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PILOT-OPERATED VALVE

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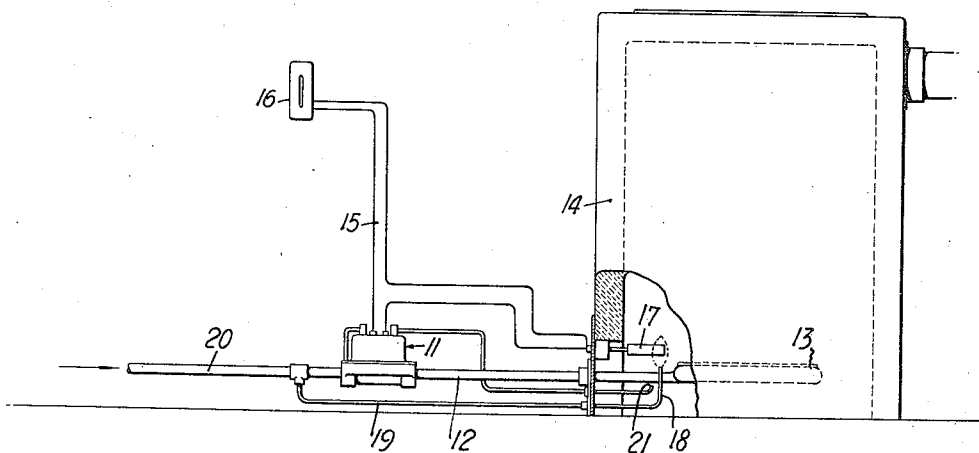
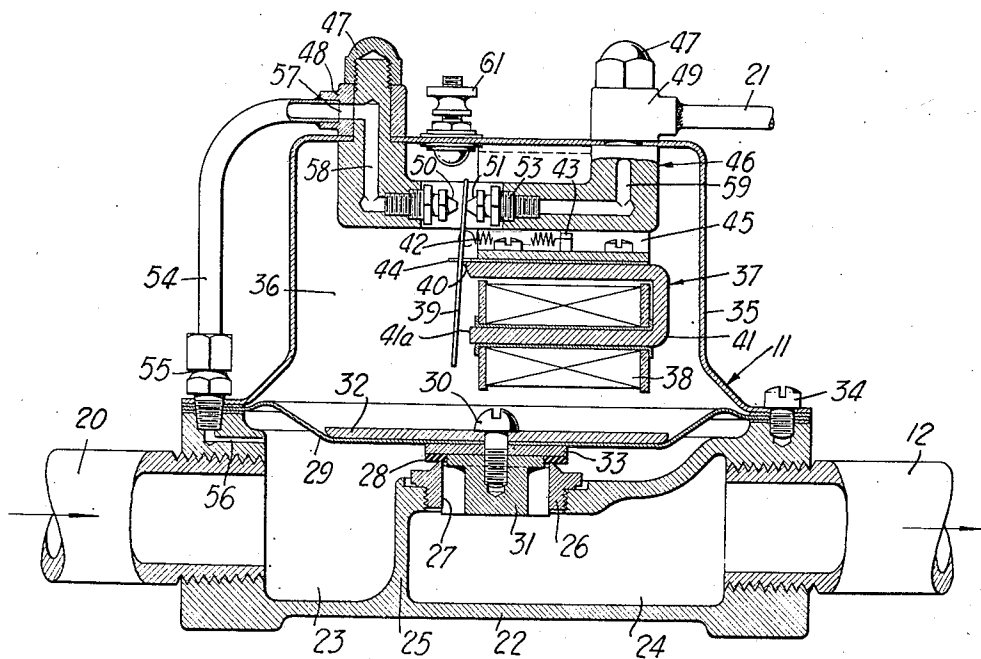


FIG. 1.

FIG. 2.



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PILOT-OPERATED VALVE

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13 Claims. (Cl. 137-139)

My invention relates to new and useful improvements in fluid control valves and has for its chief object the provision of a pilot operated valve that requires a minimum of electrical power for its operation.

A particular object of my invention is the provision of a valve for fluid control that may be readily operated by thermoelectric current generated by a thermocouple that is heated by a conventional furnace pilot burner.

A further object of my invention is the provision of a novel electrically operated pilot valve for controlling a fluid pressure operated main valve.

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

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

Figure 1 is a diagrammatic representation of a system embodying the present invention; and

Figure 2 is a sectional view of a valve embodying my invention.

Referring more particularly to Fig. 1, the numeral 11 denotes an electrically operated valve controlling gas flow through the pipe 12 to the burner 13 located in the furnace 14. Electrically connected in series with the valve 11, as by the wires 15, is the thermostat 16 and the thermocouple 17 heated by the furnace pilot burner 18 supplied with gas by means of the pipe 19 connected to the gas supply line 20 at the input side of the valve 11. A vent communicating with the valve 11 is shown at 21.

Referring now to Fig. 2, the numeral 22 denotes a valve casing having an inlet chamber 23 and an outlet chamber 24 separated by the partition 25. Threaded into said partition is the member 26 provided with a vertically extending valve port 27. Cooperable with said port is the valve member 28 secured to move with the flexible diaphragm 29 as by the screw 30 threaded into the valve guide 31. The member 32 functions both as a stiffening means and a weight-biasing means for the diaphragm 29 with the disk 33 acting as a backing. Attached to the valve casing as by the screw 34 is the housing 35 supporting the diaphragm flange therebetween to form the closed chamber 36.

Mounted in the chamber 36 is an electromagnetic device generally indicated by the numeral 37 and comprising a U-shaped core 41 supporting the coil 38 on one arm portion thereof, an

armature 39 of magnetic material and fulcrumed on the knife edge 40 of the core 41, a contractile spring 42 connected at one end thereof to the armature and at the other to the post 43, and an armature retaining member 44. Said electromagnetic device 37 is shown mounted as by the bracket 45 to the structure 46 which, in turn, is secured to the housing 35 by the nuts 47 with the sleeves 48 and 49 therebetween. The port members or jets 50 and 51 are threaded in the structure 46 and are locked in position after adjustment by the packing nuts 52 and 53. The unitary structure 46 includes the pilot valve structure proper, comprising the port members 50 and 51 as well as the portions into which these members are threaded. The structure 46 also includes the projections that cooperate with the nuts 47 to serve as a common support for the pilot valve structure and the electromagnetic device.

Communication is afforded between the inlet chamber 23 and the jet 50 through the tubular member 54, secured to the valve casing by the fitting 55 and to the sleeve 48 as by solder, the passageway 56 in the valve casing 22, the passageway 57 in the sleeve 48 and the passageway 58 in the member 46. Secured to the sleeve 49, as by solder, is the vent pipe 21 communicating through the passageway 59 with the jet 51. Binding posts 61, insulatively mounted in the upper wall of the housing 35, provide means for connecting to the coil 38 of the electromagnetic device 37.

Control of the main valve is effected by actuation of the pilot valve, comprising the electromagnetic device 37 cooperating with the port members 50 and 51.

The operation of the valve is as follows:

In the normal or un-energized position of the armature 39 as shown, the port member 50 is open, and as has been described, communication is now permitted between the chambers 23 and 36 on either side of the diaphragm. The port member 51 now being closed by the armature, spring biased in that direction, and the chamber 36 otherwise sealed, fluid pressure applied to the input side of the valve is equalized on both sides of the diaphragm. In this condition, the main valve port remains closed on account of the weight-biasing of the diaphragm. When the armature 39 is energized, it moves to open port member 51 and close port member 50, blocking communication between the chambers 23 and 36 and permitting the compressed fluid in the latter to escape through the port member 51 and

the vent 21. Fluid pressure at the input of the valve may now force the diaphragm upward to open the port 27.

In the application of my invention to a gas furnace, the valve is applied as shown in Fig. 1. Current generated by the thermocouple 17 energizes the electromagnetic device of the pilot valve, permitting flow of gas through the main valve at the demand of a limit control such as the thermostat 16. If the pilot burner accidentally becomes extinguished, no current is generated by the thermocouple and consequently the main valve closes and remains closed until the pilot burner is reignited.

It is to be understood that the word "thermocouple," as used herein, is intended to mean any thermoelectric generating device that is adapted for use with a pilot burner and which may consist of a single couple or a plurality of couples connected in series or in parallel as the electrical circuit constants may indicate.

A very apparent advantage of my invention resides in the fact that no external source of electrical power is required for the operation of the valve, with consequent elimination of additional wiring, possible electrical fire hazard, and interruptions occasioned by electrical power failure.

Fluid flow through the port members or jets 50 and 51 is controlled directly by movement of the armature 39. These jets may have a tip diameter as small as .030 inch and a passageway therethrough formed by a No. 70, or smaller, drill. On account of the small surface area of such jets, the contact pressure of the armature on them may be very great and sufficient to form gas-tight junctions, with minimum expenditure of electric power. The armature may preferably be plated with a soft metal such as cadmium or copper to ensure proper seating on, and sealing of, the port members or jets. Likewise, resilient, pad members of suitable material may be secured to the armature to cooperate with the jets. However, it has been found in practice that a smooth bare armature surface may be successfully employed.

In the drawing, for the sake of clarity, the spacing between the port members 50 and 51 and between the armature 39 and the core pole 41a have been exaggerated. In practice, the clearance between the port members and the armature may be as small as .005 inch, or even less, in both the normal position of the armature shown and when it is attracted toward the pole 41a of the core 41 when the same is energized by current flow through the coil 38. The end of the core on which the armature is fulcrumed has an exaggerated taper to show clearly that clearance is desirable adjacent the edge 40.

The port member or jet 50 is so positioned in respect to the device 37 that it limits the movement of the armature 39, preventing the armature from contacting the pole 41a when it is attracted theretoward.

The clearance between the armature and the pole, in the attracted position, may be as small as .002 inch for maximum sensitivity of operation. However, under no conditions may the armature be permitted to come in contact with the pole, as in that position residual magnetism remaining in the core, and from which no known magnetizable material is entirely free, will cause the armature to magnetically "stick," under the necessary sensitive adjustment of the armature spring 42.

Under some conditions, it may be desirable to

provide a small non-magnetic gap between the armature and the edge 40 of the core 41. This may be readily effected by plating that portion of the armature or, for example, by extension of the member 44 so that the armature fulcrums thereon slightly beyond the edge 40.

It is obvious that the novel pilot valve of my invention has utility in connection with the control of other types of fluid pressure operated valve systems that are well known in the art, and so I do not intend that its use should be limited to the particular system shown by way of example. In systems which may not require fluid flow through the one or the other of the port members 50 and 51, a stop member may be substituted to limit the movement of the armature.

And, while I have shown and described a preferred embodiment of my invention, I wish it to be understood that modifications may be made and that no limitations on the invention are intended than are imposed by the scope of the appended claims.

This application is a continuation in part of my copending application, Serial No. 172,180, filed November 1, 1937.

I claim as my invention:

1. In a fluid pressure operated control valve, in combination, a main valve casing having an inlet and an outlet, a ported partition separating said inlet and said outlet and provided with a main valve seat, a housing covering an opening in the upper wall of said casing, a flexible diaphragm member in said opening and defining with said housing and said casing an upper and a lower pressure chamber respectively, a main valve member connected to said diaphragm member and cooperable with said main valve seat, a pilot valve structure mounted within said housing for controlling the operation of said main valve, said pilot valve structure having a jet member through which fluid can pass, a pivoted armature cooperating with said jet member and having an open and a closed position with respect thereto, an electromagnet for attracting said armature to one of said positions, and means constantly urging said armature toward the other of said positions.

2. In a fluid pressure operated valve structure, a valve body having inlet and outlet openings, said valve body also having a partition providing a valve port for passing fluid through the valve, a closure structure adapted to cooperate with said port and movable between limits corresponding respectively to open and closed position, a movable member having a surface forming a chamber in communication with one of said openings and on one side of said partition, said member supporting said closure structure, means forming a fluid pressure chamber in communication with another surface of said movable member, a pilot valve structure for controlling the fluid pressure applied to said other surface, said pilot valve structure having a jet member through which fluid under pressure can pass, a pivoted armature cooperating with said jet member and having open and closed positions with respect thereto, an electromagnet for attracting said armature to one of said positions, and means constantly urging said armature toward the other of said positions.

3. In a fluid pressure operated valve structure, a valve body having inlet and outlet openings, said valve body also having a partition providing a valve port for passing fluid through the valve, a closure structure adapted to cooperate with

said port and movable between limits corresponding respectively to open and closed position, a flexible diaphragm member having a surface forming a chamber in communication with one of said openings and on one side of said partition, said diaphragm member supporting said closure structure, means forming a fluid pressure chamber in communication with the other surface of said diaphragm member, a pilot valve structure for controlling the fluid pressure applied to said other surface, said pilot valve structure having a jet member through which fluid under pressure can pass, a pivoted armature cooperating with said jet member and having open and closed positions with respect thereto, an electromagnet for attracting said armature to one of said positions, and means constantly urging said armature toward the other of said positions.

4. In a fluid pressure operated valve structure, a valve body having inlet and outlet openings, said valve body also having a partition providing a valve port for passing fluid through the valve, a closure structure adapted to cooperate with said port and movable between limits corresponding respectively to open and closed position, a movable member having a surface forming a chamber in communication with one of said openings and on one side of said partition, said member supporting said closure structure, means forming a fluid pressure chamber in communication with another surface of said movable member, a pilot valve structure for controlling the fluid pressure applied to said other surface, said pilot valve structure having a jet member through which fluid under pressure can pass, a pivoted armature cooperating with said jet member and having open and closed positions with respect thereto, an electromagnet for attracting said armature to one of said positions, and means constantly urging said armature toward the other of said positions, the area of the jet orifice and of the surface surrounding said orifice being sufficiently small to ensure sealing of the jet by cooperation with said armature by a pressure of the order of the power produced by current flow in said electromagnet capable of generation by an ordinary pilot-burner-heated thermoelectric generator.

5. In a fluid pressure operated control valve, a valve body, a movable partition dividing said body into a pair of pressure chambers, one of said chambers being constantly subjected to the inlet pressure of the fluid controlled by said valve, a pilot valve structure having an opening within said other chamber and enclosed therein, a device including electric means for operating the same enclosed within said other chamber for controlling said opening, and means forming with the pilot valve structure a unitary structure for mounting said pilot valve structure on a wall of the body.

6. In a fluid pressure operated control valve, a valve body, a movable partition dividing said body into a pair of pressure chambers, one of said chambers being constantly subjected to the inlet pressure of the fluid controlled by said valve, a pilot valve structure having an opening within said other chamber and enclosed therein, a device including electric means for operating the same enclosed in said other chamber for controlling said opening, and means projecting from the pilot valve structure and attached to a wall of the body for supporting said pilot valve structure, said last-named means having a passage-

way therein through which fluid may be passed to the pilot valve.

7. In a fluid pressure operated control valve, a valve body, a movable partition dividing said body into a pair of pressure chambers, one of said chambers being constantly subjected to the inlet pressure of the fluid controlled by said valve, a pilot valve structure having an opening within said other chamber and enclosed therein, electromagnetic means enclosed in said other chamber for controlling said opening, and means forming a unitary structure with said pilot valve structure and the electromagnetic controlling means and attached to a wall of the body.

8. In a fluid pressure operated control valve, a valve body, a movable partition dividing said body into a pair of pressure chambers, one of said chambers being constantly subjected to the inlet pressure of the fluid controlled by said valve, a pilot valve structure having an opening within said other chamber and enclosed therein, an electromagnetic device having within said other chamber a movable armature for controlling said opening and joined to the pilot valve structure, and a common means for supporting the pilot valve structure and the electromagnetic device by the aid of a wall of said body, said common means having a passageway therein for conducting fluid under pressure to said pilot valve structure.

9. A fluid pressure operated control valve comprising a valve body, a movable partition dividing said body internally into a pair of pressure chambers, one of said chambers being constantly subjected to the inlet pressure of the fluid to be controlled by said valve, a pilot valve structure for varying the pressure of the fluid in the other of said chambers, said structure including a jet member projecting into said other chamber, a pivoted arm in said other chamber for controlling fluid flow through said jet member, a knife edge forming a pivot for the arm, and electric means also in said other chamber for operating said arm.

10. A fluid pressure operated control valve comprising a valve body, a movable partition dividing said body internally into a pair of pressure chambers, one of said chambers being constantly subjected to the inlet pressure of the fluid to be controlled by said valve, a pilot valve structure enclosed within the other of said chambers for varying the pressure of the fluid therein, said structure comprising a jet member in direct communication with said other chamber, and a device including electric means for operating the same also in said other chamber and adapted to be moved to cover and to uncover said jet member, the area of the orifice of said jet member being so small that the same is sealed by pressure of said device produced by the application to said electric means of power in the order of that generated by an ordinary pilot-burner-heated thermoelectric device.

11. In a fluid control valve structure, mechanism for operating said valve and operated by the pressure of the fluid controlled by the valve, said mechanism comprising means defining a pressure chamber, said means including a movable wall, a pilot valve structure for varying the pressure of the fluid in said chamber, said structure including a jet member projecting into said chamber, a pivoted armature in said chamber and cooperable with said jet member to control fluid flow therethrough, a knife edge forming a pivot for the arm, and an electromagnet for mov-

ing said armature between open and closed position with respect to said jet member.

12. In a fluid control valve structure, mechanism for operating said valve and operated by the pressure of the fluid controlled by the valve, said mechanism comprising means defining a pressure chamber, said means including a movable wall, a pilot valve structure for varying the pressure of the fluid in said chamber, said structure including a jet member projecting into said chamber, the orifice of said jet member being bounded by a narrow surface, an arm in said chamber movable in a direction substantially normal to said surface for controlling fluid flow through said jet member, and electric means also in said chamber for operating said arm.

13. In a fluid control valve structure, mechanism for operating said valve and operated by

the pressure of the fluid controlled by the valve, said mechanism comprising means defining a pressure chamber, said means including a movable wall, a pilot valve structure for varying the pressure of the fluid in said chamber, said structure including a jet member projecting into said chamber, a movable arm in said chamber for controlling the flow of fluid through said jet member, and electric means also in said chamber for operating said arm, the area of the orifice of said jet member being so small that the same is sealed by pressure of said arm produced by the application to said electric means of power in the order of that generated by an ordinary pilot-burner-heated thermoelectric device.

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