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J. H. THORNBERRY ET AL

2,849,663

ELECTROMAGNETIC CONTROL WITH MAGNETIC SHUNT SAFETY MEANS

Filed Jan. 21, 1953

3 Sheets-Sheet 1

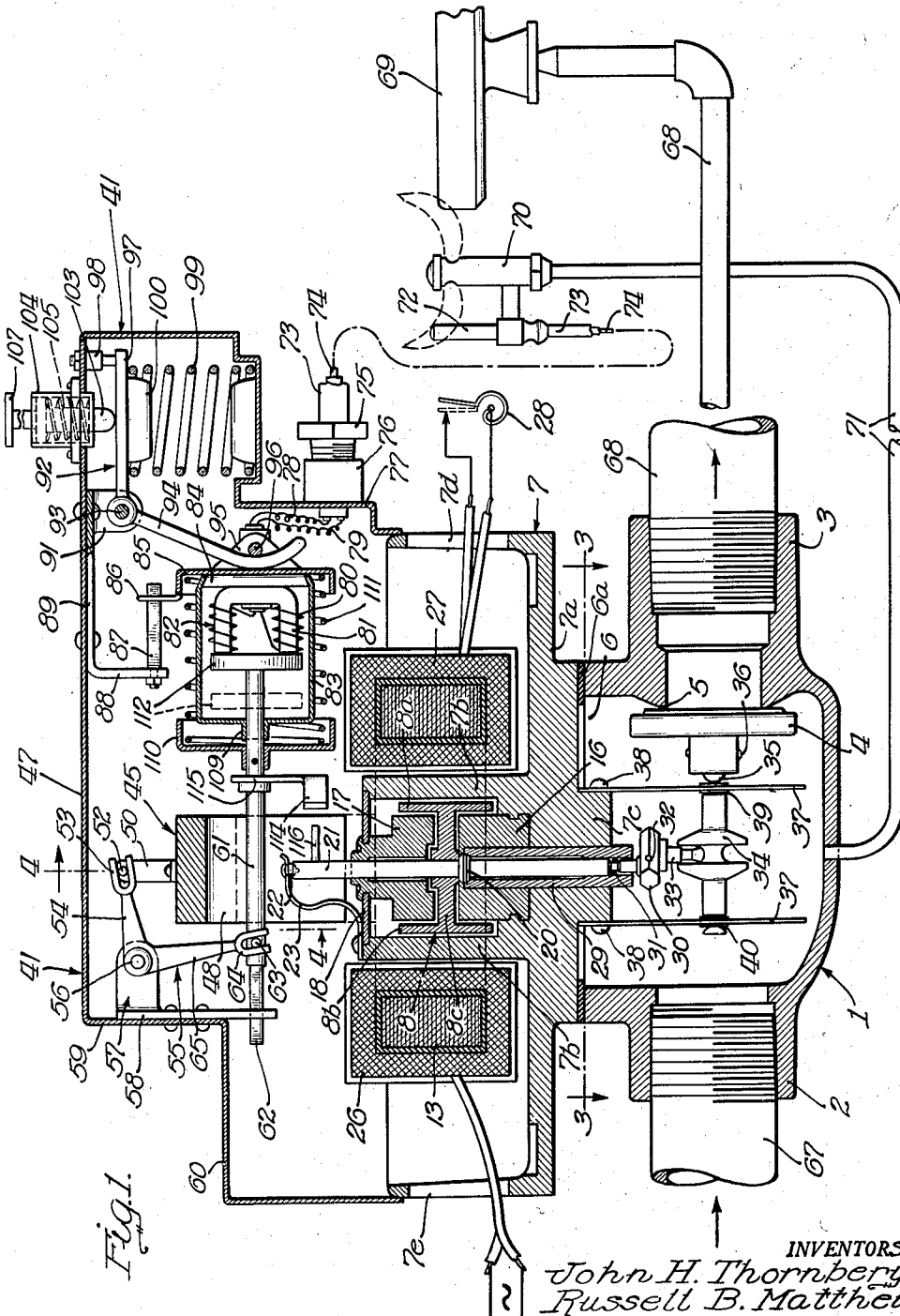


Fig. 1.

INVENTORS:

John H. Thornberry
Russell B. Matthews

By: *Chas. J. Jensen, Attorney*

Attys.

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Fig. 2.

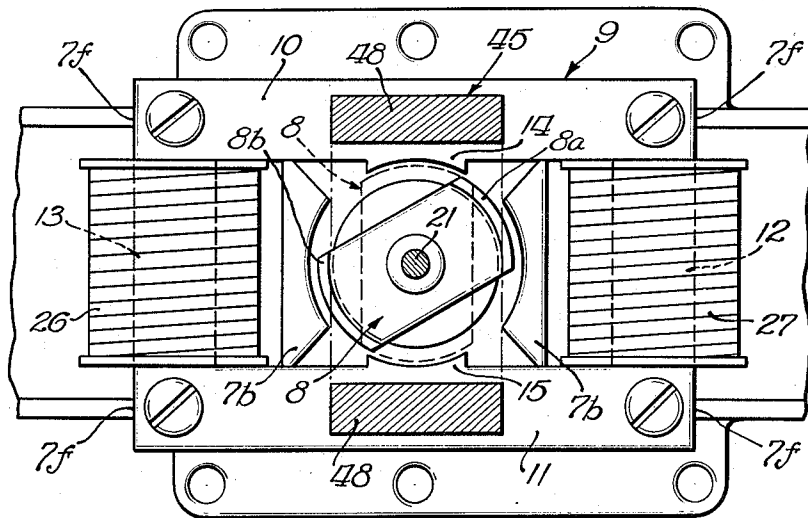
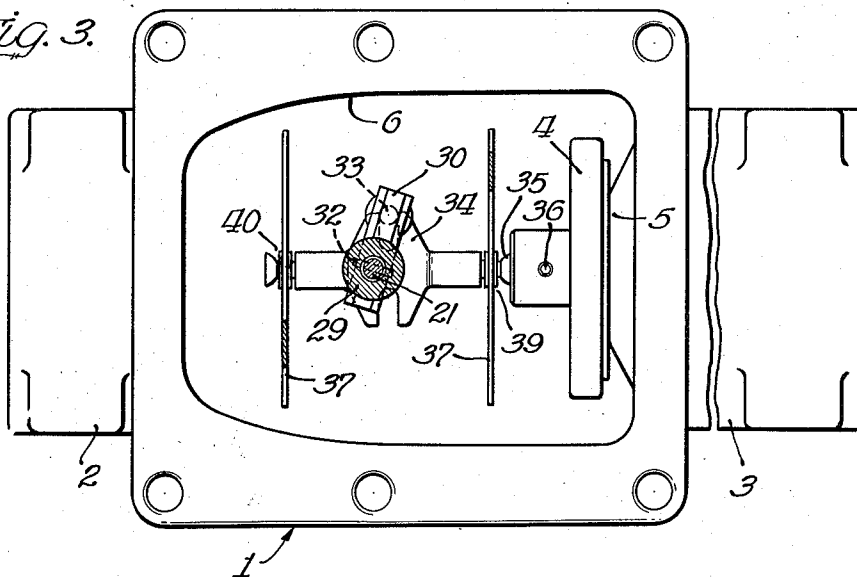


Fig. 3.



INVENTORS:

John H. Thornberry
Russell B. Matthews

By: *Oliver Jackson, Butler & Searles*
Attys.

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3 Sheets-Sheet 3

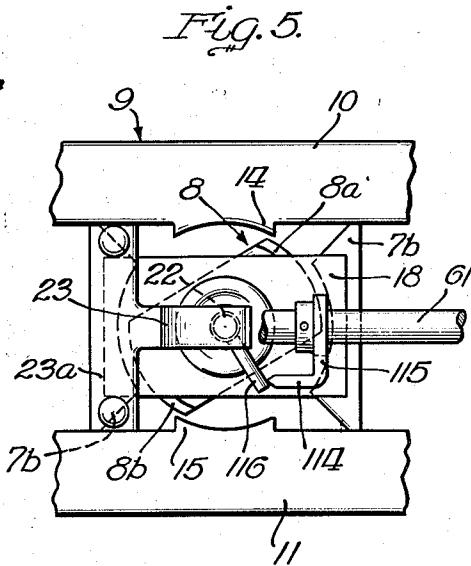
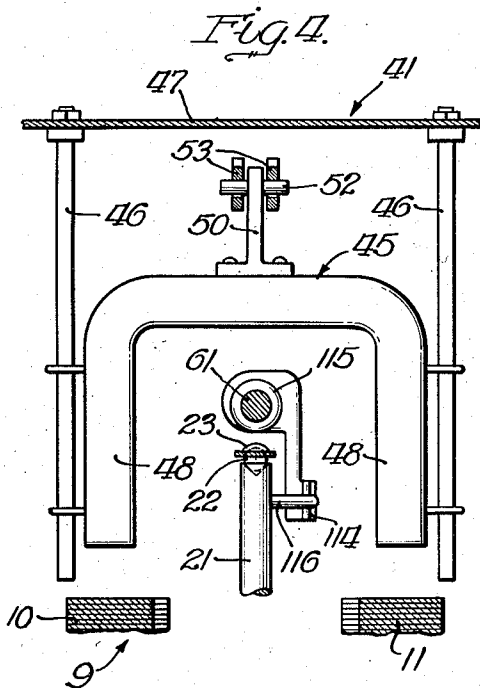


Fig. 6.

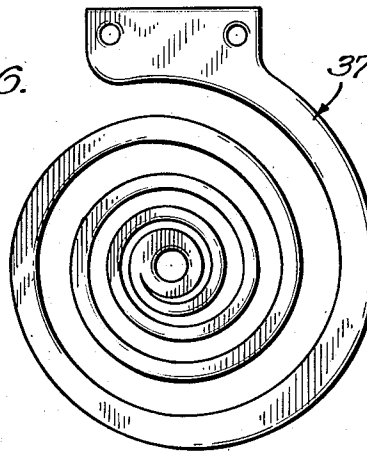
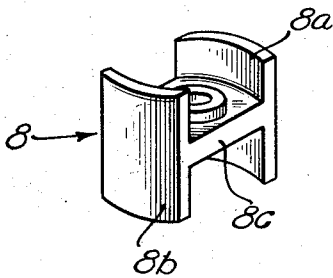


Fig. 7.



INVENTORS:

John H. Thornberry
Russell B. Matthews

By: *Brown, Jelen, Butcher & Sienko*
Attys.

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2,849,663

ELECTROMAGNETIC CONTROL WITH MAGNETIC SHUNT SAFETY MEANS

John H. Thornbery, Whitefish Bay, and Russell B. Matthews, Wauwatosa, Wis., assignors to Baso Inc., a corporation of Wisconsin

Application January 21, 1953, Serial No. 332,464

10 Claims. (Cl. 317-197)

This invention relates to control devices, and has to do with electromagnetic operators for valves controlling flow of fuel to burners and provided with means for automatically shutting off flow of fuel in the event of extinguishment of the burners.

In the copending application of Floyd J. Bydalek and Russell B. Matthews, Serial No. 270,666, filed February 8, 1952, there is disclosed an electromagnetic control device in which a control valve is operated by electromagnetic means effective for opening and closing the valve responsive to requirements or variations in conditions to be controlled, for example, variations in temperature in a space to be heated. The control valve is actuated by a rotor turnable in an air gap of electromagnetic means the effective strength of the magnetic field of which is varied responsive to variations in the conditions to be controlled and, in conjunction with means yieldingly urging the valve toward one position in opposition to the magnetic field, is effective for opening and closing the control valve.

The present invention is in the nature of an improvement in the electromagnetic control means of the above identified copending application. It is directed to the provision of safety means effective for interrupting flow of fuel to a main burner in the event of extinguishment of an associated pilot burner and whether or not the conditions to be controlled are then calling for supply of fuel to the main burner, such means also assuring that flow of fuel to the main burner will remain cut off during resetting of the safety means. To that end, we provide means whereby the electromagnetic operator means is rendered ineffective when the pilot burner is extinguished. The safety means comprises a magnetic shunt for the electromagnetic operator means, held in an ineffective position so long as the pilot burner is lit and moved to effective position responsive to extinguishment of the pilot burner. More particularly, we provide a bridging member of high magnetic permeability held out of cooperative relation to the core of the electromagnetic operator means when the pilot burner is lit, and moved into cooperative bridging relation to the core of the electromagnetic operator means responsive to extinguishment of the pilot burner, effective for shunting around the air gap of the latter means a substantial portion of the magnetic flux thereof and thereby rendering the electromagnetic operator means ineffective for opening the control valve. The means for holding the bridging member in inoperative or ineffective position comprise electromagnetic means energized by thermoelectric generator means heated by the pilot burner, extinguishment of the latter causing deenergization of the electromagnetic means and movement of the bridging member to its operative or effective position. A further and important object of our invention is the provision of safety means of the character above stated which, when the pilot burner is lit, in no way interferes with the intended operation of the electromagnetic control device of the above identified copending application and may read-

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ily be incorporated therein without necessity for any substantial change in such device. Further objects and advantages of our invention will appear from the detail description.

In the drawings:

Figure 1 is an axial sectional view of an electromagnetic control device embodying the safety means of our invention;

Figure 2 is a plan view, on an enlarged scale, of the electromagnetic operator means of the device of Figure 1, with the cover and the parts carried thereby removed, certain parts being omitted for clearness of illustration and certain other parts being broken away;

Figure 3 is a sectional view, on an enlarged scale, taken substantially on line 3-3 of Figure 1, partly broken away;

Figure 4 is a fragmentary sectional view, on an enlarged scale, taken substantially on line 4-4 of Figure 1;

Figure 5 is a fragmentary plan view, on an enlarged scale, of the core and the rotor of the electromagnetic operator means and associated parts;

Figure 6 is a side view of one of the combined biasing spring and control valve supporting members; and

Figure 7 is a perspective view of the rotor of the device shown in Figure 1.

It will be helpful to describe first the electromagnetic operator and control means with which the safety shut-off means of our invention is combined. Such means comprises a valve body 1 having a fluid inlet 2 and a fluid outlet 3. A valve member 4 cooperates with a valve seat 5 at the outlet 3 to control the flow of fluid through the valve, for example, the flow of gaseous fuel to a burner hereinafter referred to. It will be noted that the controlled fluid tends to hold the valve member 4 closed. This may, of course, vary within the scope of the invention.

The valve body 1 has an opening 6 covered by an enclosure 7 for electromagnetic operating means hereinafter described, the bottom wall 7a of enclosure 7 affording a plate-like cover for opening 6 and being secured in place, for example, by screws (not shown), threaded into the valve body 1. Sealing means 6a is preferably interposed between the plate 7a and valve body 1 to render the connection gas-tight. The enclosure 7 is preferably a die casting of nonmagnetic material such as aluminum.

The upper side of base plate 7a is provided with a pair of integrally formed upstanding arms 7b of configuration best shown in Figure 2, forming a partial enclosure for a rotor or rotary armature 8 hereinafter described.

Mounted on base plate 7a is a power unit comprising a magnetic core 9 of laminated, or of any other suitable form. The particular core selected for illustration is of generally rectangular configuration, comprising a pair of parallel side legs 10 and 11 magnetically connected by parallel end legs 12 and 13.

The core is arranged in position with its legs surrounding arms 7b of base plate 7a which arms serve to locate the core laterally while abutments 7f (Figure 2) integrally formed in the base plate 7a serve to locate the core lengthwise thereon. The side legs 10 and 11 of the core 9 have spaced pole pieces 14 and 15 formed, for example, as integral parts of the core laminations, which pole pieces are of configuration best shown in Figure 2 and have arcuate inner edges defining with arms 7b of the base plate 7a a well in which the rotor 8 is adapted to turn.

As best illustrated in Figure 1, the core is completed by a split core comprising a first cylindrical core piece 16 located at the bottom of the aforementioned well and

attached to base plate 7a, and a second cylindrical core piece 17 suspended in said well from above, core piece 17 being supported therein by a plate 18 resting on suitable abutments formed at the upper ends of arms 7b and held in position by suitable means to be described later. The plate 18 is preferably non-magnetic and suitably insulated with lacquer, anodizing or other means, to reduce eddy currents.

The rotor 8 is of magnetic material, such as steel preferably fabricated by powder metallurgy techniques, and is of form best illustrated in Figure 7. In general, the rotor 8 is of H-shape in vertical section as shown in Figure 1 and comprises a pair of arcuately formed arms 8a and 8b joined by a connecting portion 8c midway between the ends of the arms. The connecting portion 8c is adapted to be positioned between the split core pieces 16 and 17 which provide bearing surfaces therefor as illustrated by the bearing 20 mounted on the shaft 21 which extends through and is non-rotatably connected to the rotor 8, and by the thrust bearing comprising a ball 22 and a bowed leaf spring 23 having a base 23a secured by screws 19 to arm 7b of base plate 7 and overlying plate 18 effective for holding it in position.

As shown in Figures 1 and 2, the core pieces 16 and 17 are radially spaced from the upstanding arms 7b and pole faces 14 and 15 a sufficient distance to afford clearance for the arms 8a and 8b of rotor 8 through 360° of rotation. The split core diminishes the amount of material necessary in the rotor 8 and hence decreases its inertia, while at the same time defining a relatively small air gap between the pole pieces of core 9 and the core pieces 16 and 17. As will be apparent, this air gap need be no greater than the clearance needed for the arms of rotor 8 at each of the pole faces 14 and 15.

The power unit further comprises a primary winding 26 adapted to be connected to a suitable source of electrical energy, and a secondary coil or winding 27, the circuit of which may include condition responsive means such as the thermostat illustrated schematically at 28 in Figure 1. It will be understood that when the primary winding 26 is energized, and the secondary circuit is open, the magnetic flux created in the core 9 will tend to flow around the core through the end leg 12 upon which the secondary winding is mounted, in preference to jumping the air gap between pole faces 14 and 15, whereas when the secondary circuit is closed, induced currents in the secondary winding 27 will divert the magnetic flux across the aforementioned air gap to cause movement of the rotor as will hereinafter be described.

As shown in Figure 1, the shaft 21 connected to rotor 8 extends downwardly through a sleeve 29 carried by core piece 16 and extending through base plate 7a, the lower end of shaft 21 being connected non-rotatably, but adjustably to one end of a crank member 30. A resilient or rubber-like O-shaped ring 31 is mounted in an annular groove near the lower end of shaft 21 and within sleeve 29 to provide a gastight seal therebetween.

As best shown in Figure 3, the crank member 30 is non-rotatably connected to the shaft 21 as by a pin 32 for transmission of any movement of rotor 8 to crank member 30. At the opposite end of the crank 30 is a downwardly extending pin 33 off center with respect to the axis of rotation of shaft 21. The pin 33 is adapted to engage a yoke 34 (Fig. 1) connected at one end as by a stem 35 and pin 36 to valve member 4.

The aforementioned yoke-valve member assembly is preferably suspended in the valve body 1 as by a pair of springs 37 attached as by screws 38 to a portion 7c of the base plate 7 extending downwardly through opening 6 of the valve body. The springs 37 serve both to support the valve member assembly in alignment with the valve seat 5 and to bias both the rotor 8 and valve member 4 as will hereinafter become apparent. When the base plate 7 carrying and enclosing the power unit aforementioned

is removed and/or replaced, the valve member assembly is removable therewith as a unit.

The springs 37, as best shown in Figure 6, are of flat spiral configuration in side elevation and conically helical in edge elevation when uncompressed but numerous other configurations are contemplated. That is to say, when the turns are in a plane as shown in Figure 1 they are under compression and imparting a sealing force to valve member 4 against its valve seat 5. Movement of the valve member 4 to open position against the bias of springs 37 further compresses the latter. In this regard while, as aforementioned, the ends of the outermost turns of the springs 37 are attached to base plate portions 7c as aforementioned, the innermost turn in each case is attached to the yoke assembly as at 39 and 40.

The enclosure 7 is further provided with openings 7d and 7e for electrical conduit connections for the windings of the power unit, while the open top thereof is preferably provided with a cover 41 of non-magnetic material and of suitable form.

The valve member 4 selected for illustration is, in general, of the type more fully disclosed in the copending application of Carl Wolff, Serial No. 194,505, filed November 7, 1950, but may, of course, be of other suitable form.

The mode of operation of the aforescribed device is as follows: Assuming the primary coil 26 to be energized, as it will be under ordinary circumstances, since the device inherently has a very low stand-by power loss, a magnetic flux will be created in the core 9 in a clockwise direction as viewed in Figure 2, the flux as aforementioned flowing through the leg 12 of core 9 so long as the circuit of secondary winding 27 remains open. The rotor 8 is angularly disposed on shaft 21 so that in unenergized condition the leading edges of the rotor or armature arms 8a and 8b are barely within the air gaps between the pole faces 14 and 15 and the core pieces 16 and 17; that is, a very small portion of the rotor 8 is presented to the pole faces 14 and 15 respectively as shown in full line in Figure 2. It is, of course, understood that the angular disposition of shaft 21 and hence rotor 8 when unenergized is determined by the bias afforded by the springs 37, also supporting and biasing the valve member 4. In the embodiment illustrated in Figure 1, the seating of valve member 4 against the valve seat 5 under the bias of springs 37 limits the rotation of rotor 8 and provides a stop therefor in its unenergized state.

When the circuit of secondary winding 27 is closed, as for example, by closure of the contacts of the thermostat 28, the magnetic flux of core 9 will no longer flow through leg 12 thereof, but will be diverted to the pole pieces 14 and 15. Since the flux will cross the air gap therein at the point of minimum air gap, and since the minimum air gap occurs at the points where the leading edges of the rotor 8 are presented to the pole pieces, the magnetic flux will be concentrated at those points imparting a counterclockwise torque to the rotor 8. The inherent tendency of the device is to tend toward a condition of minimum air gap. Hence the rotor 8 will be rotated into the air gap until the arms 8a and 8b thereof are in registry with the pole faces 14 and 15 respectively as shown in dotted lines in Figure 2. Further rotation of the rotor 8 will not occur since such movement would tend to increase the air gap, and movement of the leading edges of the arms 8a and 8b beyond the pole faces would set up magnetic forces creating a torque in the opposite direction. The rotor 8 is thereby afforded a magnetic stop limiting its rotation in counterclockwise direction as viewed in Figure 2 to a position wherein the arms of rotor 8 are in registry with the pole faces of core 9 as aforescribed.

The foregoing phenomenon may be further elucidated by reference to the mathematical relationships involved which may be expressed as follows:

$$F = \frac{B^2 A}{72} \text{ lbs.}$$

where F is the force of attraction brought to bear upon the rotor 8 expressed in pounds, B is the magnetic flux density, and A is the area of rotor 8 presented to the pole pieces 14 and 15. From this relationship it will also be seen that the device described inherently imparts a greater force at the beginning of the stroke than at the end thereof, since A (the area of the rotor presented to the pole pieces) increases as the rotor approaches registry with the pole pieces and F varies inversely with A. For example, if the rotor area presented to the pole pieces is .0508 square inch when the rotor is unenergized and the total area of the rotor arms which may be presented to the pole pieces when in registry therewith is .71 square inch, the force at the beginning of the stroke will be 13.95 times the force exerted at the end of the stroke. This relationship has obvious advantages in that the rotor torque varies in the same manner as the forces required to operate a mechanism requiring greater force to initiate movement thereof than to maintain such movement, as for example, a valve member such as member 4 which must be moved against fluid pressure initially.

It is, of course, understood that rotation of the rotor 3 and consequent movement of valve member 4 through the linkage of shaft 21, crank member 30 and yoke 34 is against the bias of springs 37, which return both the valve members 4 and rotor 3 to their initial positions upon deenergization of the rotor as, for example, by re-opening of the thermostat 28. In this connection, it may be observed that the spring rate of the biasing means may be matched to the torque characteristics of the rotor to enhance its desired characteristic.

It should be further noted that such return will be prompt and without danger of sticking since the rotor 8 never seals against the pole pieces 14 and 15; that is, the air gap therebetween, although minimized by registration of the rotor arms with the pole pieces, is never completely eliminated and remains constant throughout the life of the device. The device is therefore not subject to residual magnetism of the core 9, the differential in the flux valve required to "pick up" the rotor and that at which it will "drop out" is greatly minimized, thereby rendering the control extremely sensitive and fast acting. Another desirable feature of the aforescribed device is that it is inherently more efficient than known electromagnetic operators as, for example, the power requirement is about one third that of a conventional solenoid operator capable of actuating a valve of the same size.

A suitably formed cover 41 of aluminum or any suitable non-magnetic metal or alloy, conveniently formed as a die casting, is removably secured, in any suitable manner, on the enclosure or housing 7. A U-shaped yoke or bridging member 45 is slidably mounted on vertical guide rods 46 fixed to and extending downward from top wall 47 of cover 41 (Figure 4). The yoke 45 is formed of iron or any suitable metal or alloy of high magnetic permeability and is of a width to bridge the core 9 of the electromagnetic operator means, with the lower ends of its arms 48 seating on legs 10 and 11 of core 9, when yoke 45 is lowered into its operative or effective position.

A T bracket is fixed to the upper face of the right portion 51 of yoke 45, centrally thereof, and has a transverse pin 52 secured therethrough adjacent its upper end. The pin 52 extends through slotted fingers of a forked head 53 at the inner end of the upper arm 54 of a bell crank lever 55 pivoted at 56 in a mounting bracket 57 having a base 58 secured, conveniently by riveting, to a vertical wall 59 of cover 41. The vertical wall 59 joins one end of top wall 47 of cover 41 to a lower auxiliary top wall 60 thereof and base 58 of bracket 57 extends downward beyond wall 60, as shown in Figure 1. A horizontally disposed operating rod 61 is provided at its outer end with a reduced extension 62 of squared cross section which is slidable through a corresponding opening in the lower end portion of base 58 of bracket

57. A pin 63 is secured through rod 61, a short distance in advance of extension 62 thereof, and extends through slotted fingers of a forked head 64 at the lower end of the lower arm 65 of the bell crank lever 55. Under normal operating conditions the rod 61 is held in its retracted position shown in Figure 1, by means to be described presently, and is then effective for holding the yoke 45 in its raised ineffective position providing air gaps of substantial extent between the lower ends of arms 48 of yoke 45 and the legs 10 and 11 of core 9. When in its raised ineffective position the yoke 45 has no appreciable effect upon the flow of magnetic flux through core 9 and does not interfere in any way with the operation of the electromagnetic operator means as and for the purposes above described.

A fuel gas supply pipe or conduit 67 is connected to the inlet 2 of valve body 1, and a pipe or conduit 68 connects the outlet 3 to a main burner 69 of suitable known type. The burner 69 may be located in the fire-box of a furnace or space heater, or any suitable apparatus, the enclosure about burner 69 preferably being vented to atmosphere. A pilot burner 70 of suitable known type is mounted adjacent main burner 69 for igniting gas flowing therefrom, as is known, and is connected to the interior of valve body 1 by a gas supply tube 71. A thermo-electric generator, preferably in the form of a thermocouple 72 of suitable known type, is mounted on pilot burner 70 in proximity thereto and disposed to be heated thereby. The thermocouple 72 may be of the general character of that disclosed and claimed in the Oscar J. Leins Patent No. 2,126,564, although any suitable thermocouple may be used. It has two thermocouple members joined together to form a "hot" junction, which is heated by a flame of the pilot burner 70, an outer tubular lead conductor 73 connected at one end to one of the thermocouple members and an inner lead conductor 74 connected at one end to the other thermocouple member and mounted within and electrically insulated from conductor 73. The other ends of lead conductors 73 and 74 are detachably connected in insulated relation to a terminal connector or fitting 76 in an end wall 77 of cover 41. The lead conductors 73 and 74 are connected, through fitting 76 and coiled flexible leads 78 and 79 to coils 80 wound upon the arms of a U-shaped core 81 of an electromagnet 82.

The electromagnet 82 is disposed within a cylindrical housing 83 in the outer end of which is secured a base 84 to which the core 81 is fixed. A cupped spring seat member 85, of greater diameter than housing 83, and concentric therewith, is secured to base 84. Seat member 85 has an upwardly extending finger 86 provided with a squared opening and slidable on a squared supporting and guide pin 87 secured through a downwardly extending arm 88 of an angle bracket 89 fixed to top wall 47 of cover 41. The bracket 89 is provided at its outer end with a pair of depending ears 91 between which a bell crank lever 92 is pivoted on a pin 93. The lower arm 94 of lever 92 is curved at its lower portion and extends downward between two spaced ears 95 extending outwardly from spring seat member 85 and between the latter and a pin 96 secured in ears 95. The upper arm 97 normally is held raised and in contact with a stop 98, secured through top wall 47 of cover 41, by a compression coil spring 99 seating at its upper end on arm 97, about a rounded boss 100 secured thereto, and seating at its lower end in a depressed portion 101 of cover 41, about a rounded boss 102 therein. A plunger 103, slidable in a housing 104 secured to top wall 47 of cover 41, normally is held in retracted position by a compression spring 105 within housing 104 confined between the bottom wall thereof and a shoulder 106 at the upper end of plunger 103. A reset button 107 is secured to the upper end of plunger 103, the lower end of which is in close proximity to, or in contact with, the upper face of arm

97 of lever 92, when the latter is in its normal position shown in Figure 1.

When bell crank lever 97 is in its normal position shown in Figure 1, it holds the housing 83, with the electromagnet 82 therein, in its outer position toward the right, as will be clear from what has been said. The operating rod 61 is slidable through a reduced neck 109 of housing 83 and has secured thereon, inwardly beyond neck 109, a cup shaped spring seat member 110 similar to member 85. A light compression spring 111 is disposed about the electromagnet housing 83 and seats at its ends in the members 85 and 110. Under normal operating conditions, the pilot burner 70 is burning, the coils 80 of the electromagnet 82 are energized, effective for holding an armature 112, secured on the end of rod 61 within housing 83, seated on the pole ends of electromagnet 82, and the housing 83 is held in its outer position. The bridging member or yoke is then held in its ineffective raised position and the electromagnetic operator then functions in its intended manner, as above explained.

In the event the pilot light is extinguished, the thermocouple cools thus deenergizing the coils 80 of electromagnet 82 and releasing the armature 112. The compression spring 111 then expands and the operating rod 61 moves inward toward the left, lowering the yoke 45 into seating contact with the legs 10 and 11 of core 9. In that connection, the compression spring 111 is light, as noted, and exerts but enough force to overcome the friction of the moving parts sufficiently to assure that the yoke 45 will move downward to effective position. Such downward movement of yoke 45 is accomplished by gravity supplemented by magnetic attraction as yoke 45 approaches the core 9, as will be understood, and the compression spring 111 at no time exerts sufficient force to pull the armature away from the electromagnet 82 when the latter is energized. In its lowered effective position yoke 45 provides a path of high magnetic permeability which shunts the magnetic flux of core 9 around the pole pieces 14 and 15 thereof. That immediately releases the rotor 8, if the control valve 4 is then open, and valve 4 closes promptly, cutting off flow of gas to the main burner 69, which is then extinguished. The armature 112 then is in its inner position indicated in dotted lines in Figure 1, with the electromagnet 82 and its housing 83 remaining in the normal outer position thereof shown.

In the inward movement of rod 61 a finger 114 of an angle arm 115, fixed on rod 61 adjacent member 110, contacts a pin 116 fixed to shaft 21 and extending substantially radially therefrom. The pin 116 is of such length and so disposed that in the raised ineffective position of yoke 45 it clears finger 114, so as to permit freedom of turning of rotor 8 in either direction. When the control valve 4 is in full open position, with rotor 8 in its dotted line position of Figure 2, the pin 116 extends toward member 110 and is disposed in underlying substantially parallel relation to rod 61. If the pilot burner 70 is then extinguished, the rotor 8, and with it shaft 21, turns in clockwise direction, as viewed in Figures 2 and 5, and passes in front of finger 114 as yoke 45 approaches its full lowered or effective position. At that time finger 114, in the continued inward travel of rod 61, contacts pin 116. Thereafter, the yoke 45 moves downward a further and short distance, to its full lowered position. In this final downward movement of yoke 45, shaft 21 is turned a short distance clockwise, forcing control valve 4 tightly shut, after which that valve is maintained shut by the weight of yoke 45 and the attractive force then exerted between yoke 45 and core 9. That assures that valve 4 will be maintained sealed tightly closed when yoke 45 is in its lowered effective position. If the control valve 4 is in closed position when the pilot burner 70 is extinguished, the pin 116 will then be in a position but slightly in advance, counterclockwise, of its position

shown in Figure 5. As the rod 61 approaches the limit of its inward movement, finger 114 will contact pin 116 and valve 4 will be urged toward its seat and held tightly closed, as before. As previously noted, the chamber or combustion space within which the main burner 69 and the pilot burner 70 are located is vented to atmosphere. Gas escaping from the pilot burner 70, after extinguishment and before relighting thereof, will be in comparatively small volume and readily vented to atmosphere, incurring no risk of explosion when the pilot burner 70 is again lit. If desired, or if conditions require, suitable means may be provided for cutting off flow of gas to the pilot burner, when the yoke 45 is released and moved to effective position, and reestablishing such flow during the resetting operation and while the control valve 4 remains closed.

After release of the yoke 45 and closing of the control valve 4, if open when yoke 45 is released, it is necessary to perform a resetting operation in order that the electromagnetic operator means may resume control. In performing the resetting operation, the reset button is depressed in opposition to compression spring 99, after the pilot burner 70 has been relit and the thermocouple 72 has been heated sufficiently to energize the coils 80 of electromagnet 82. When reset button 107 is depressed plunger 103 forces arm 97 of bell crank 92 downward, swinging arm 94 thereof toward the left, as viewed in Figure 1. At that time, the armature 112 is in its inner position indicated in dotted lines. As arm 94 swings inward it moves the housing 83 and the parts carried thereby inward sufficiently to bring the poles of electromagnet 82 into close proximity to armature 112. The armature 112 is then picked up by the electromagnet 82 and held tightly seated on the pole ends thereof by magnetic attraction. The reset button 107 is then released and compression spring 99 returns bell crank lever 92 to its normal position. In the return movement of lever 92, the housing 83 and the parts therein, including armature 112, are moved outward to normal position. That pulls the operating rod 61 outward, to the right, and raises the yoke 45 to its upper ineffective position, through the bell crank lever 55 and associated parts, the mechanical advantage afforded by lever 55 being adequate for that purpose. The parts are then in their positions shown in Figure 1 and thereafter the control valve 4 may open and close under control of thermostat 28, as before, pilot burner 70 serving to ignite gas issuing from the main burner 69 whenever valve 4 is opened, as will be understood.

It will be clear, from what has been said, that the control valve 4, if open, is immediately closed upon extinguishment of the pilot burner 70 and flow of fuel to the main burner 4 is interrupted. Also, if control valve 4 is closed when pilot burner 70 is extinguished, it remains closed. In either case, flow of fuel to the main burner 4 is interrupted during the resetting operation.

It will be understood that changes in detail may be resorted to without departing from the field and scope of our invention, and we intend to include all such variations, as fall within the scope of the appended claims, in this application in which the preferred form only of our invention has been disclosed.

We claim:

1. Control means comprising, means defining a low reluctance flux path and an air gap operatively associated therewith, an actuable member in said air gap responsive to flow of magnetic flux thereacross, means for producing magnetic flux flow in said low reluctance path, condition responsive flux diverting means comprising a winding associated with said flux path and energized in response to a given condition by magnetic flux afforded by said flux producing means for diverting magnetic flux around a portion of said flux path for flow across said air gap and actuation of said member, flux shunting

means including a movable magnetic member having an inoperative position and having an operative position bridging said air gap and affording a magnetic shunt therefor to prevent any substantial magnetic flux flow across said air gap and hence to prevent actuation of said actuatable member irrespective of the response of said flux diverting means to said condition, and electromagnetic operating means for said magnetic member.

2. Control means comprising, means defining a low reluctance flux path and an air gap operatively associated therewith, an actuatable member in said air gap responsive to flow of magnetic flux thereacross, means for producing magnetic flux flow in said low reluctance flux path means, condition responsive flux diverting means comprising a winding associated with said flux path means and energizable in response to a given condition by the magnetic flux afforded by said flux producing means for diverting magnetic flux around a portion of said flux path for flow across said air gap and actuation of said member, an electromagnet and armature movable to relative attracted and separated relation, and a magnetic member operatively related to said electromagnet and armature and movable by relative movement of said electromagnet and armature from attracted to separated relation from an inoperative position to an operative position wherein it bridges said air gap and affords a magnetic shunt therefor to prevent any substantial magnetic flux flow across said air gap and hence to prevent actuation of said actuatable member irrespective of the response of said flux diverting means to said condition.

3. Control means comprising, means defining a low reluctance flux path and an air gap operatively associated therewith, an actuatable member in said air gap responsive to flow of magnetic flux thereacross, means for producing magnetic flux flow in said low reluctance flux path means, condition responsive flux diverting means comprising a winding associated with said flux path means and energizable in response to a given condition by the magnetic flux afforded by said flux producing means for diverting magnetic flux around a portion of said flux path for flow across said air gap and actuation of said member, resettable safety shut-off means including an electromagnet and armature movable to relative attracted and separated relation and a magnetic member operatively related to said electromagnet and armature and movable by relative movement of said electromagnet and armature from attracted to separated relation from an inoperative position to an operative position wherein it bridges said air gap and affords a magnetic shunt therefor to prevent any substantial magnetic flux flow across said air gap and hence to prevent actuation of said actuatable member irrespective of the response of said flux diverting means to said condition, and reset means for simultaneously positioning said electromagnet and armature in attracted relation and said magnetic member in its said operative position to prevent actuation of said actuatable member during resetting of said electromagnet and armature.

4. Control means comprising, means defining a low reluctance flux path and an air gap operatively associated therewith, an actuatable member in said air gap responsive to flow of magnetic flux thereacross, means for producing magnetic flux flow in said low reluctance flux path means, condition responsive flux diverting means comprising a winding associated with said flux path means and energizable in response to a first condition by the magnetic flux afforded by said flux producing means for diverting magnetic flux around a portion of said flux path for flow across said air gap and actuation of said member, an electromagnet and armature having a relative attracted position in which they are held in response to a second condition and movable to separated relation upon termination of said second condition, and a magnetic member operatively related to said electromagnet and arma-

ture and movable upon termination of said second condition by relative movement of said electromagnet and armature from attracted to separated relation from an inoperative position to an operative position wherein it bridges said air gap and affords a magnetic shunt therefor to prevent any substantial magnetic flux flow across said air gap and hence to prevent actuation of said actuatable member irrespective of the response of said flux diverting means to said first condition.

5. Electromagnetic control means comprising, a permeable core having a first flux path and a second flux path including an air gap, means for producing a magnetic flux in said core, a member in said air gap actuatable in response to flow of magnetic flux thereacross, means for blocking flow of flux in a portion of said first flux path and tending to force said blocked flux through said air gap, means affording a low reluctance shunt path available to said blocked flux including a permeable member coacting with said core for bridging said air gap, and electromagnetic means responsive to a given condition for holding said permeable member out of coacting engagement with said core, whereby actuation of said member is effected by said flux blocking means but only when said given condition is present.

6. Control means comprising, a magnetically permeable core provided with an air gap, an actuatable member in said air gap responsive to flow of magnetic flux thereacross, flux generating means energizable in response to a given condition to produce magnetic flux flow in said core and across said air gap for actuation of said actuatable member, flux shunting means including a movable magnetic member having an inoperative position and having an operative position bridging said air gap and affording a magnetic shunt therefor to prevent any substantial magnetic flux flow across said air gap and hence to prevent actuation of said actuatable member by flux generated by said flux generating means in response to said condition, and electromagnetic operating means for said magnetic member.

7. Control means comprising, a magnetically permeable core provided with an air gap, an actuatable member in said air gap responsive to flow of magnetic flux thereacross, flux generating means for producing magnetic flux flow in said core and across said air gap for actuation of said actuatable member, an electromagnet and armature movable to relative attracted and separated relation, and a magnetic member operatively related to said electromagnet and armature and movable by relative movement of said electromagnet and armature from attracted to separated relation from an inoperative position to an operative position wherein it bridges said air gap and affords a magnetic shunt therefor to prevent any substantial magnetic flux flow across said air gap and hence to prevent actuation of said actuatable member in response to generation of flux by said flux generating means.

8. Control means comprising, a magnetically permeable core provided with an air gap, an actuatable member in said air gap responsive to flow of magnetic flux thereacross, flux generating means for producing magnetic flux flow in said core and across said air gap for actuation of said actuatable member, resettable safety shut-off means including a pair of releasable coupling means relatively movable to coupled and released relation, and a magnetic member operatively related to one of said members and movable by relative movement of said members from coupled to released relation from an inoperative position to an operative position wherein it bridges said air gap and affords a magnetic shunt therefor to prevent any substantial magnetic flux flow across said air gap and hence to prevent actuation of said actuatable member in response to generation of flux by said flux generating means, and reset means for simultaneously positioning said coupling members in coupled relation and said magnetic member in its said operative position to prevent

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actuation of said actuatable member during a resetting operation.

9. Control means comprising, a magnetically permeable core provided with an air gap, an actuatable member in said air gap responsive to flow of magnetic flux thereacross, flux generating means energizable in response to a first condition for producing magnetic flux flow in said core and across said air gap for actuation of said member, an electromagnet and armature having a relative attracted position in which they are held in response to a second condition and movable to separated relation upon termination of said second condition, and a magnetic member operatively related to said electromagnet and armature and movable upon termination of said second condition by relative movement of said electromagnet and armature from attracted to separated relation from an inoperative position to an operative position wherein it bridges said air gap and affords a magnetic shunt therefor to prevent any substantial magnetic flux flow across said air gap and hence to prevent actuation of said actuatable member by flux generated by said flux generating means in response to said first condition.

10. Electromagnetic control means comprising, a permeable core provided with an air gap, flux generating

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means for producing a magnetic flux in said core and across said air gap, a member in said air gap actuatable in response to flow of magnetic flux thereacross, means affording a low reluctance shunt path for said flux including a permeable member coacting with said core to bridge said air gap, and electromagnetic means responsive to a given condition for holding said permeable member out of coacting engagement with said core, whereby actuation of said member is effected by operation of said flux generating means but only when said given condition is present.

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