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VALVE CONTROL SYSTEM

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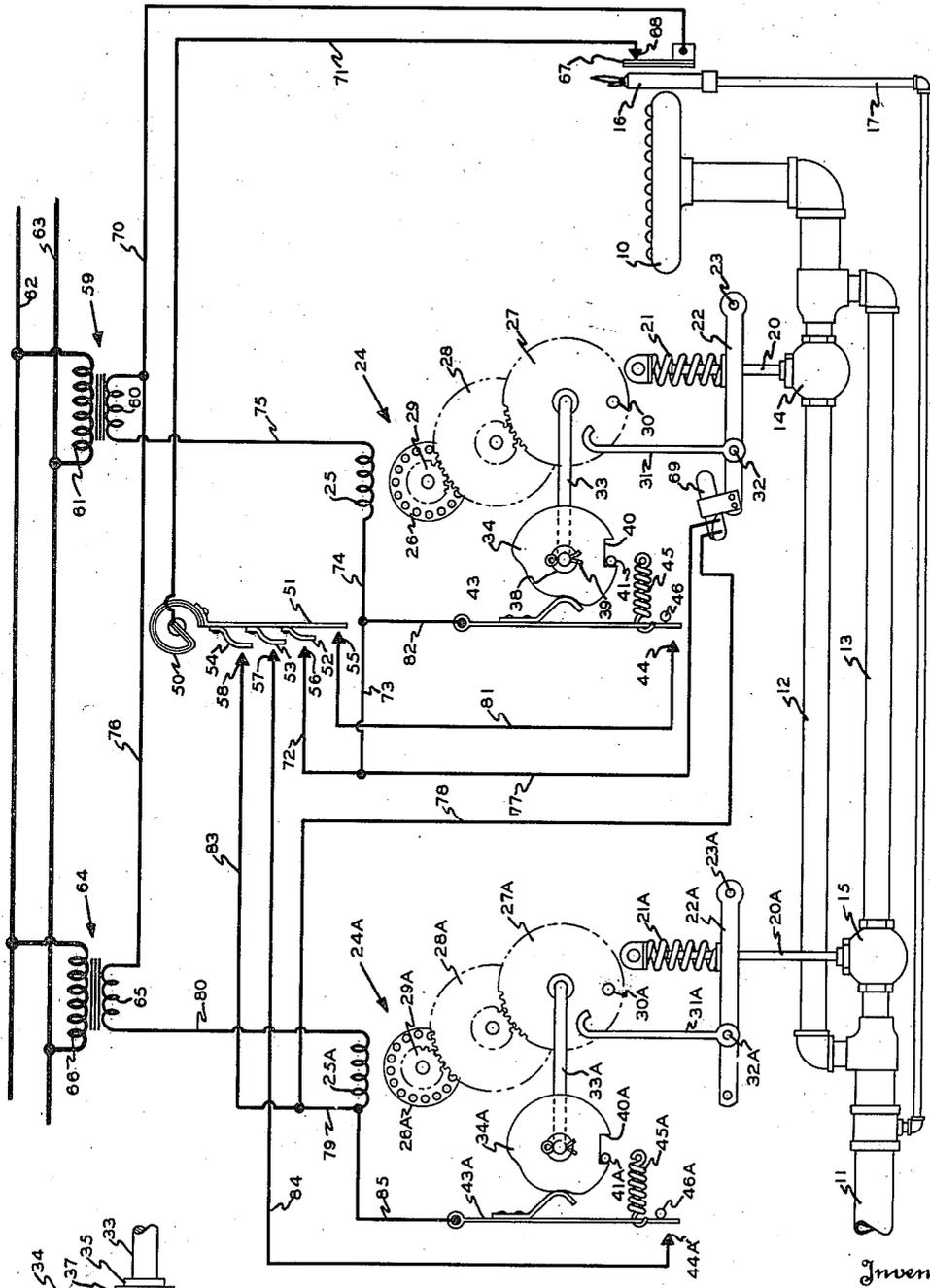


Fig. 1.

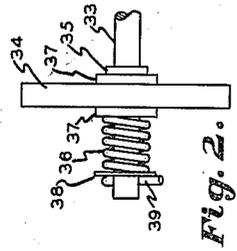


Fig. 2.

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VALVE CONTROL SYSTEM

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The present invention relates to an automatic control system by which a plurality of valves may be controlled and has particular utility in connection with the control of a plurality of valves which control the supply of fuel to a heating device such as a gas burner.

One of the objects of the present invention is the provision of a control system, including a member movable back and forth along a predetermined path of travel in response to changes in a condition, together with means by which the control member sequentially opens a plurality of valves upon changes in the value of a condition to which the movable member responds and sequentially closes the valves upon restoration of said condition, the arrangement being such that each of the valves is closed at a different value of the condition than that at which they are opened.

In controlling the supply of fuel to a burner and particularly to a gas burner, it is often desired to initially supply a relatively small amount of fuel upon small deviations of the value of the controlling condition. However, most gas burners while allowing a relatively great throttling of the gas supply when the burner is already in operation require a larger initial supply of gas thereto in order to give proper ignition. As a result, the initial supply of gas must be relatively large and it often happens that this large initial supply of gas is larger than it is desired to burn continuously until the value of the controlling condition has deviated from the desired value by a considerable amount. It has therefore been proposed to provide an arrangement whereby upon a demand for a relatively small amount of fuel, a large amount of fuel will be momentarily supplied to provide for proper ignition and thereafter the supply of fuel will be decreased to an amount corresponding to the demand. The present invention provides an improved system whereby such operation may be obtained.

A further object of the invention is the provision of a control system by which a pair of valves are moved to open position upon a demand for a relatively small flow of fluid, together with means controlled by movement of one of the valves to open position for closing the other of the valves whereby one of the valves is momentarily opened to provide a large initial flow of fluid and is then quickly closed to reduce the flow of fluid to an amount corresponding to the demand. The valves are preferably of the electricaly operated type and the momentary

opening of one of the valves is preferably accomplished by energizing said valve through a switch that is moved to open position upon opening of the other of the valves.

A further object of the invention is the provision of a control system for a pair of valves by which both of the valves are opened upon a demand for a small flow of fluid, there being means controlled by the first valve when moved to open position for closing the second valve, together with means for again opening the second valve and maintaining the same open upon an increase in the demand for fluid flow.

Other objects of the invention include the provision of a complete system of the class above described which system includes a single pilot switch responsive to the condition of a pilot burner for igniting a main burner the flow of fuel to which is controlled by a pair of valves one of which is momentarily opened upon an initial demand for a small amount of fuel.

Another object of the invention comprises the provision of a system of the nature defined above in which all of the apparatus and particularly the two valves are standard equipment readily available on the market and are arranged, by the simple addition of a single switch controlled by one of the valves, to give a momentary opening of the other of the valves upon an initial demand for a relatively small flow of fuel to the burner.

Other objects of the invention will be found in the following description, the accompanying drawing and the appended claims.

For a more complete understanding of the invention, reference may be had to the following detailed description, and the accompanying drawing in which:

Fig. 1 is a diagrammatic showing of one form of the present invention, and—

Fig. 2 is a showing of a detail of construction of the valves utilized in the invention.

Referring to the drawing, the present invention is herein shown as applied to the control of the flow of gas to a main gas burner 10 which is connected to a gas supply main 11 by means of branch pipes 12 and 13. The flow of gas through gas pipe 12 is controlled by a first electrically operated valve 14 and the flow of gas through the branch pipe 13 is controlled by a second electrically operated valve 15. The gas issuing from main burner 10 is adapted to be ignited by a pilot burner 16 which is connected to gas main 11 by means of a pilot pipe 17.

The electrically operated valves 14 and 15 are

diagrammatical representations of commercial valves of well-known construction and both of these valves are identical in their details. The valves 14 and 15 include valve stems 20 and 20a which are normally biased to valve closing position by means of coiled springs 21 and 21a. The valve stems 20 and 20a are adapted to be lifted against the bias of their springs 21 and 21a by means of levers 22 and 22a which are pivoted at points indicated at 23 and 23a. The valve 14 is operated by a rotary electrical motor 24 which comprises a field winding 25 and a rotor 26. Rotor 26 drives a gear 27 through a gear and pinion assembly 28 and a rotor pinion 29. Valve 15 is operated by a motor 24a which comprises a field winding 25a and a rotor 26a. Rotor 26a is adapted to drive a gear 27a through a gear and pinion assembly 28a and a rotor pinion 29a. The gears 27 and 27a respectively carry crank pins 30 and 30a which, upon energization of motors 24 and 24a, are adapted to engage hooked links 31 and 31a that are pivoted to levers 22 and 22a at points indicated at 32 and 32a. In this manner, the valves 14 and 15 are opened against their biasing springs upon energization of their respective motors 24 and 24a and, having been moved to open position, they are maintained therein against their biases by stalling of their respective motors. When the operating motors are deenergized, the biasing springs 21 and 21a close the valves 14 and 15 and rotate the gears 27 and 27a and the other gears and pinions associated therewith, as well as the motor rotors, in the reverse direction.

The gears 27 and 27a are carried upon shafts 33 and 33a which operate cams 34 and 34a through suitable slip friction connecting means.

Referring to Fig. 2 of the drawing, it will be seen that the shaft 33 is provided with a collar 35 against which the cam 34 is pressed by means of a coiled spring 36. Washers 37 are interposed between coiled spring 36 and cam 34 and between collar 35 and cam 34. The other end of the coiled spring 36 is confined against longitudinal movement by means of a washer 38 held in place by means of a cotter pin 39 which is received in a suitable opening in shaft 33. The pressure of coiled spring 36 presses cam 34 against collar 35 with sufficient force to ordinarily cause cam 34 to rotate in unison with shaft 33. However, if the cam 34 is restricted in its movement, the slip frictional connection above described will allow continued movement of shaft 33. The cam 34a is connected to shaft 33a through a similar slip friction connecting means.

Cams 34 and 34a are provided with notches 40 and 40a which cooperate with stop pins 41 and 41a, whereby the movements of cams 34 and 34a are restricted. Cam 34 operates a switch arm 43 which is adapted to be moved into engagement with a stationary contact 44 but is normally biased from engagement therewith by means of a spring 45. Similarly, cam 34a is adapted to operate a switch arm 43a that is movable into engagement with a contact 44a but is normally biased from engagement therewith by means of a spring 45a. Stop pins 46 and 46a limit the movement of switch arms 43 and 43a away from their cooperating contacts 44 and 44a. The switch arm 43 and contact 44 comprise a first holding switch and the switch arm 43a and contact 44a comprise a second holding switch. From an inspection of the drawings, it will be noted that the arrangement is such that upon

initial movement of cam 34 in clockwise direction, switch arm 43 will be moved into engagement with contact 44. The stop pin 41 will thereafter prevent further clockwise rotation of cam 34 and, about this time, crank pin 30 will engage hooked link 31 to begin raising valve stem 20 of valve 14. The holding switch comprised by switch arm 43 and contact 44 is therefore closed upon initial movement of gear 27 in valve opening direction. Similarly, the second holding switch comprised by switch arm 43a and contact 44a is moved to closed position upon initial movement of gear 27a in valve opening direction.

Valves 14 and 15 are herein shown as controlled by a condition responsive element in the form of a bimetallic element 50 which responds to the temperature of a room or space to be heated. One end of the bimetallic element 50 is held stationary and the other end thereof controls switch arms 51, 52, 53 and 54 which are adapted to sequentially engage contacts 55, 56, 57 and 58 in the order named upon temperature fall. Upon temperature rise, switch arm 54 first disengages contact 58, then switch arm 53 disengages contact 57 thereafter switch arm 52 disengages switch arm 56 and lastly switch arm 51 disengages contact 55.

Power for field winding 25 is supplied by a step-down transformer 59, having a low voltage secondary 60 and a high voltage primary 61 connected to suitable line wires 62 and 63. The capacity of the transformer 59 is sufficient to operate motor 24 but is insufficient to additionally operate motor 24a. Power for motor 24a is supplied by a similar transformer 64, having a low voltage secondary 65 and a high voltage primary 66 which is also connected to the line wires 62 and 63.

The system also preferably includes a pilot switch comprised by a bimetallic element 67 which engages a contact 68 whenever the pilot burner 16 is operating properly. Such pilot switches are well known in the art.

The lever 22 supports a mercury switch 69, the arrangement being such that mercury switch 69 is moved to open position only when valve 14 has been completely or substantially completely opened and is closed at all other times.

The remaining circuit connections will be described in detail under the heading "Operation".

Operation

With the parts in the position shown, the room temperature is at or above the desired point so that both the first and second gas valves 14 and 15 are closed. The main burner 16 is inoperative but the pilot burner 16 is operating properly as indicated by the fact that bimetallic element 67 is engaged with its contact 68.

Now as the room temperature falls, switch arm 51 will engage contact 55 but such engagement of switch arm 51 with contact 55 does not complete any initial energizing circuits. Upon further fall in space temperature, switch arm 52 will engage contact 56 whereupon field windings 25 and 25a will be simultaneously energized. The circuit for field winding 25 is as follows: secondary 60 of transformer 59, wire 70, bimetallic element 67, contact 68, wire 71, bimetallic element 50, switch arm 51, switch arm 52, contact 56, wire 72, wire 73, wire 74, field winding 25, and wire 75 to the other side of secondary 60. The energizing circuit for field winding 25a is as follows: secondary 65 of transform-

er 64, wire 76, wire 70, bimetallic element 67, contact 68, wire 71, bimetallic element 50, switch arm 51, switch arm 52, contact 56, wire 72, wire 77, mercury switch 69, wire 78, wire 79, field winding 25a, and wire 80 to the other side of secondary 65.

Gears 27 and 27a will thereupon be rotated in clockwise direction. The first and second holding switches comprised by switch arms 43 and 43a and contacts 44 and 44a will first be closed in the manner heretofore described. Engagement of switch arm 43 with contact 44 establishes a holding circuit for field winding 25 as follows: secondary 60, wire 70, bimetallic element 67, contact 68, wire 71, bimetallic element 50, switch arm 51, contact 55, wire 81, contact 44, switch arm 43, wire 82, wire 74, field winding 25 and wire 75 to secondary 60. Engagement of switch arm 43 with contact 44 also establishes a temporary holding circuit for field winding 25a as follows: secondary 65, wire 76, wire 70, bimetallic element 67, contact 68, wire 71, bimetallic element 50, switch arm 51, contact 55, wire 81, contact 44, switch arm 43, wire 82, wire 73, wire 77, mercury switch 69, wire 78, wire 79, field winding 25a, and wire 80 to the other side of secondary 65. Continued clockwise rotation of gears 27 and 27a causes the crank pins 30 and 30a to engage their respective hooked links 31 and 31a whereby valves 14 and 15 are moved toward open position. When valve 14 is completely or substantially completely opened, mercury switch 69 will be moved to open circuit position whereby the energizing circuit for field winding 25a will be interrupted. Valve 15 will therefore close and its holding switch will be returned to the open position shown in the drawing. Valve 14 will remain in its open position by reason of stalling of its motor 24 and will remain in such open position until switch arm 51 disengages contact 55.

From the foregoing description, it will be seen that upon an initial fall in room temperature, demanding a relatively small flow of gas, both valves 14 and 15 are opened but valve 15 is reclosed as a result of valve 14 moving to open position. In other words, valve 15 is momentarily opened whereby to provide an initial large flow of gas to the main burner 10 which flow of gas is reduced in accordance with the demands by the closing of valve 15. The large flow of gas produced by the combined openings of valves 14 and 15 provides a full flow of gas to main burner 10 which is readily ignited by the pilot burner 16. After the main burner 10 is placed in operation, the reduced flow of gas allowed by valve 14 will remain burning properly since ignition has already been established.

If there should be a continued fall in room temperature so as to bring switch arm 53 into engagement with contact 57 and then bring switch arm 54 into engagement with contact 58, field winding 25a of gas valve 15 will again be energized by a circuit as follows: secondary 65, wire 76, wire 70, bimetallic element 67, contact 68, wire 71, bimetallic element 50, switch arm 51, switch arm 54, contact 58, wire 83, wire 79, field winding 25a and wire 80 to the other side of secondary 65. The holding switch comprised by switch arm 43a and contact 44a will be quickly closed as previously explained and will establish a holding circuit for field winding 25a as follows: secondary 65, wire 76, wire 70, bimetallic element 67, contact 68, wire 71, bimetallic element 50, switch arm 51, switch arm 53, contact

57, wire 84, contact 44a, switch arm 43a, wire 85, field winding 25a and wire 80 to the other side of secondary 65. The gas valve 15 is therefore moved to open position upon a further fall in room temperature so as to again give a full supply of gas to the main burner 10. Valve 15 will now remain open until the room temperature is restored sufficiently to move switch arm 54 from engagement with contact 58, thereby breaking the energizing circuit for field winding 25a, and until switch arm 53 disengages contact 57 whereupon the holding circuit for field winding 25a is interrupted. When the room temperature has thus been partially restored and both the energizing and holding circuits for field winding 25a are interrupted, valve 15 will close and its controlling mechanism will return to the position shown in the drawing. If the room temperature should thereafter again decrease so as to bring switch arms 53 and 54 into engagement with contacts 57 and 58, gas valve 15 will again be energized as previously explained. However, if the room temperature continues to increase, switch arm 52 will move from engagement with contact 56 and interrupt the energizing circuit for gas valve 14. Gas valve 14 will remain open however until the room temperature is completely restored so as to move switch arm 51 from engagement with contact 55 to interrupt its holding circuit.

If the pilot burner 16 should become extinguished at any time, the pilot switch defined by 67-68 will open and prevent opening of gas valves 14 and 15 or prevent their remaining open if they should be open when this occurs.

The levers 22 and 22a may of course operate secondary air dampers in the usual manner if desired.

From the foregoing description, it will be seen that the present invention provides a simple system utilizing standard parts and requiring merely the addition of the single mercury switch 69 in order to provide a system wherein two valves are simultaneously opened upon a demand for a small flow of fluid and one of them is thereafter immediately closed whereby a large initial supply of fluid is provided and the supply is then reduced in accordance with the demand. Furthermore, if there should thereafter be a demand for a larger supply of fluid, the second valve is again opened and maintained open. Further, it will be noted that the first and second valves are sequentially opened upon changes in the value of a condition in one direction and are sequentially closed upon restoration of the condition but at values of the condition which are different than those at which the valves were opened.

It is obvious that the invention is applicable to systems other than that disclosed herein and that many changes can readily be made by those skilled in the art and I therefore intend to be limited only in view of the appended claims.

I claim:

1. In combination, a movable member adapted to move back and forth along a predetermined path of travel, a first valve, a second valve, connections between said member and first valve for opening the latter when said movable member reaches a first point in its path of travel while moving in a first direction and for closing the same when said movable member reaches a second point in traveling in a second direction, connections between both of said valves and said movable member for also opening said second valve when the movable member reaches said 75

first point and for closing said second valve upon opening of said first valve without further movement of said movable member and connections between said movable member and second valve for again opening the latter when said movable member reaches a third point in its path of travel when moving in said first direction and for closing said second valve when said movable member reaches a fourth point in its path of travel upon movement in said second direction, all four of said points being spaced one from another.

2. In combination, a movable member adapted to move along a predetermined path of travel, first and second valves, and connections between said movable member and valves for opening said first and second valves at a first point, then closing said second valve, and for again opening said second valve at a second point as said movable member moves along its path of travel in one direction and for closing said second and first valves when said movable member reaches third and fourth points in its path of travel upon return movement of said movable member, said movable member passing through said third and fourth points in moving to said first and second points when moving in said first direction.

3. In combination, first and second switches, means responsive to a condition for sequentially closing said switches in the order named upon continued change of said condition in a single direction, a first electrically operable valve, a third switch moved to open position by said valve when the valve reaches open position, a second electrically operable valve, an energizing circuit for said first valve controlled by said first switch, an energizing circuit for said second valve controlled by said first switch and third switch in series whereby said second valve is opened momentarily upon closure of said first switch, a second energizing circuit for said second valve controlled by said third switch and holding circuits for said valves controlled by said condition responsive means.

4. In combination, means responsive to the value of a condition, three switches sequentially closed thereby upon continued change of said condition in one direction, a first electrically operable valve, a fourth switch which is closed and a fifth switch which is opened by said first valve upon opening thereof, an energizing circuit for said first valve controlled by said second switch, a holding circuit for said first valve controlled by said first and fourth switches, a second electrically operable valve, a first energizing circuit therefor controlled by said second and fifth switches in series, and a second energizing circuit for said valve controlled by said third switch.

5. In combination, means responsive to the value of a condition, four switches sequentially closed thereby upon a change in said condition in a single direction, a first electrically operable valve, a fifth switch moved to open position and a sixth switch moved to closed position by said valve upon opening thereof, a second electrically operable valve, a seventh switch closed by the second valve when opened, an energizing circuit for said first valve controlled by said second switch, an energizing circuit for said second valve controlled by said second and fifth switches in series whereby said second valve is opened momentarily upon closure of said second switch, a holding circuit for said first valve controlled by said first and sixth switches, a second energizing circuit for said second valve controlled by said

fourth switch, and a holding circuit for said second valve controlled by said third and seventh switches in series.

6. In combination, a condition responsive switch, a first electrically operable valve, a second switch, means associated with said first valve and second switch by which the second switch is moved to open position as a result of opening of said first valve, a second electrically operable valve, first and second transformers for said first and second valves, each transformer having sufficient capacity to operate its respective valve but insufficient capacity to operate both of said valves, a circuit comprising said first transformer, condition responsive switch, and first valve, and a circuit comprising said second transformer, condition responsive switch, second switch and second valve.

7. The combination with a heating system comprising first and second electrically operable valves controlling the supply of fuel to a main burner and a pilot burner for igniting the main burner, of a control system for said valves, comprising, in combination, a pilot switch, a main control switch, a third switch moved to open position by said first valve when opened, a first transformer having sufficient capacity to operate only said first valve, a second transformer having sufficient capacity to operate only said second valve, a circuit comprising said first transformer, first valve, pilot switch and main control switch and a circuit comprising said second transformer, second valve, pilot switch, main control switch and third switch.

8. A heating system of the class described, comprising in combination, first and second electrically operated gas valves for controlling the flow of gas to a burner for heating a space, a space temperature responsive thermostatic element, four control switches sequentially closed thereby upon temperature fall, first and second holding switches respectively closed by said first and second gas valves when energized, a valve operated switch moved to open position by said first gas valve as a result of movement thereof to open position, an energizing circuit for said first gas valve controlled by said second control switch, an energizing circuit for said second gas valve controlled by said valve operated switch and second control switch in series, a holding circuit for said first gas valve controlled by said first control switch and first holding switch in series, a second energizing circuit for said second gas valve controlled by said fourth control switch, and a holding circuit for said second gas valve controlled by said third control switch and second holding switch in series.

9. In combination, means responsive to the value of a condition, three switches sequentially closed thereby upon continued change of said condition in one direction, first and second electrically operable valves, a fourth switch which is opened by said first valve upon opening thereof, a fifth switch which is closed by said second valve upon opening thereof, an energizing circuit for the first valve controlled by said first switch, a first energizing circuit for the second valve controlled by the first switch and fourth switch in series, a second energizing circuit for the second valve controlled by the third switch, and a holding circuit for the second valve controlled by the second switch and fifth switch in series.

10. In a valve controlling system, in combination, a first valve including motor means in control thereof, a second valve including entirely

separate and independent motor means in control thereof, a control member in control of the motor means of both valves operable to cause simultaneous opening of both of said valves, and control means actuated by said first valve in control of the motor means of the second valve operable to close said second valve upon opening of said first valve.

11. In a valve controlling system, in combination, a first valve including motor means in control thereof, a second valve including entirely separate and independent motor means in control thereof, a control member in control of the motor means of both valves operable to cause simultaneous opening of both of said valves, control means actuated by said first valve in control of the motor means of the second valve operable to close said second valve upon opening of said first valve, and a second control member in control of said second valve motor operable to open the second valve independently of the condition of said control means.

12. In an electrical valve controlling system, in combination, a first valve including electric motor means in control thereof, a second valve including a separate electric motor means in control thereof, a first control switch, circuit connections for the motor means of both valves controlled by said first control switch operable to open both valves upon closure of the first control switch, and switching means operated by said first valve which causes closure of the second valve upon opening movement of said first valve.

13. In an electrical valve controlling system, in combination, a first valve including electric motor means in control thereof, a second valve including a separate electric motor means in control thereof, a first control switch, circuit connection for the motor means of both valves controlled by said first control switch operable to open both valves upon closure of the first control switch, switching means operated by said first valve which causes closure of the second valve upon opening movement of said first valve, a second control switch, and circuit connections controlled thereby for the motor means of said second valve to cause opening thereof upon closure of the second control switch.

14. In an electrical valve controlling system, in combination, a first valve including electric motor means in control thereof, a second valve including a separate electric motor means in control thereof, a first control switch, circuit connection for the motor means of both valves controlled by

said first control switch operable to open both valves upon closure of the first control switch, switching means operated by said first valve which causes closure of the second valve upon opening movement of said first valve, a second control switch, circuit connections controlled thereby for the motor means of said first valve to cause opening thereof upon closure of the second control switch, and a movable member responsive to a condition which sequentially closes said first and second control switches.

15. In a valve controlling system, in combination, a first valve comprising means to bias the same to closed position and an electric motor to open the same and hold it open against its bias when energized, a second separate valve including separate biasing means which biases the same to closed position and a separate electric motor to open the same and maintain it open against its bias when energized, a first control switch, energizing circuits for each of the motors of said valves completed by closure of said first control switch, a second control switch in the circuit for the motor of the second valve, connections between the first valve and second control switch to open the second control switch upon opening movement of said first valve, a third control switch, and a separate energizing circuit for the motor of said second valve controlled by said third control switch independently of said second control switch.

16. In a valve controlling system, in combination, a first valve comprising means to bias the same to closed position and an electric motor to open the same and hold it open against its bias when energized, a second separate valve including separate biasing means which biases the same to closed position and a separate electric motor to open the same and maintain it open against its bias when energized, a first control switch, energizing circuits for each of the motors of said valves completed by closure of said first control switch, a second control switch in the circuit for the motor of the second valve, connections between the first valve and second control switch to open the second control switch upon opening movement of said first valve, a third control switch, a separate energizing circuit for the motor of said second valve controlled by said third control switch independently of said second control switch, and a single condition responsive member to sequentially close said first and third control switches.

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