June 8, 1937. C. G. KRONMILLER 2,083,532

ELECTRICALLY OPERATED SNAP ACTION MODULATING VALVE

Filed Nov. 11, 1933 2 Sheets-Sheet 1

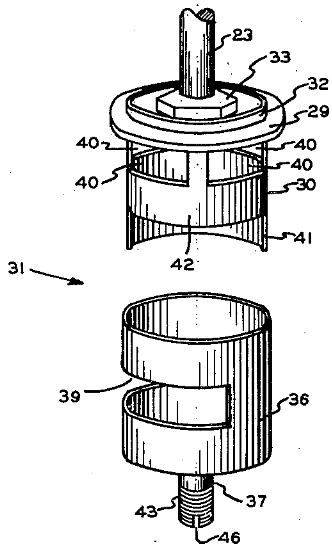

FIG. 2.

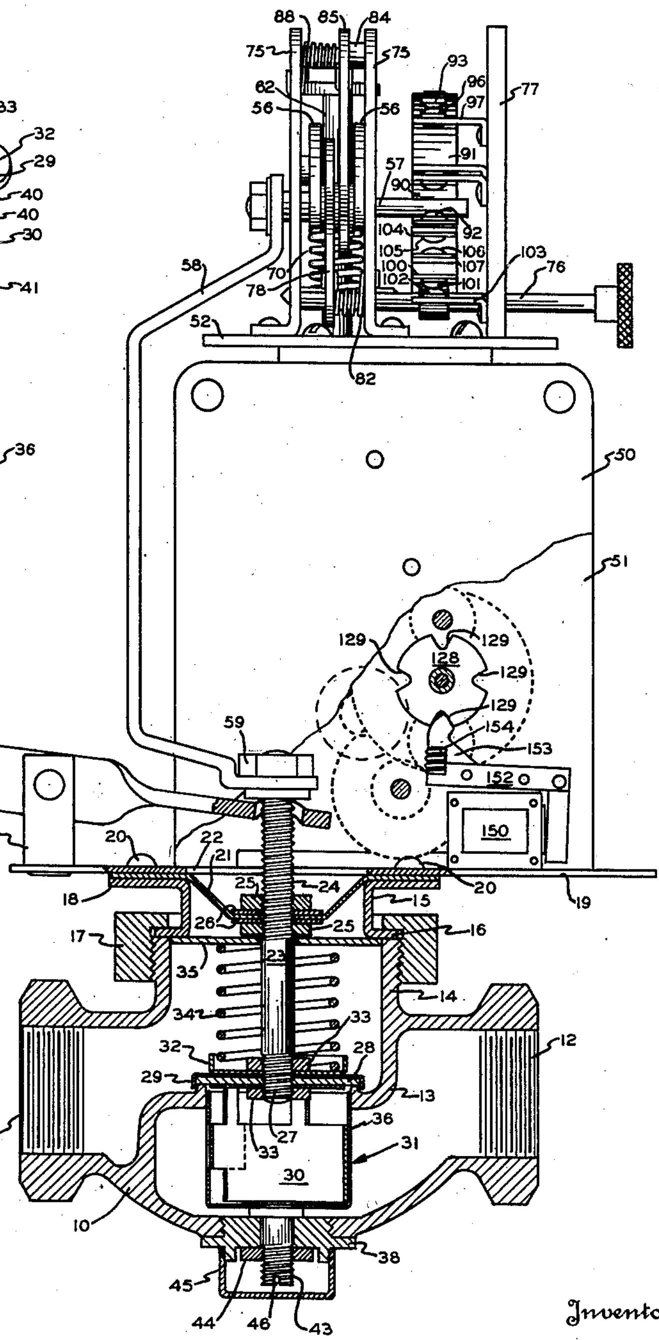

FIG. 1.

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Filed Nov. 11, 1933 2 Sheets-Sheet 2

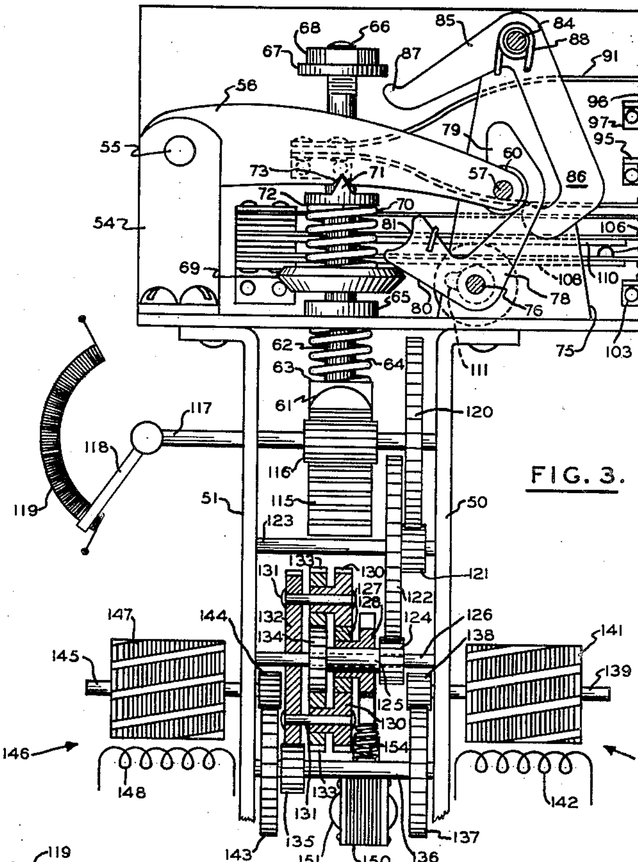

FIG. 3.

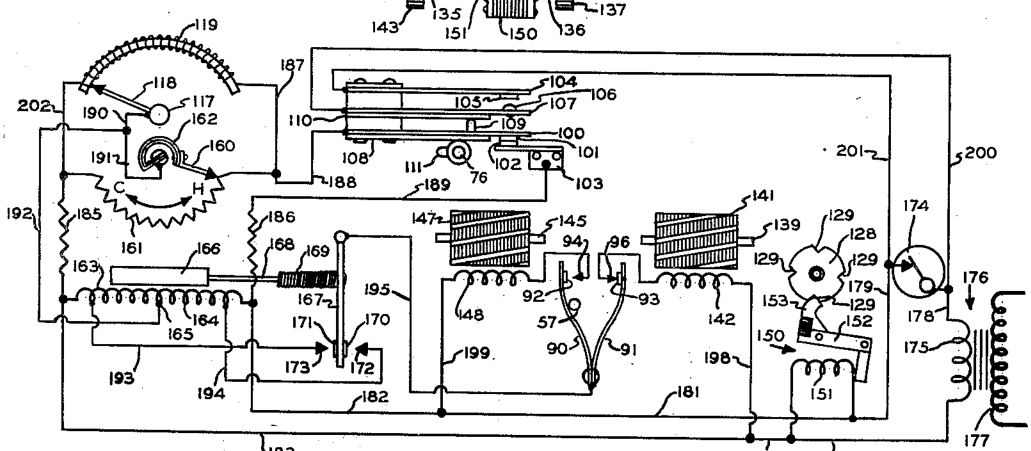

FIG. 4.

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ELECTRICALLY OPERATED SNAP ACTION MODULATING VALVE

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Application November 11, 1933, Serial No. 697,688

8 Claims. (Cl. 137—139)

The present invention relates to the art of positioning an instrumentality in various positions as the result of movement of a control member, usually remotely located, and has particular utility in controlling the flow of fuel to a burner, such for example, as the flow of gas to a gas burner.

It is well known in the art of gas burning that most gas burners can be turned down to a relatively low flame fairly efficiently and without much danger of a pop-back into the mixer, but in most cases, these burners require a considerably larger initial flow of gas in order to be successfully ignited.

One of the objects of the present invention is the provision of electrical control mechanism for a single valve, the control mechanism being so arranged that the valve remains closed until there is a demand for a predetermined supply of fluid at which time the valve is quickly opened and thereafter may be moved to an intermediate flow position if the demand decreases but is still greater than zero demand.

Another object of the invention is the provision of an electrical control system for a single valve, the control system being so arranged that the valve remains closed until there is a predetermined demand whereupon the valve quickly moves to a partially open position and may thereafter be opened further automatically if the demand increases.

While present day gas burners may be throttled down to a relatively low flame without the flame popping back into the mixer, it is still impossible to throttle such burners to a completely closed position without encountering difficulties before the valve is completely closed. It is therefore desirable to quickly close such a valve when the flow therethrough reaches a predetermined minimum.

A further object of the invention, therefore is the provision of an electrical valve control mechanism for quickly closing a single valve when the demand for fluid flow reaches a predetermined minimum.

Another object of the invention is the provision of an electrical control system for a single valve, the system being so arranged that the demand for fluid flow must reach a predetermined minimum before the valve opens and at which time the valve opens quickly with a snap movement and is thereafter opened more widely or moved to more nearly closed position according to the demands for fluid flow until a minimum flow position is reached whereupon the valve is snapped closed or quickly moved to closed position.

In automatic control systems, and particularly in those automatic control systems for controlling heating valves, dampers, and similar instrumentalities, it is often desirable to move the valve in one direction by one motor means and in the other direction by another motor means, the valve remaining stationary when both motor means are deenergized or, in some cases, when both are energized. In such a system, the valve will remain in the position to which it was last moved if the supply of electrical power should fail. Such a situation often gives rise to a dangerous heater condition and it is therefore desirable to include mechanism in such a system whereby the valve will move to one of its extreme positions in the event there should be a failure of electrical power.

Another object of the present invention, therefore, is the provision of a control system for a valve, damper, or similar instrumentality which moves the valve in one direction upon energization of a first motor means and moves it in another direction upon energization of a second motor means, the arrangement being such that the valve remains stationary when both motor means are equally energized or both deenergized, together with means for moving the valve to one of its extreme positions if the supply of power should be interrupted. In addition, the apparatus of this invention is so arranged that the valve can be manually moved to another position during a power failure together with means for returning the valve to automatic control upon the resumption of power and these features are likewise embraced by the objects of my invention.

A further object of the invention is the provision of an improved adjustable flow proportioning port or valve for general use.

Another object of the invention is the provision of an improved mechanical snap action device of general utility.

Other objects of the invention will become apparent from the description, the drawings, and the appended claims.

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

Fig. 1 is a side view of the apparatus comprising the present invention, there being parts in section and others broken away to show the construction more clearly,

Fig. 2 is a stretch-out view, in perspective, of my novel flow proportioning port or valve,

Fig. 3 is a front view of the control mechanism shown in Fig. 1, certain of the parts being shown in section, and

Fig. 4 is a schematic wiring diagram of the system of my invention.

Referring first to Figs. 1 and 2, a valve casing **10** is provided with an inlet port **11** and an outlet port **12**, there being a partition wall **13** therebetween which has a valve opening formed therein. The upper side of valve casing **10** is provided with an upwardly extending cylindrical extension **14** which is provided with exterior screw threads. A circular bracket **15** is provided with a lower flange **16** which is clamped against the end of tubular extension **14** by means of a collar **17**. The bracket **15** is further provided with an upper flange **18** which is secured to a circular base plate **19** by any suitable means such as the screws **20** there being a sealing-off diaphragm **21** clamped between circular base plate **19** and flange **18** of bracket **15**. The base plate **19** is provided with a circular opening **22**.

A valve stem **23** is provided with an upper threaded portion **24** which passes through sealing-off diaphragm **21**, extends through circular opening **22**, and terminates above base plate **19**. The diaphragm **21** is secured to the upper portion **24** of valve stem **23** by suitable nuts **25** and washers **26** whereby fluid is prevented from passing to the atmosphere by way of tubular extension **14**. The lower end of valve stem **23** is threaded as indicated at **27** and supports a valve disc **28** which is received within a valve disc retainer **29**, the valve disc **28** cooperating with the valve opening in partition **13** to prevent the flow of fluid from the inlet **11** through the valve opening and out the outlet **12**. The lower end **27** of valve stem **23** further supports the movable member **30** of an adjustable fluid flow throttling device generally indicated at **31**. A spring retainer **32** is placed upon the lower end of valve stem **27** above the valve disc retainer **29** and these parts are all secured in their proper positions by means of nuts **33** which cooperate with the lower threaded portion **27** of valve stem **23**. A coiled spring **34** has one of its ends abutting spring retainer **32** and its other end abuts a circular disc **35** which in turn is pressed against the lower surface of flange **16** of bracket **15**. In this manner, the valve disc **28** and the movable member **30** of the flow proportioning device are normally biased to the position shown in Fig. 1 of the drawings.

Referring now particularly to Fig. 2, it will be seen that the adjustable flow proportioning device comprises a relatively stationary cylindrical member **36** which is carried by a stud **37** rotatably mounted in a nut **38** which is threaded into the lower portion of valve casing **10**. A portion of the surface of the relatively stationary cylindrical member **36** is cut away as indicated at **39**. The movable member **30** of the adjustable flow proportioning device **31** comprises a cylindrical member which is provided near its upper end with a plurality of openings **40** by means of which fluid may flow within the member **30** when the valve disc **28** has been raised from the valve opening in partition wall **13**. The member **30** is further provided with a skirt **41** of substantially semi-circular formation. The member **30** is adapted to be received within the cylindrical member **36**. By adjusting the relatively stationary cylindrical member **36**, the opening **39** therein may be placed so that it will be completely covered by skirt **41** when the movable member **30** is in any of its positions including its highest elevated position and its lowermost position. The cylindrical member **36** may additionally be adjusted so that skirt **41** is located oppositely thereto whereby upon raising of member **30**, the portion **42** thereof will gradually uncover the opening **39** in cylinder **36** to allow a variable flow of fluid through opening **39**. Likewise, the member **36** may be adjusted to any desired intermediate position whereby upon raising of movable member **30**, the skirt **41** thereof will maintain only a portion of the opening **39** covered. In this manner, by properly adjusting the cylindrical member **36**, the amount of fluid which will flow through the opening **39** thereof for the various vertical positions of member **30** may be adjusted as desired. Stud shaft **37** is provided with screw threads **43** which receive a nut **44** by means of which the cylindrical member **36** may be secured in any desired position of adjustment and preferably a cap **45** cooperates with threads formed on nut **38** to prevent the passage of fluid from within the casing **10** to the atmosphere through the hole in the nut **38** which receives the stud **37**. The end of stud **37** is preferably slotted as indicated at **46** to facilitate adjusting of cylindrical member **36**.

By means of this arrangement, when valve stem **23** is initially elevated, the valve disc **28** uncovers the valve opening in partition wall **13** and upon continued elevation of valve stem **23**, a variable amount of fluid flow through the valve casing **10** is permitted, the amount of fluid flow depending upon the adjustment of cylindrical member **36**.

Referring particularly now to Figs. 1 and 3, the base plate **19** supports a pair of side plates **50** and **51** which extend upwardly from the base plate **19** and support an upper horizontal frame plate **52**. A pair of spaced brackets **54** are secured to the upper surface of frame plate **52** and extend upwardly therefrom. These brackets **54** journal a stud shaft **55** upon which is mounted a pair of links **56** that extend across the frame plate **52**. The opposite ends of links **56** are secured together by a pin **57** which extends outwardly to receive one end of a link **58**, the other end of link **58** being connected to the upper end of valve stem **23** by means of a nut **59**. The pin **57** also journals a roller **60** which is located between the pair of links **56**. A vertically movable actuating rod **61** is located between plates **50** and **51** and is provided with a reduced portion **62** whereby a shoulder **63** is formed against which one end of a coiled spring **64** abuts, the other end of coiled spring **64** abutting the under surface of frame plate **52** whereby the actuating rod **61** is normally biased to move downwardly. In the device as built, the rod **61** extends downwardly into engagement with the base plate **19** whereby the amount of downward movement of rod **61** under the bias of spring **64** is limited so that the extreme lowermost position of the rod **61** corresponds with the position shown in Fig. 3 of the drawings. The reduced portion **62** of rod **61** extends through frame plate **52** and a guiding collar **65** secured thereto, extends upwardly between links **56**, and terminates thereabove in a threaded portion **66** which receives a threaded washer **67** and a locking nut **68**. A combination tripping member and spring retainer **69** is adjustably secured to the reduced portion **62** of actuating rod **61** at a point slightly above collar **65** and considerably below the links **56**. The lower end of a coiled spring **70** rests upon spring retainer **69** and the upper end thereof holds projections **71** of a collar **72**, which is slidably received on reduced portion 62 of actuating rod 61, just below suitable notches 73 formed in links 56.

From the construction so far described, it will be apparent that upon upward movement of actuating rod 61, the links 56 will be rotated in a counter-clockwise direction as viewed in Fig. 3 about the stud 55 whereupon the pin 57 will raise valve stem 23 by means of connecting link 58 whereby to lift valve disc 28 to uncover the valve opening in partition wall 13 so that the valve disc 28 and movable member 30, in the absence of the mechanism which is to be described hereinafter, will be raised and lowered in exact accordance with the upward and downward movements of actuating rod 61.

The frame plate 52 supports a second pair of brackets 75 which extend upwardly therefrom. A shaft 76 extends through an insulating panel 77 secured to plate 52 and is journaled in the lower portions of brackets 75. A combined locking and tripping member 78 located between brackets 75 is secured to shaft 76. This locking and tripping member 78 comprises a bell-crank, one arm of which is formed into a hook 79 which is adapted to engage the upper surface of roller 60 and restrains upward movement of the links 56. The other arm of the locking and tripping member 78 is provided with a surface 80 which is in the path of upward movement of spring retainer 69 and the end of this arm is formed with a concave surface 81 for a purpose which will appear hereinafter. A spring 82 which is coiled about shaft 76 has one of its ends engaging one of the brackets 75 and its other end engaging the latching and tripping member 78 to normally bias the same to the position shown in Fig. 3 of the drawings wherein the hook 79 is engaged with the roller 60.

Near the upper ends of bracket 75 is journaled a stud shaft 84 on which is pivotally mounted a second latching and tripping member 85 which takes the form of a bell-crank having one of its arms formed in a hook 86 which is adapted, under certain conditions to be hereinafter set forth in detail, to engage the lower surface of roller 60 and prevent clockwise rotation of links 56. The other arm of the bell-crank which comprises the latching and tripping member 85 comprises a trip 87 which extends beneath the washer 67 and lies in the path of downward movement thereof. A coiled spring 88 is coiled upon a reduced portion of stud shaft 84 and has one of its ends bent around one of the brackets 75 and its other end bent around the tripping arm 87 of latching and tripping member 85 whereby this latching and tripping member is normally biased to assume a position wherein its hook 86 engages the under surface of roller 60.

An insulating panel 77 supports a pair of flexible switch arms 90 and 91, the switch arm 90 carrying a contact 92 upon its upper surface and the switch arm 91 carrying a contact 93 upon its lower surface. Contact 92 is normally biased into engagement with a contact 94 which is carried by a bracket 95 secured to insulating panel 77 and in a similar manner, contact 93 is normally biased into engagement with a contact 96 carried by a bracket 97 secured to insulating panel 77. The pin 57 has an extended end which lies between flexible switch arms 90 and 91 and when the links 56 are in valve closing position as shown in Fig. 3 of the drawings, this extended end of pin 57 engages switch arm 90 to move contact 92 from engagement with contact 94. As links 56 are rotated in a counterclockwise direction, the extended end of pin 57 first allows switch arm 90 to move upwardly under its bias whereupon contact 92 engages contact 94. Upon continued rotation of links 56 in a counter-clockwise direction, the extended end of pin 57 moves away from switch arm 90 and when the links 56 have rotated to a position corresponding to a full opening of the valve, the extended end of pin 57 engages switch arm 91 and raises the same to move contact 93 from engagement with contact 96. The switches 92—94 and 93—96 comprise limit switches as will become evident hereinafter.

The insulating panel 77 also supports a second switching mechanism which comprises a switch arm 100 that carries a contact 101 which normally engages a contact 102 carried by a bracket 103 secured to panel 77. This switching mechanism also includes a flexible switch arm 104 which carries a contact 105 that is normally biased to disengage a contact 106 carried by a flexible switch arm 107. Associated with the switch arm 100 and engaging the underside thereof is a strip of insulating material 108. The switch arm 100 is provided with an actuating pin 109. Similarly, a strip of insulating material 110 is associated with switch arm 107 and engages the underside thereof. The shaft 76 is provided with an actuating stud 111 which, upon proper manipulation of shaft 76, engages insulating strip 108 and raises switch arm 100 to move contact 101 from engagement with its cooperating contact 102. Such upward movement of switch arm 100 causes its actuating pin 109 to press upwardly upon insulating strip 110 whereupon switch arm 107 is raised to move its contact 106 into engagement with the contact 105 carried by switch arm 104.

Now with the parts shown in Fig. 3, as actuating rod 61 is moved upwardly, links 56 are restrained from counterclockwise rotation by reason of engagement of hook 79 with the upper surface of roller 60. The compression spring 70 is thereby compressed and the spring retainer 69 bears against the surface 80 of latching and tripping member 78. As actuating rod 61 continues its upward movement, the hook 79 gradually moves from engagement with roller 60 and after actuating rod 61 has moved upwardly a sufficient amount, the compression spring 70 will rotate links 56 in a counterclockwise direction with a snap movement because the same have been released for such movement by hook 79 passing off the roller 60. At this time, the coiled spring 88 swings latching and tripping member 85 about stud shaft 84 in a clockwise direction to bring hook 86 underneath roller 60. This movement of links 56 has carried the end of extended pin 57 from engagement with switch arm 90, whereupon contact 92 engages contact 94. It will therefore be seen that the valve remains closed during initial upward movement of actuating rod 61 and when this rod has moved upwardly a predetermined amount, the valve is snapped open to an intermediate position, corresponding to the amount of upward movement of actuating rod 61. The position of rod 61 at which hook 79 will disengage roller 60 may be varied by changing the position of spring retainer 69 upon the reduced portion 62 of rod 61. The valve now having been opened, it will thereafter be moved strictly in accordance with the movements of actuating rod 61 and if the actuating rod 61 moves upwardly sufficiently far to move the valve to full open position, then the extended end of pin 57 will engage switch arm 91 to disengage contact 93 from contact 96. When the actuating rod 61 during downward movement has reached such a position that the valve is placed in a position wherein the desired minimum flow of fluid is permitted, projection 71 will have moved out of notches 73 and the washer 67 will have engaged trip 87 to begin moving hook 86 from beneath roller 60. Upon further slight downwardly movement of actuating rod 61, the hook 86 will be moved from beneath roller 60 sufficiently to allow coiled spring 34 to rotate links 56 in a clockwise direction with sufficient force to snap the valve closed and, at this instant, the coiled spring 82 will rotate latching and tripping member 78 to the position shown in Fig. 3 wherein its hook 79 again engages the upper portion of roller 60. The valve is thereby again latched in closed position and can only be reopened after actuating rod 61 has again been raised to a position wherein hook 79 disengages roller 60. The minimum flow position at which the valve is snapped closed by disengagement of hook 86 from roller 60 may be adjusted by adjusting washer 67 and locking nut 68 in respect to the end 66 of actuating rod 61.

The lower end of actuating rod 61 is provided with teeth 115 which mesh with a pinion 116 secured to a main operating shaft 117 that is journalled in plates 50 and 51. The main operating shaft 117 carries a balancing contact finger 118 which engages a resistance 119 and sweeps thereacross upon rotation of main operating shaft 117 in a direction to raise actuating rod 61. Main operating shaft 117 also carries a gear 120 which is located between side plates 50 and 51 and meshes with a pinion 121. Pinion 121 is secured to a gear 122 which is secured to a shaft 123 journalled in side plates 50 and 51. Gear 122 meshes with a pinion 124 which is formed integral with a sleeve 125 loosely journaled upon a shaft 126 mounted in side plates 50 and 51. Loosely mounted on sleeve 125 is a pinion 127 to which is secured a locking disc 128 that is provided with a plurality of notches 129. Pinion 127 meshes with a pair of pinions 130 which are mounted on stud shafts 131 carried by a gear 132 near the periphery thereof. Secured to the extended hubs of pinions 130 are a pair of similar pinions 133 but the pinions 133 are provided with a slightly smaller number of teeth than the pinions 130, the pinions 130 preferably having one more tooth than the pinions 133. The pinions 133 both mesh with a pinion 134 which is secured to the sleeve 125 whereby pinions 124 and 134 are connected together and rotate in unison. The pinion 127 has the same number of teeth as the pinions 133 and the pinion 134 has the same number of teeth as the pinion 130 so that in the example herein described, the pinion 134 has one more tooth than the pinion 127. The gear 132 meshes with a pinion 135 which is secured to a shaft 136 journaled in side plates 50 and 51. Secured to the shaft 136 is a gear 137 which meshes with a motor pinion 138 carried by the rotor shaft 139 of a motor 140 which has a rotor 141 and a field winding 142. Similarly, a gear 143 which is secured to shaft 136 meshes with a motor pinion 144 which is secured to the rotor shaft 145 of a motor 146 having a rotor 147 and a field winding 148.

A magnet 150, mounted upon base plate 19, is provided with a field winding 151 and a pivoted armature 152. Pivoted to the armature 152 is a latching member 153 which is adapted to enter any one of the notches 129 in disc 128 to prevent rotation of the same when the field winding 151 of magnet 150 is energized. A spring 154 is preferably interposed between armature 152 and latch 153 whereby the same are resiliently connected.

Referring now to Fig. 4 of the drawings, the system is shown as being controlled by a movable member 160 which is adapted to sweep across a resistance 161. The movable member 160 is herein shown as controlled by a bimetallic element 162 which preferably responds to the temperature of the space being heated as the result of a flow of fluid through valve casing 10 but it is to be expressly understood that the movable member 160 may be controlled in accordance with any condition other than temperature or in any other desired manner. Associated with resistances 119 and 161 is a pair of solenoid coils 163 and 164 which are connected in series, their junction being indicated at 165. The solenoid coils 163 and 164 conjointly control the position of a plunger 166 which is connected to a flexible switch arm 167 through a rod 168 and a light coiled spring 169. Switch arm 167 carries contacts 170 and 171 which are adapted to cooperate with relatively stationary contacts 172 and 173.

If the valve of the instant invention is used in connection with a heating or similar device, it is preferred to utilize a limit control of well-known construction indicated at 174 which opens the circuit when some condition of the heating system becomes excessive. Low voltage electrical power is supplied by the low voltage secondary 175 of a step-down transformer 176, having a high voltage primary 177 suitably connected to the usual line wires. The relay winding 151 is connected across the secondary 175 through the limit control 174 by means of wires 178, 179, and 180 whereby the relay winding 151 is normally constantly energized. Similarly, the solenoid coils 163 and 164 are connected in series across transformer secondary 175 through limit control 174 by wires 178, 179, 181, 182, 183, 184 and 180. Resistances 119 and 161 are connected in parallel with the series connected solenoid windings 163 and 164 through protective resistances 185 and 186 and through the switch 101—102 by wires 202, 187, 188 and 189. Balancing contact finger 118, movable member 160, and the junction 165 of solenoid coils 163 and 164 are interconnected by wires 190, 191 and 192. Contact 173 is connected to a small number of turns of solenoid coil 163 by a wire 193 and contact 172 is connected to a small number of turns of solenoid coil 164 by a wire 194. Switch arm 167 is connected to switch arms 90 and 91 by means of a wire 195. One end of field winding 142 is connected to contact 96 and the other end thereof is connected to one side of secondary 175 by wires 198, 184 and 180. One end of field winding 148 is connected to the other side of secondary 175 through limit switch 174 by wires 199, 181, 179 and 178. The switch 105—106, which is normally opened, is connected to shunt the limit control 174 by means of wires 200 and 201.

Operation

With the parts in the position shown in the various figures of the drawings, the temperature of the space to be heated is at or above that desired as indicated by movable member 160 being in engagement with the extreme right hand end of resistance 161. The valve is closed and balancing contact finger 118 is in engagement with the extreme left hand end of balancing resistance 119 so that solenoid coils 163 and 164 are equally energized. Plunger 166 is therefore in a central position wherein contacts 170 and 171 are disengaged from their respective cooperating contacts 172 and 173. Limit switch 92—94 is open and both field windings 142 and 148 are deenergized. The limit control 174 is closed and electrical power is available as indicated by the attraction of armature 152 whereby the latch 153 is positioned in one of the notches 129. As the result, disc 128 and the attached pinion 127 are prevented from rotating.

Since no heat is being supplied to the space to be heated, it is evident that the temperature thereof will soon begin to fall and this fall in temperature will be accompanied by a slow movement of movable member 160 along resistance 161 towards the left hand end thereof. A very small movement of movable member 160 in this direction rearranges the effective resistances connected in circuit with solenoid coils 163 and 164 in such a manner that solenoid coil 164 will become more highly energized than solenoid coil 163. Plunger 166 will therefore move to the right and bring contact 170 into engagement with contact 172 whereby an energizing circuit for field winding 142 is established as follows: secondary 175, wire 178, limit control 174, wire 179, wire 181, wire 182, a small number of turns of solenoid coil 164, wire 194, contact 172, contact 170, switch arm 167, wire 195, switch arm 91, contact 93, contact 96, field winding 142, wire 198, wire 184, and wire 180 to the other side of secondary 175. The current flow through the small number of turns of solenoid coil 164 brings contact 170 more firmly into engagement with contact 172. Energization of field winding 142 causes rotor 141 to rotate in a clockwise direction as viewed from the left in Fig. 3 so that the gear 132 is likewise rotated in a clockwise direction. The studs 131 are therefore rotated about shaft 126 in a clockwise direction and carry the pinions 130 and 133 with them in the same direction. Inasmuch as pinion 127 is held stationary and because the pinions 133 have a lesser number of teeth than the pinions 130, the pinions 134 and 124 will slowly rotate in a clockwise direction. Gear 122 is therefore driven in a counter-clockwise direction and gear 120, pinion 116 and main operating shaft 117 in a clockwise direction whereupon actuating rod 61 is raised slowly and balancing contact finger 118 slowly moves along balancing resistance 119 toward the right hand end thereof as viewed in Fig. 4. As balancing contact finger 118 moves along balancing resistance 119, the effective resistance connected in circuit with solenoid coils 163 and 164 will be slowly changed until the current flow through solenoid coil 163 is so proportioned in respect to the current flow through solenoid coil 164 and the small number of turns thereof that plunger 166 will be returned to its central position to separate contacts 170 and 172 and deenergize field winding 142. This small upward movement of actuating rod 161 compresses coiled spring 70 slightly inasmuch as links 56 are held stationary by engagement of hook 79 with roller 60.

In this manner, as the space temperature falls, the movable member 160 slowly moves along resistance 161 towards the left end thereof and actuating rod 61 will be slowly raised in small increments. When the space temperature has dropped to a point demanding a flow of fuel which beforehand has been predetermined as being sufficient to properly support combustion, hook 79 will be tripped from roller 60 as heretofore explained and the valve will snap open to a position allowing a flow of fuel corresponding to the demand of the space thermostat. At this time, the extended end of pin 57 moves from engagement with switch arm 90 and allows contact 92 to move into engagement with contact 94. If contacts 170 and 172 are still closed, or the next time they are closed as the result of further fall in space temperature, it will be noted that the small number of turns of solenoid coil 164 will be connected in parallel with field winding 148 and the full flow of current through these parallel circuits will traverse field winding 142. In this manner, after closing of limit switch 92—94, field winding 142 will be more highly energized than field winding 148 whenever contacts 170 and 172 are closed. The torque exerted by rotor 141 is therefore greater than the torque exerted by rotor 147 and the actuating rod 61 will be raised. Whenever contact 170 separates from contact 172, the field windings 142 and 148 will be connected in series across transformer secondary 175 and through limit control 174 by a circuit as follows: secondary 175, wire 178, limit control 174, wire 179, wire 181, wire 199, field winding 148, contact 94, contact 92, switch arm 90, switch arm 91, contact 93, contact 96, field winding 142, wire 198, wire 184, and wire 180 to the other side of secondary 175 so that the torques produced by rotors 141 and 147 are equal and actuating rod 61 remains stationary, it being noted that the drives through the planetary gearing comprised by gear 132 and the associated pinions is an irreversible drive.

If there is a further drop in the space temperature accompanied by movement of movable member 160 along resistance 161 towards the left end thereof, rod 61 will be moved upwardly a corresponding amount and the valve will be more widely opened. If the space temperature should drop to such a point as to demand a full flow of fuel so that the valve is opened to its wide open position, then the extended end of pin 57 will engage switch arm 91 to separate contacts 93 and 96. When this happens, the series circuit through field windings 142 and 148 is broken and all circuits for field winding 142 are broken so that field winding 142 cannot be energized when the valve is in wide open position.

Whenever the space temperature rises, the reverse action takes place. In other words, movable member 160 slowly moves along resistance 161 towards the right hand end thereof and such movement changes the effective resistance connected in circuit with solenoid coils 163 and 164 to unbalance the current flows therethrough, but in this instance, the current flow through solenoid coil 163 becomes greater than the current flow through solenoid coil 164. Plunger 166 therefore moves to the left to bring contact 171 into engagement with contact 173. If, at this time, limit switch 93—96 is open, a circuit through field winding 148 will be established as follows: secondary 175, wire 178, limit control 174, wire 179, wire 181, wire 199, field winding 148, contact 94, contact 92, switch arm 90, wire 195, switch arm 167, contact 171, contact 173, wire 193, a small number of turns of solenoid coil 163, wire 183, wire 184, and wire 180 to the other side of secondary 175. If the valve is not in its full open position so that limit switch 93—96 is closed, the field winding 142 will be in parallel with the small number of turns of solenoid coil 163 with the result that field winding 148 will be more highly energized than field winding 142. In either event, rotor 147 will turn in a counter-clockwise direction as viewed from the left in Fig. 3 so that gear 132 is likewise rotated in a counter-clockwise direction and actuating rod 61 is moved downwardly at a slow speed. Balancing contact finger 118 is therefore slowly moved along balancing resistance 119 towards the left end thereof. As heretofore explained, the current flow through the small number of turns of solenoid coil 163 will exert an additional pull on plunger 166 so as to hold contact 171 in firm engagement with contact 173.

Movement of balancing contact finger 118 along balancing resistance 119 toward the left end thereof will again change the effective resistances connected in circuit with solenoid coils 163 and 164 to return the plunger 166 to its central position after actuating rod 61 has been moved downwardly sufficiently to position the valve in accordance with the new demand for heat. When plunger 166 returns to its central position, contact 171 will separate from contact 173 so that field windings 142 and 148 will be placed in series across secondary 175 so that they are equally energized and further rotation of rotor 147 ceases.

The valve will now be opened and closed in small increments in accordance with fluctuations in the space temperature and this action will continue until such time as the demand for heat bcomes so low as to cause the valve to be positioned to deliver such a small flow of fuel that there is danger of a pop-back or of the fires going out at which time trip 87 will be engaged by washer 67 to trip hook 86 from beneath roller 60 and the valve will snap shut, the mechanical parts returning to the position shown in the drawings.

From the foregoing description, it will be observed that the mechanism of the present invention provides means whereby a single valve is snapped open to a minimum flow position required for proper ignition upon an initial demand for heat and is thereafter modulated or positioned in small steps in accordance with changes in the demand until the demand becomes so low as to require such a small flow of fuel that there is danger of a pop-back, the fires going out, etc., whereupon the valve automatically snaps closed and cannot again be reopened until there is a demand which corresponds to the minimum initial flow which has been determined as necessary for proper ignition.

In the event that the supply of electrical power should fail while the valve is in any of its open positions, relay winding 151 will be deenergized whereupon armature 152 is no longer attracted to hold latch 153 in one of the notches 129. Disc 128 and associated pinion 127 will be thereupon freed for rotation. This allows the planetary gear mechanism to rotate freely and the combined actions of coiled springs 64 and 34 return the mechanical parts to the position shown in the drawings wherein the valve is latched closed. This same action will occur in the event that some condition in the heating system to which the limit control 174 responds becomes excessive so as to open limit control 174.

It is often desirable to open the valve and latch it open by manual operation in the event the same closes by reason of a failure in electrical power. Referring to Fig. 1, it will be noted that base plate 119 supports a bracket 205 on which is pivoted a lever 206, the inner end of which embraces valve stem 23. The valve may be opened by depressing the outer extended end of lever 206 and may then be latched open by rotating shaft 76 in a clockwise direction as viewed in Fig. 3 so as to move hook 79 from the path of roller 60 and bring concave surface 81 of the latching and tripping mechanism 78 underneath roller 60. Such operation of shaft 76 causes actuating stud 111 to engage insulating strip 108, as heretofore explained, thereby separating contact 101 from contact 102 and moving contact 106 into engagement with contact 105. Separation of contacts 101 and 102 disconnects the right hand ends of resistances 119 and 161 from the right hand end of solenoid coil 164 and closure of contacts 105 and 106 shunts limit control 174. Therefore, upon the resumption of power and irrespective of the condition of limit control 174, a circuit will be completed through solenoid coil 164, the circuit thereafter branching and parts of it going through solenoid 163, resistance 161, and resistance 119 to the other side of secondary 175. The plunger 166 therefore moves to the right and brings contact 170 into engagement with contact 172 to energize field winding 142 as heretofore explained, whereupon the valve will be more widely opened, lifting roller 60 from the concave surface 81 and allowing coiled spring 82 to return the latching and tripping arm 78 to move from latching engagement and in so doing rotate shaft 76 at least sufficiently to allow contacts 101 and 102 to reclose and contacts 104 and 106 to reopen, whereupon the system is returned to automatic control.

It will therefore be additionally noted that the present invention provides for the positioning of an instrumentality such as a valve by oppositely acting motor means, the valve remaining in the position to which it has been moved whenever the motor means are equally energized (or both deenergized) together with means whereby the instrumentality returns to some desired position upon the occurrence of a failure of electrical power and in addition, means are provided whereby the instrumentality may be manually placed in some desired position and upon the resumption of power, the instrumentality will again be automatically placed under automatic control.

While a specific embodiment of the invention has been herein described, it is evident that those skilled in the art can make many changes therein without departing from the invention and I am therefore only to be limited according to the scope of the appended claims.

I claim as my invention:

1. In combination, a flow controlling element, a control member movable back and forth along a predetermined path of travel, reversible motor means, circuits for operatively energizing said motor means, switching mechanism in control of said circuits, connections between said member and switching means for controlling said switching means, an instrumentality to be controlled, connections between said motor means, switching means and instrumentality, electrical means constantly connected to a source of electrical power for releasing said instrumentality for return to a given position independently of said motor means upon a failure in electrical power, a manual operator for moving said instrumentality to some other position independently of said motor means and latching it therein, and switching means for returning said instrumentality to the control of said motor means upon the resumption of power.

2. In combination, a flow controlling element, reversible electric motor means in control thereof,

electrical means constantly connected to a source of electrical power for allowing said element to move to a predetermined position independently of said motor means upon an interruption in the supply of electrical power, a manual operator for moving said element to another predetermined position independent of said motor means, and manually operable switching means associated with said motor means for returning said element to the control of said motor means upon the resumption of power.

3. In combination, a single fluid flow controlling element, a member movable back and forth along a predetermined path of travel in response to changes in fluid flow demand, an electrical control system associated with said movable member and fluid flow controlling element for normally gradually moving the latter from closed to open position as the movable member moves from one of its extreme positions to the other of its extreme positions, and means associated with said electrical control system for maintaining said fluid flow controlling element in its closed position until said movable member reaches an intermediate point in its path of travel during movement in opening direction at which time said element is quickly moved to an open position corresponding to the position of the movable member and for moving said fluid flow controlling element to closed position when said movable member reaches a second position during movement in closing direction, said second position lying between said first position and the extreme position corresponding to closure of said fluid flow controlling element.

4. In combination, a single valve biased to closed position, a movable member, electrical means for moving the same to a plurality of open positions in response to the movements of the movable member, said means allowing said valve to move to closed position upon the occurrence of a failure in electrical power, and means for manually moving said valve to an open position and for returning said valve to the control of said electrical means upon the resumption of power irrespective of the position of said movable member.

5. In combination, a valve biased to closed position, a member movable through a predetermined range in response to changes in flow demand, means including an electrical operator for quickly moving said valve from closed position to an intermediate open position only after said movable member has moved to a position requiring a substantial fluid flow and for thereafter opening the valve in small increments as the movable member continues its movement in the same direction, said means allowing the valve to move to closed position upon the occurrence of a power failure, and means for manually latching said valve in an open position during a power failure and for returning the same to the control of said movable member upon the return of power irrespective of the position of said movable member when power returns.

6. In a fluid flow regulating system, a main shut off valve, throttling means operatively supported and controlled by said shut off valve for graduating said fluid flow supply, actuating means for actuating said shut off valve, and control means for said actuating means, said control means comprising an element variably positioned in accordance with the fluid demand and being operative upon continuous movement of said element from one of its extreme positions to cause said actuating means first to move quickly said valve to a predetermined partially open position wherein a minimum amount of fluid flow is permitted and then to move said valve and consequently said throttling means to a position in which said throttling means is effective to permit a flow substantially corresponding to the position of said element, and means for adjusting the minimum amount of flow permitted when said valve is in its predetermined partially open position without varying said partially open position.

7. In a fluid flow regulating system, a main shut off valve, throttling means operatively supported and controlled by said shut off valve for graduating the fluid flow supply, a valve casing housing said main shut off valve and said throttling means, actuating means for actuating said shut off valve, said actuating means being located on said valve casing, and control means for said actuating means, said control means comprising an element variably positioned in accordance with the fluid demand and being operative upon continuous movement of said element from one of its extreme positions to cause said actuating means first to move quickly said valve to a predetermined partially open position wherein a minimum amount of fluid flow is permitted and then to move said valve and consequently said throttling means to a position in which said throttling means is effective to permit a flow substantially corresponding to the position of said element, and manually operable means in said valve casing for adjusting the minimum amount of flow permitted when said valve is in its predetermined partially open position without varying said partially open position.

8. In combination, a fluid flow controlling element, a reversible power operated motor for actuating said fluid flow controlling element, a power flow controlling member movable back and forth along a predetermined path of travel in response to changes in fluid flow demand, said member being located at a substantial distance from said motor, a control system for said fluid flow controlling element employing said power flow controlling member as a means for controlling said system and said power operated motor as the actuating means for the system, said control system being effective upon movement of said power flow controlling member from one of its extreme positions in one direction to cause said fluid flow controlling element to remain in closed position until said power controlling member reaches a first intermediate position in its path of travel, then to move quickly to an intermediate partially open position, and thereafter to move gradually to a position corresponding to the position of the controlling member, and said system being effective upon movement of said power flow controlling member in the opposite direction to cause said fluid flow controlling element to move gradually towards closed position in accordance with the position of said controlling member until said fluid flow controlling element reaches a predetermined partially closed position and to thereafter move quickly to full closed position, said partially closed position lying between said partially open position and full closed position.

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