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D. H. McCORKLE

2,118,443

ELECTRIC VALVE

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FIG. 1.

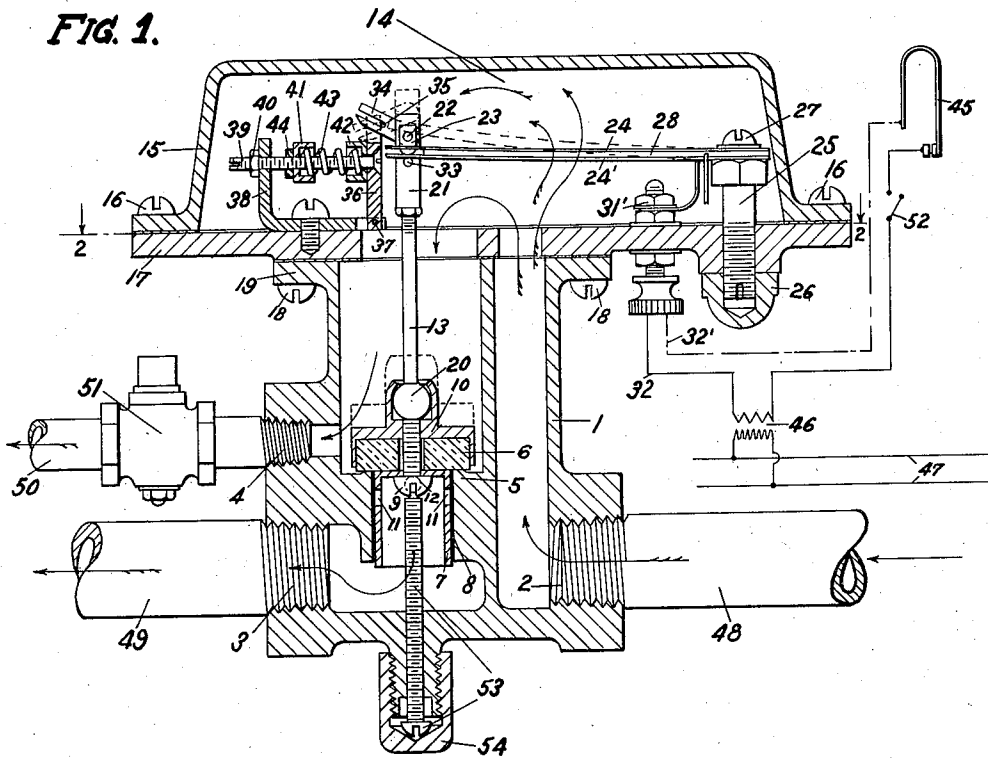


FIG. 2.

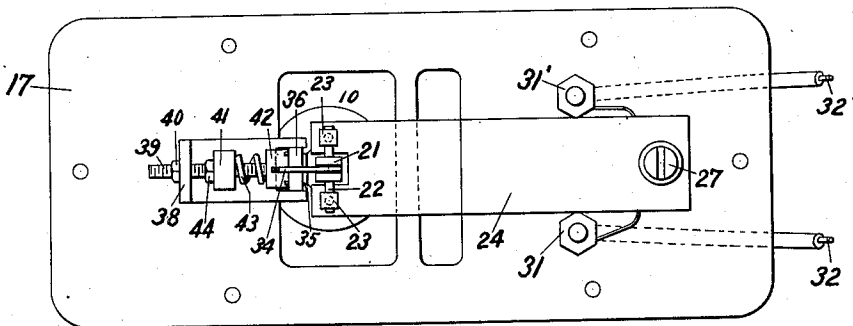
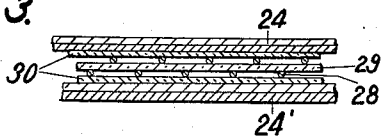


FIG. 3.



INVENTOR.

DONALD H. McCORKLE

BY *Miller Boylen & Bried*
ATTORNEYS.

UNITED STATES PATENT OFFICE

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ELECTRIC VALVE

Donald H. McCorkle, Berkeley, Calif., assignor
to Claire L. McCorkle, Berkeley, Calif.

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6 Claims. (Cl. 137—139)

This invention relates to electrically operated valves as used to automatically control the flow of fuel to a burner, and the object of the invention is to provide an effective, reliable, simple construction which may be produced at low cost.

Specific objects and advantages of the construction will appear in the following description and accompanying drawing.

In the drawing Fig. 1 is a vertical central section of my improved electric valve shown in connection with a diagram of the electric circuit wiring and controlling room thermostat.

Fig. 2 is a plan of the mechanism as seen from line 2 of Fig. 1 with cover removed.

Fig. 3 is a greatly enlarged fragmentary cross section taken through the two bimetallic strips of the thermal motor showing the electric heating wires therebetween.

Before describing the device in detail it may be said that while the valve will operate to control the flow of any fluid, liquid or gas, which it is desired to control by an electric thermostat or other electric switch from a distance, it is intended principally to be used for controlling fuel gas flow to a furnace or boiler burner under control of any desired type of room thermostat which will make and break the operating electric circuit, and the current for which is preferably supplied by a small low voltage transformer connected to the house wiring.

On the majority of gas fired domestic gas furnaces, boilers, heaters, etc., the Bunsen type of burner is used in conjunction with a continuous pilot burner. In order to prevent "back-firing" (burning at the orifice or within the burner) it is necessary to have the valve open with a sudden or "snap" movement and instantly admit a flow of gas sufficient in volume to insure burning at the burner ports or openings. The required volume of gas for this is generally about 20% of the total capacity of the burner. It is also desirable to as suddenly shut off the gas supply in the same manner for the reason that in turning on or off a burner of the Bunsen type if the velocity of the gases through the mixer chamber is less than the velocity of the speed of flame propagation the gases will ignite and burn within the burner causing it to soot up and also producing carbon-monoxide as a result of incomplete combustion.

While it will be seen that it is not advisable to slowly open or close the gas supply valve within certain limits of low fire or reduced flow it will also be seen that when the supply valve is suddenly opened to admit the maximum flow

of gas to the burner there will be a decided tendency for the flame to "float" or be forced out the front of the fire box due to the fact that it takes an appreciable length of time for the heated gases of combustion to find their way into the escape flue and establish a draft therein and properly exhaust the burnt gases from the fire box and to entrain sufficient secondary air through the fire box to obtain complete combustion of the burning gases.

From the foregoing it will be seen that the ideal control valve would open to the required minimum gas flow with a sudden or "snap" movement and then would gradually open further to the full flow required for the maximum flame, and in its closing movement would gradually cut down the maximum flow to the required minimum and then would completely and instantly close the valve.

In the figures the valve body 1 has a threaded inlet 2 and an outlet 3 and pilot connection 4, and at a point beyond the pilot outlet is the valve seat 5 on which rests a valve disk 6 of suitable material. A valve guide 7 extends below and loosely through the throat 8 below the valve. This guide is tubular and is secured to the underside of the valve disk by a screw 9 passing into the disk holder 10, and provided with side ports or holes 11, 12 drilled at right angles through the tubular guide near its upper end, holes 12 being higher so as to open first when the valve is lifted.

A stem 13 extends upwardly from the valve holder into an upper chamber 14 enclosed by a gas-tight cover 15 secured around its edge by screws 16 to a plate-like flange 17 in turn secured as by screws 18 to a smaller flange 19 on the valve body 1, suitable gaskets being interposed in the joints.

The valve stem 13 is secured to the disk holder 10 by means of a ball 20 and socket or other form of flexible joint and is threaded at its upper end into the head 21. This head is pivoted on a small pin 22 which in turn is supported between two bearings 23 mounted (as by screws or rivets dotted under the bearings in Fig. 2) on the free end of the upper of two pairs of bimetallic strips 24—24' which are arranged parallel and are both anchored at their other ends to an adjustable post 25 threaded through plate 17 and slotted at its lower end so as to be adjustable in height from below with a screw driver. A screw cap 26 covers the end of the post to prevent leakage of gas and serving as a lock nut, and one or more screws as at 27 screws the strips rigidly to

the top of the post and must be loosened when the post is adjusted. The upper bimetallic strip 24 is somewhat thinner or lighter in gage than the lower one 24' as it must flex more, and sandwiched between the two flat bimetallic strips is a flatly wound electric heating coil 28 of fine resistance wire wound around a mica or other insulating sheet 29 and covered on both outer sides with additional insulating sheets 30. The terminals of the heating coil are brought out to a pair of binding posts 31, 31' to connect with line wires 32, 32'.

Projecting from the head 21 of the valve stem under the lower bimetallic strip 24' is a pin 33 which takes the downward thrust of the lower strip due to the spring of the metal, and also the downward thrust of the upper bimetallic strip 24 acting through the heads of the rivets or screws which hold bearings 23 in place and which bear against the lower bimetallic strip 24' as shown in Fig. 1, and the height of the head 21 and adjustment of post 25 are such as to normally exert a downward pressure on pin 33 (when the bimetallic strips are cold) so as to hold the valve 6 closed and with ball 20 at the bottom of its socket which is made of a depth in excess of the ball so that the stem has some play before lifting the valve when the stem is raised as it would be through upward flexing of the bimetallic strips when heated by actuation of resistance coil 28.

Head 21 is centrally slotted and carries a laterally projecting slotted toggle link 34. This link is pivoted in the slot of the head over pin 22 and the slot of the link engages a small pin 35 mounted on the upper end of a vertical lever 36 pivoted at its lower end at 37 to an angle bracket 38 secured to plate 17 and the upper end of which bracket supports a horizontally extending screw 39 which is threaded through the bracket and extends freely through a loose hole in lever 36 with its head acting as a limit or stop to the lever in swinging towards the valve stem head 21. This screw 39 is provided with a lock nut 40 to hold it at any point of longitudinal adjustment on the bracket, and it carries a pair of cups 41, 42 urged apart by a small coil spring 43, the cup to the right bearing against lever 36 and the one to the left being threaded to the screw and locked in any place of adjustment by a nut 44 to hold the spring at any desired pressure.

The heating current for the sandwich coil is supplied by the closing of the contacts on any desired form of adjustable room thermostatic switch indicated at 45 in the drawing and may be supplied by a battery or a small low voltage transformer 46 from line wires 47.

In operation, and assuming that fuel gas is being delivered into the valve body from pipe 48 and that pipe 49 leads to a furnace burner, and pipe 50 to the pilot flame of the burner which is always open through the valve body 1 unless closed down by pilot service cock 51, when the temperature of the room falls below the desired point at which the controlling or room thermostat 45 is set and switch 52 is closed it closes the circuit and heats the coil between the bimetallic strips causing them to tend to expand upward at their free ends, but by reason of the pressure of spring 43 against pivoted lever 36 the toggle link 34 resisting the upward movement of stem 13 the bimetallic strips can only build up energy until they are able to snap the toggle link over its center to the dotted position, and which instantly opens the valve 6 to supply gas fuel to the burner through upper cross holes 12 which is

sufficient to insure a flame which will not flare back. The vertical play in ball and socket joint 20 aids in rod 13 lifting to the toggle center before cracking the valve, then the valve will lag or pause in this position until the heat is built up in the bimetallic strip to catch up to the toggle position, and as the coil continues to heat the bimetallic strips the valve will lift still further (as pin 35 slides in the toggle link slot) and fuel ports 13 will be opened up so that the flame will gradually rise after the initial lighting until it reaches the maximum or capacity of the valve.

This pause or lag in the valve between the snap movement and slow movement may be adjusted for the desired duration by adjusting the tension on the toggle spring 43.

When the room temperature rises sufficiently it will cause the thermostat 45 to break the circuit and the sandwich coil will begin to lose heat by radiation to the gases continually flowing over it so that it will slowly lower the valve (and flame) until it meets the mounting resistance due to the toggle spring 43 and at which time further movement of the valve will lag or pause for an appreciable length of time until the continued cooling of the bimetallic strips again build up enough tension to snap the toggle over its center and instantly close the valve without first lowering the flame to the danger point of a flare-back.

A very important feature of the apparatus should be noted and that is, if a sufficiently sensitive room thermostat is used it will respond to the gradual turning up and down of the flame which takes place through movement of the bimetallic strips above the toggle center, so that the burner need not go entirely out and on full blast as in the other automatic burners of this type, though if a relatively sluggish room thermostatic switch is used it will go completely on and off, but only by passing through the phases described.

However, in some installations it is desirable to avoid the flame going out, and in such cases the valve may be stopped from entirely closing through the provision of an adjustable set screw 53 accessible at the bottom of the body upon taking off screw cap 54.

Adjusting the position of the head of the screw 39 regulates the distance that the valve disk 5 is lifted off the valve seat 5 during the first stage of the valve opening and thus the amount of gas allowed to pass through the valve during the first stage of opening can be regulated by this screw. As the temperature of the bimetallic strips continues to rise their free ends will be further deflected upwards causing the valve disk to be lifted above its seat to the position of maximum flow of gas through the valve as described.

One of the features of my valve is that it is self-closing in the event of a failure of the supply current or a burning out of any of the electrical parts in the valve or in the control device connected to same. This is a safety feature of the greatest importance as it will be seen that a serious accident might occur, for instance in a steam boiler, for should the current fail after the valve was turned on it would not turn off when the steam pressure had reached the danger point. It will be seen that my construction provides for a valve which is normally in the closed position and will open or remain open only so long as the electric current flows through the heating element 28. When the current is interrupted for any reason the flow of cool gas passing over the bimetallic strips cools them down to the point

where their downward deflection causes the valve disk to be forced against its seat so closing the valve. The downward pressure of the strips at normal temperatures can be adjusted by raising or lowering the supporting screw 25 which is threaded into the supporting plate 17 for that purpose.

Another feature of my invention is to provide means for exerting a considerable pressure on the valve disk against the valve seat. Most valves of this type depend on the weight of the disk holder and the added pressure of the gas on top of the disk to obtain a proper seating of the valve. As many gases are difficult to hold considerable trouble is experienced due to improper seating and leaky valves. With my construction it will be seen that there are four forces exerting a closing pressure on the valve disk 6 against the seat. The gas pressure on the upper side of the disk, the weight of the disk holder stem etc., the downward spring pressure of the two bimetallic strips and the force of the spring 43 which is directed downward through the toggle link. The total downward or closing force is far greater than generally found on valves of this type. To obtain maximum closing force is of the greatest importance and in order to secure this pressure it has become more or less general practice to provide motor driven valves geared to the valve stem which greatly adds to the complication and cost.

Another feature of this construction is a valve which will not operate instantly on the opening or closing of the supply circuit. In the heating of buildings it has been found that it is not practical to use thermostats which are too sensitive for the reason that the air in a room does not change its temperature uniformly at all points. In fact there are certain "pockets" or strata of air that are hotter or colder than the main bulk of air that are constantly circulating through the room. If the control thermostat is too sensitive, say within one quarter of one degree, the rapid circulation of air at these slightly different temperatures would cause the ordinary gas valve to open and close with a series of closely timed cycles which would cause the burner to "back-fire" with the resulting danger and annoyance. It has been found that in general practice that in order to eliminate burner troubles two degrees variation in the thermostat is about the limit of practical temperature control.

With my valve it will be seen that there will be an appreciable "lag" or delay in the actual opening or closing of the valve after the operating circuit has been opened or closed. The delayed opening of the valve is due to the time required for the heating element to heat the bimetallic strips to the required point and the delayed closing action is due to the time required for the flow of cool gas passing through the upper valve chamber to cool the bimetallic strips to the point where they will close the valve. It will thus be seen that my valve will not respond to sudden or repeated making and breaking of the operating circuit which will allow very close limits of temperature adjustment on the room thermostat within a fraction of one degree. In other words the energy in the form of heat is gradually being stored in, or discharged from, the two strips and the heating element and no action in the valve proper will take place until a given amount of this heat has been absorbed or given off by the bimetallic strips.

Another feature of my construction is a valve which will operate with a small amount of current consumption. It will be seen that this is possible because of the fact that a small amount of energy in the form of heat may be slowly stored in the bimetallic strips until they reach a temperature that will make them operative. As a matter of fact it is practical to operate my valve with less than 4 watts current consumption whereas most closed circuit valves require more than twice this amount of current input.

Another feature of my construction is the elimination of all make and break contact points. Contact points are one of the greatest causes of valve failure either through losing their original adjustment or because they become pitted or burned out through arcing. It will be noted that there are no make and break contacts required in my construction.

Another feature of my construction is the elimination of all noise within the valve when it is energized. Where solenoid coils are used to hold the valve in an open position considerable objectional "A. C. hum" is developed. This is conducted to the rooms through the connecting pipes or ducts. With my construction there is no noise when the valve is energized as I do not use a form of winding that in any way sets up a magnetic field.

Another feature of my construction is to provide means for preventing any overheating of the operating parts. It will be seen that the gas after it enters the inlet is directed upward into the chamber formed by the cover plate 15 and impinges directly against the under-side of the bimetallic strips. This rapid flow of gas serves to keep all the operating parts at a low temperature and it will also be noted that the amount of gas flow through the valve is of course dependent on the temperature of the strips.

A structural feature for the upper bimetallic strip of the pair being thinner than the lower one, is that since its tendency to flex more upon the application of heat than the lower strip would tend to lift its ends from the lower strip, and since its ends are held down against the lower strip, this results in the entire strip pressing against the heating coil and holding it snugly between the strips at all times for the efficient transfer of heat with minimum current loss.

Having thus described my invention and shown its several advantages, it will be evident that changes in details of construction may easily be made without affecting the mode of operation, and I therefore feel entitled to cover the invention broadly within the scope of my appended claims.

I claim:

1. Apparatus of the character described comprising a valve body having separated through passages extending adjacent one another into one end of the body and terminating at spaced points, a closed compartment overlying said end of the body and the ends of the passages therein and forming a communicating chamber for said passages, a valve in one of said passages closing off the same and provided with a stem extending into said compartment, a heat-deflectable strip in said compartment extending substantially at right angles to said stem, means engaging one end of said strip with said stem, means anchoring the other end of said strip whereby the opposite end will bear against the stem to hold the valve closed, and electrically

heated means for heating the strip whereby its flexing will open the valve.

2. Apparatus of the character described comprising a valve body having separated through
5 passages extending adjacent one another into one end of the body and terminating at spaced points, a closed compartment overlying said end of the body and the ends of the passages therein and forming a communicating chamber for said
10 passages, a valve in one of said passages closing off the same and provided with a stem extending into said compartment, a heat-deflectable strip in said compartment extending substantially at right angles to said stem, means engaging one
15 end of said strip with said stem, means anchoring the other end of said strip whereby the opposite end will bear against the stem to hold the valve closed, and electrically heated means for heating the strip whereby its flexing will open the valve,
20 said strip extending substantially across the open ends of the passages so that fluid flowing from one to the other by way of said compartment will impinge said strip.

3. In a structure as specified in claim 1, spring-
25 actuated toggle means arranged to produce a snap opening to part way open only of said valve upon flexing of said strip while providing for further progressive opening upon further flexing of the strip, and said valve formed to present suc-
30 cessive openings for fluid flow upon opening movement of the same.

4. In a structure as specified in claim 1, spring-
actuated toggle means arranged to produce a
snap opening to part way open only of said valve
35 upon flexing of said strip while providing for further progressive opening upon further flexing of the strip, and said valve formed with an apertured sleeve slidable in the passage.

5. In a device of the character described, an electrically-operated thermostat comprising two pairs of heat deflectable flat metal strips, each pair composed of two sheets of dissimilar metals united together forming a bimetallic strip and the
5 two pairs being superimposed, means firmly mounting both pairs of strips at one end on a support with their free ends arranged for flexing simultaneously under restraint of the work to be done, and a flat flexible electrical heating element
10 sandwiched tightly between the two pairs of strips for controllably heating the same, the two pairs of strips being arranged in respect to their dissimilar metals to flex in the same direction upon the generation of heat in said heating element.

6. In a device of the character described, an electrically-operated thermostat comprising two
15 pairs of heat deflectable flat metal strips, each pair composed of two sheets of dissimilar metals united together forming a bimetallic strip and the two pairs being superimposed, means firmly
20 mounting both pairs of strips at one end on a support with their free ends arranged for flexing simultaneously under restraint of the work to be done, a flat flexible electrical heating element
25 sandwiched tightly between the two pairs of strips for controllably heating the same, the two pairs of strips being arranged in respect to their dissimilar metals to flex in the same direction upon the generation of heat in said heating element,
30 and one of said pairs of strips being of lighter gage metal than the other pair and arranged in a manner whereby the tendency to quicker and greater flexing of the lighter gage pair of strips upon the application of heat will bring increased
35 pressure on the electrical heating element sandwiched between the two pairs of strips.

DONALD H. McCORKLE.