoid and a projecting arm 13 so that when said solenoid is energized all the parts of said core are lifted, means connecting said collar and core and operative to lift said collar when said solenoid is energized, a detent 32 and a detent lever 29 with a pin 33 normally pulled to the right, branching from said mains a line leading to and from said solenoid, ending in a contact point and adapted for the passage of an electric current to energize said solenoid, a switch 19 provided with a spring 21 and normally depressed on said contact point, a double locking arm 25 having a tooth 27 normally pulled to the right and a lock extension 34, and means actuated by the passage of a current at approximately the time when the current through said mains is turned off and operative on said detent to permit said stem to drop.

39. In combination a stem, a solenoid, a core in said solenoid such that when said solenoid is energized said core is lifted, means connecting said stem and core and operative to lift said stem when said solenoid is energized, means operative to lock said stem in such lifted position after each such lifting, a first line leading to and from said solenoid, ending in a contact point and adapted for the passage of an electric current to energize said solenoid, a switch adapted to be connected with said contact point, means whereby after said core has been energized and said stem has been so lifted and locked the connection between said switch and contact

point is broken, a second line leading from said first line between said solenoid and said contact point and provided with a resistance, means whereby a current sufficient to pass through said resistance further lifts and locks said stem after such connection has been broken, and means for subsequently releasing and dropping said stem.

40. In combination electric mains, a stem, a solenoid, a core in said solenoid such that when said solenoid is energized said core is lifted, means connecting said stem and core and operative to lift said stem when said solenoid is energized, means operative to lock said stem in such lifted position after each such lifting, branching from said mains a first line leading to and from said solenoid, ending in a contact point and adapted for the passage of an electric current to energize said solenoid, a switch adapted to be connected with said contact point, means whereby after said core has been energized and said stem has been so lifted and locked the connection between said switch and contact is broken, a second line leading from said first line between said solenoid and said contact point and provided with a resistance, means whereby a current sufficient to pass through said resistance further lifts and locks said stem after such connection has been broken, and means for releasing and dropping said stem actuated by the passage of a current at approximately the time when the current through said mains is turned off.

41. In combination a stem normally depressed, a collar on said stem, a solenoid, a core in said solenoid having a top extending above said solenoid and a projecting arm 13 so that when said solenoid is energized all the parts of said core are lifted, a dog attached to said core and operative to engage said collar so as to lift said stem when said solenoid is energized, a detent 32 and a detent lever 29 with a pin 33 normally pulled to the right, a first line leading to and from said solenoid, ending in a contact point and adapted for the passage of an electric current to energize said solenoid, a switch 19 provided with a spring 21 and normally depressed on said contact point, a double locking arm 25 having a tooth 27 normally pulled to the right and a lock extension 34, a second line leading from said first line between said solenoid and said contact point and provided with a resistance, means whereby after the action of said top on the spring 21 has elevated said switch from said contact point a current sufficient to pass through said resistance further lifts and locks said stem, and means operative on said detent after said stem has been lifted to permit said stem to drop.

42. In combination electric mains, a stem normally depressed, a collar on said stem, a solenoid, a core in said solenoid having a top extending above said solenoid and a project-



ing arm 13 that when said solenoid is energized all the parts of said core are lifted, a dog attached to said core and operative to engage said collar so as to lift said stem when  
 5 said solenoid is energized, a detent 32 and a detent lever 29 with a pin 33 normally pulled to the right, branching from said mains a first line leading to and from said solenoid, ending in a contact point and adapted for the  
 10 passage of an electric current to energize said solenoid, a switch 19 provided with a spring 21 and normally depressed on said contact point, a double locking arm 25 having a tooth 27 normally pulled to the right  
 15 and a lock extension 34, a second line leading from said first line between said solenoid and said contact point and provided with a resistance, means whereby after the action of said top on the spring 21 has elevated said  
 20 switch from said contact point a current sufficient to pass through said resistance further lifts and locks said stem, and means actuated by the passage of a current at approximately the time when the current through said mains  
 25 is turned off and operative on said detent to permit said stem to drop.

43. In combination a stem, a solenoid, a core in said solenoid such that when said solenoid is energized said core is lifted, means  
 30 connecting said stem and core and operative to lift said stem when said solenoid is energized, means operative to lock said stem in such lifted position after each such lifting, a first line leading to and from said solenoid,  
 35 ending in a contact point and adapted for the passage of an electric current to energize said solenoid, a switch adapted to be connected with said contact point, means whereby after said core has been energized and said stem  
 40 has been so lifted and locked the connection between said switch and contact point is broken, a second line leading from said first line between said solenoid and said contact point and provided with a resistance, a circuit  
 45 breaker in said second line, a core in said resistance operative to open said circuit breaker when the current passing through said resistance exceeds a predetermined limit, means whereby a current sufficient to  
 50 pass through said resistance further lifts and locks said stem after such connection has been broken and before said circuit breaker has been opened, means for subsequently releasing and dropping said stem, and means  
 55 for again closing said circuit breaker.

44. In combination electric mains, a solenoid, a core in said solenoid such that when said solenoid is energized said core is lifted, means connecting said stem and core and op-  
 60 erative to lift said stem when said solenoid is energized, means operative to lock said stem in such lifted position after each such lifting, branching from said mains a first line leading to and from said solenoid, ending in a contact  
 65 point and adapted for the passage of an elec-

tric current to energize said solenoid, a switch adapted to be connected with said contact point, means whereby after said core has been energized and said stem has been so lifted and locked the connection between said  
 70 switch and contact point is broken, a second line leading from said first line between said solenoid and said contact point and provided with a resistance, a circuit breaker in said second line, a core in said resistance opera-  
 75 tive to open said circuit breaker when the current passing through said resistance exceeds a predetermined limit, means whereby a current sufficient to pass through said resistance further lifts and locks said stem after  
 80 such connection has been broken and before said circuit breaker has been opened, means for releasing and dropping said stem actuated by the passage of a current at approximately the time when the current through  
 85 said mains is turned off, and means for again closing said circuit breaker.

45. In combination a stem normally depressed, a collar on said stem, a solenoid, a core in said solenoid having a top extending  
 90 above said solenoid and a projecting arm 13 so that when said solenoid is energized all the parts of said core are lifted, a dog attached to said core and operative to engage said collar so as to lift said stem when said solenoid is en-  
 95 ergized, a detent 32 and a detent lever 29 with a pin 33 normally pulled to the right, a first line leading to and from said solenoid, ending in a contact point and adapted for the passage of an electric current to energize said so-  
 100 lenoid, a switch 19 provided with a spring 21 and normally depressed on said contact point, a double locking arm 25 having a tooth 27 normally pulled to the right and a lock extension 34, a second line leading from said  
 105 first line between said solenoid and said contact point and provided with a resistance, a circuit breaker in said second line, a core in said resistance operative to open said circuit breaker when the current passing through  
 110 said resistance exceeds a predetermined limit, means whereby after the action of said top on the spring 21 has elevated said switch from said contact point a current sufficient to pass through said resistance further lifts and  
 115 locks said stem before said circuit breaker has been opened, means operative on said detent after said stem has been lifted to permit said stem to drop, and means for again closing said circuit breaker.  
 120

46. In combination electric mains, a stem normally depressed, a collar on said stem, a solenoid, a core in said solenoid having a top extending above said solenoid and a project-  
 125 ing arm 13 so that when said solenoid is energized all the parts of said core are lifted, a dog attached to said core and operative to engage said collar so as to lift said stem when said solenoid is energized, a detent 32 and a  
 130 detent lever 29 with a pin 33 normally pulled



to the right, branching from said mains a first line leading to and from said solenoid, ending in a contact point and adapted for the passage of an electric current to energize said solenoid, a switch 19 provided with a spring 21 and normally depressed on said contact point, a double locking arm 25 having a tooth 27 normally pulled to the right and a lock extension 34, a second line leading from said first line between said solenoid and said contact point and provided with a resistance, a circuit breaker in said second line, a core in said resistance operative to open said circuit breaker when the current passing through said resistance exceeds a predetermined limit, means whereby after the action of said top on the spring 21 has elevated said switch from said contact point a current sufficient to pass through said resistance further lifts and locks said stem before said circuit breaker has been opened, means actuated by the passage of a current at approximately the time when the current through said mains is turned off and operative on said detent to permit said stem to drop, and means for again closing said circuit breaker.

47. In combination a stem, a first solenoid, a core in said solenoid such that when said solenoid is energized said core is lifted, means connecting said stem and core and operative to lift said stem when said solenoid is energized, means operative to lock said stem in such lifted position after each such lifting, a first line leading to and from said solenoid, ending in a first contact point and adapted for the passage of an electric current to energize said solenoid, a switch adapted to be connected with said first contact point, means whereby after said core has been energized and said stem has been so lifted and locked the connection between said switch and first contact point is broken, a second line leading from said first line between said solenoid and said first contact point and provided with a first resistance, a circuit breaker in said second line having a projecting arm, a core in said first resistance operative to open said circuit breaker when the current passing through said first resistance exceeds a predetermined limit, means whereby a current sufficient to pass through said first resistance further lifts and locks said stem after such connection has been broken and before said circuit breaker has been opened, a second solenoid, a core in said second solenoid fitted with a pin such that when said second solenoid is energized said pin acts on said arm to close said circuit breaker, a second contact point adapted to make contact with said switch simultaneously with said first contact point, a third line leading from said first line between said first solenoid and the source of power through said second solenoid to said second contact point, a fourth line leading from said first line between said first solenoid

and said first contact point and provided with a second resistance greater than said first resistance, means whereby a current sufficient to pass through said second resistance further lifts and locks said stem after said circuit breaker has been opened, and means for subsequently releasing and dropping said stem.

48. In combination electric mains, a stem, a first solenoid, a core in said solenoid such that when said solenoid is energized said core is lifted, means connecting said stem and core and operative to lift said stem when said solenoid is energized, means operative to lock said stem in such lifted position after each such lifting, branching from said mains a first line leading to and from said solenoid, ending in a first contact point and adapted for the passage of an electric current to energize said solenoid, a switch adapted to be connected with said first contact point, means whereby after said core has been energized and said stem has been so lifted and locked the connection between said switch and first contact point is broken, a second line leading from said first line between said solenoid and said first contact point and provided with a first resistance, a circuit breaker in said second line having a projecting arm, a core in said first resistance operative to open said circuit breaker when the current passing through said first resistance exceeds a predetermined limit, means whereby a current sufficient to pass through said first resistance lifts and locks said stem after such connection has been broken and before said circuit breaker has been opened, a second solenoid, a core in said second solenoid fitted with a pin such that when said second solenoid is energized said pin acts on said arm to close said circuit breaker, a second contact point adapted to make contact with said switch simultaneously with said first contact point, a third line leading from said first line between said first solenoid and the source of power through said second solenoid to said second contact point, a fourth line leading from said first line between said first solenoid and said first contact point and provided with a second resistance greater than said first resistance, means whereby a current sufficient to pass through said second resistance further lifts and locks said stem after said circuit breaker has been opened, and means for releasing and dropping said stem actuated by the passage of a current at approximately the time when the current through said mains is turned off.

49. In combination a stem normally depressed, a top collar on said stem, a first solenoid, a core in said solenoid having a top extending above said solenoid and a projecting arm 13 so that when said solenoid is energized all the parts of said core are lifted, a dog attached to said core and operative to



engage an adjacent collar on said stem so as to lift said stem when said solenoid is energized, a detent 32 and a detent lever 29 with a pin 33 normally pulled to the right, a first line leading to and from said solenoid, ending in a first contact point and adapted for the passage of an electric current to energize said solenoid, a switch 19 provided with a spring 21 and normally depressed on said first contact point, a double locking arm 25 having a tooth 27 normally pulled to the right and a lock extension 34, a second line leading from said first line between said solenoid and said first contact point and provided with a first resistance, a circuit breaker in said second line having a projecting arm, a core in said first resistance operative to open said circuit breaker when the current passing through said first resistance exceeds a predetermined limit, a second collar 8 on said stem, a second solenoid, a core in said second solenoid fitted with a pin such that when said second solenoid is energized said pin acts on said arm to close said circuit breaker, a second contact point adapted to make contact with said switch simultaneously with said first contact point, a third line leading from said first line between said first solenoid and the source of power through said second solenoid to said second contact point, a fourth line leading from said first line between said first solenoid and said first contact point and provided with a second resistance greater than said first resistance, a third collar 9 on said stem, and means operative on said detent after said stem has been lifted to permit said stem to drop.

50. In combination electric mains, a stem normally depressed, a top collar on said stem, a first solenoid, a core in said solenoid having a top extending above said solenoid and a projecting arm 13 so that when said solenoid is energized all the parts of said core are lifted, a dog attached to said core and operative to engage an adjacent collar on said stem so as to lift said stem when said solenoid is energized, a detent 32 and a detent lever 29 with a pin 33 normally pulled

to the right, branching from said mains a first line leading to and from said solenoid, ending in a first contact point and adapted for the passage of an electric current to energize said solenoid, a switch 19 provided with a spring 21 and normally depressed on said first contact point, a double locking arm 25 having a tooth 27 normally pulled to the right and a lock extension 34, a second line leading from said first line between said solenoid and said first contact point and provided with a first resistance, a circuit breaker in said second line having a projecting arm, a core in said first resistance operative to open said circuit breaker when the current passing through said first resistance exceeds a predetermined limit, a second collar 8 on said stem, a second solenoid, a core in said second solenoid fitted with a pin such that when said second solenoid is energized said pin acts on said arm to close said circuit breaker, a second contact point adapted to make contact with said switch simultaneously with said first contact point, a third line leading from said first line between said first solenoid and the source of power through said second solenoid to said second contact point, a fourth line leading from said first line between said first solenoid and said first contact point and provided with a second resistance greater than said first resistance, a third collar 9 on said stem, actuated by the passage of a current at approximately the time when the current through said mains is turned off and operative on said detent to permit said stem to drop.

51. In combination electric mains, a stem and automatic means actuated by some current and predetermined increasing quantities of current conducted by said mains to position said stem in different predetermined positions and by the turning off of such current to restore said stem to its original position.

GEORGE P. CARROLL.

Witnesses:

EDWARD F. HALLEN,  
A. MAUDE KIMBER.