

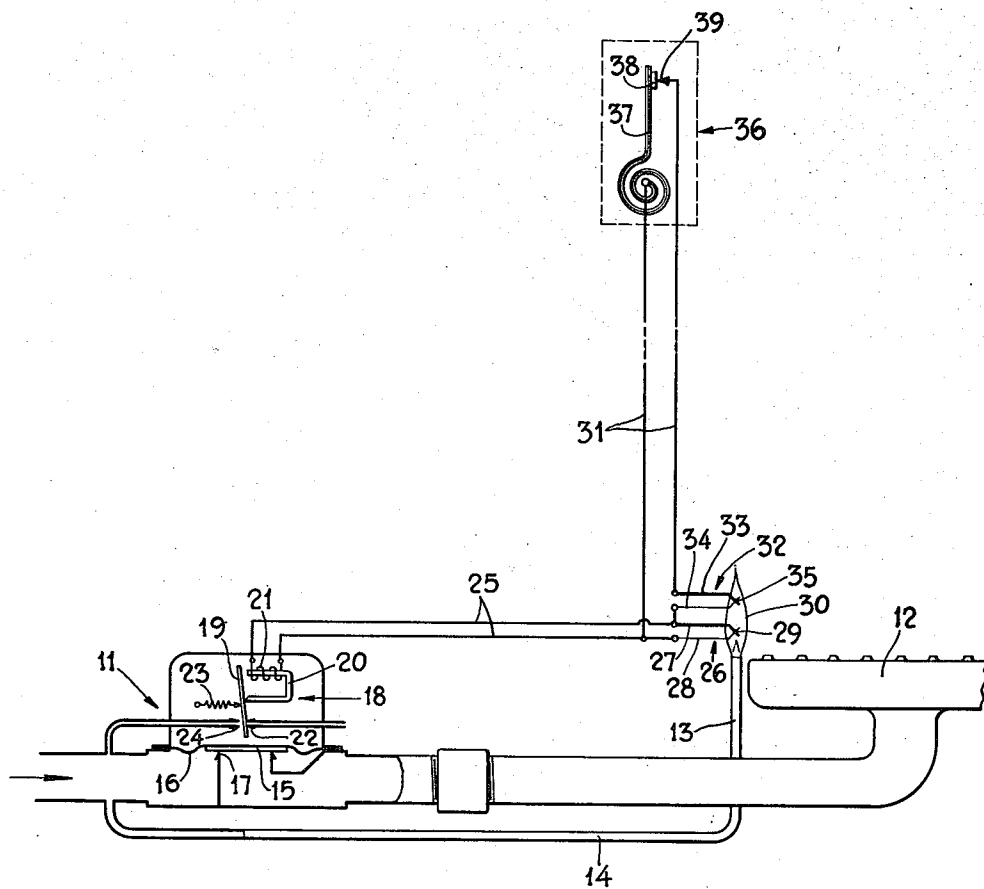
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THERMOELECTRIC CONTROL CIRCUIT

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THERMOELECTRIC CONTROL CIRCUIT

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My present invention relates to systems employing thermoelectric generating means, and more particularly to circuits for controlling such systems.

It is well known that the E. M. F. produced by an ordinary thermocouple is minute—in the order of 25 millivolts (delivered to a matched load) when it is heated by an ordinary gas flame and is constructed of the most effective known alloys (such as "Chromel" and "Copel") which are capable of withstanding the heat of the flame. When the amount of energy available from the thermocouple is also small, as when it is of a size adapted for heating by an ordinary pilot-burner flame and the energy is of the order of 20 milliwatts, it is necessary that the resistance of the conductors connecting the thermocouple to its load be low so that but a minimum amount of energy is "lost" in the conductors. When, in order to permit remote control of the energization of the load, the circuit is extended to a considerable distance from the thermocouple and the load, it is necessary to employ massive copper conductors for the purpose of minimizing the "line-loss"—as is pointed out in Ray patent, No. 2,294,694, wherein it is taught that such loss can be reduced by providing a plurality of thermocouples which are so constructed and arranged as to produce an E. M. F. higher than that of a single thermocouple, but the same amount of electrical energy, so that no additional heat is required. In order to remotely control a circuit wherein a single thermocouple is employed, it has been suggested that some form of relay, controllable from a remote position, be introduced into the circuit; an example of such an arrangement being found in the Lange patent, No. 2,265,294. However, an additional source of energy is then required for the relay, which is obviously undesirable.

In view of the foregoing, it is a general object of this invention to provide means whereby a circuit, which includes but a single thermocouple of the type described, can be controlled from a remote position by the aid of ordinary house or "bell" wiring, and without the requirement for energy other than that available from the means employed to heat the thermocouple. I accomplish this object by providing a controllable circuit in shunt to the load normally energized by the thermocouple, and means for introducing into the shunt circuit an E. M. F. opposing that generated by the thermocouple; which means may conveniently consist of an additional thermocouple heated by the same means as is employed for heating the load-energizing thermocouple. While

in Betz et al, Patent No. 2,217,785, it has been proposed to control a thermocouple circuit by means of a simple local shunt, such control is not effective for remote operation when ordinary house wiring is employed, as will be pointed out hereinafter by reference to actual tests made in connection with a controlling shunt circuit which included a source of opposing E. M. F., and with one which did not.

Other objects and advantages of the invention will be found in the description, the drawing, and in the claims; and, for full understanding of the invention, reference may be had to the following detailed description and accompanying drawing, the single figure of which is a schematic view of a burner control system embodying my invention.

In the drawing, the numeral 11 indicates a fluid control valve which is connected to supply fuel to a main gas burner 12, a pilot-burner 13 for the main burner being connected by a pipe 14 to the inlet of the valve. The valve 11 is of the electrically-controlled fluid-pressure-operated type and comprises a closure member 15 carried by a flexible diaphragm 16 and cooperable with a valve seat 17. To actuate the closure, the pressure of the gas acting on diaphragm 16 is varied by an electrically operated three-way pilot valve 18, which comprises a pivoted combination pilot-closure-member and armature 19 arranged to be attracted toward the upper arm of a U-shaped core 20 when the same is energized by passage of current through its coil winding 21. When armature 19 is in engagement with the vent jet 22, as shown, the fluid pressures acting on opposite sides of the diaphragm 16 are equal and the closure 15 is therefore held on its seat mainly by gravity; and when the armature is attracted, against the force of compression spring 23, into engagement with the inlet jet 24, the main closure is raised to open position by the fluid pressure acting on the underside of the diaphragm.

Connected to coil 21, by wires 25, is a thermocouple 26 composed of elements 27 and 28 which are joined to form a hot junction 29 positioned in the flame 30 of pilot burner 13. The energy generated by the thermocouple 26, passing through coil 21, is sufficient to cause attraction of armature 19 by the core 20 and thus effect opening of the main closure 15. To control the energization of the pilot valve 18, there is provided a circuit in shunt to the coil 21 and thermocouple 26. This shunt circuit comprises wires 31 and an additional thermocouple 32 composed of elements 33 and 34 which are joined to form a hot junction 35, also positioned in flame 30.

The thermoelectric property of element 27 differs from that of element 28 in the same sense as does the thermoelectric property of element 33 differ from that of element 34, as is indicated by the different widths of the lines representing the elements. While the materials of which the two thermocouples are constructed may be different to suit various circuit conditions, in the tests to be referred to hereinafter the elements 27 and 33 were of Copel and the elements 28 and 34 of Chromel. The upper ends of wires 31 lead to a thermostat 36 comprising a bimetallic member 37 which carries a contact 38 cooperable with a fixed contact 39. When these contacts are in engagement, as shown, the circuit through wires 31 is complete and, since the energy generated by the additional thermocouple 32 is substantially equal and opposite to that generated by thermocouple 26, coil 21 is deenergized and the valve closed. When the thermostat contacts open, the coil 21 is energized solely by the thermocouple 26 and consequently the valve is opened. If the pilot-burner flame 30 is extinguished, the coil is deenergized and the valve closes regardless of the condition of the thermostat.

In actual tests made in connection with the system shown and described, the circuit components had the following resistance values at room temperature: coil 21, 0.063 ohm; each of thermocouples 26 and 32, 0.113 ohm; wires 25, 0.010 ohm; wires 31, varied. The Copel and Chromel elements of each of the thermocouples were of No. 16 A. W. G., each 5 inches long; wires 25 of No. 14 A. W. G. copper, each 25 inches long; and wires 31 of No. 18 A. W. G. copper, of varied length. Armature 19 pulled-in when the voltage across coil 21 was 23 mv., and dropped-out at 17 mv. The flame 30 was so adjusted with respect to the thermocouples that the voltage across the coil was 24 mv. when the shunt circuit was open.

In the preliminary test, the additional thermocouple 32 was eliminated, i. e., the lower end of right-hand wire 31 was connected directly to the upper wire 25. The upper end portions of wires 31 were then shorted at varying distances from their bottom ends where they join wires 25. When the wires 31 were each 11 feet long (0.140 ohm total resistance), the voltage across the coil was 18 mv. and the armature failed to drop-out. Upon reduction of the length to 9 feet (0.115 ohm) the coil voltage was 17.5 mv. and the armature still failed to drop-out. Upon further reduction to 7.5 feet (0.096 ohm) the voltage was 17 mv. and the armature dropped-out. It is thus seen that the effectiveness of the simple shunt circuit is determined by its resistance, which resistance, under the conditions set forth, was too high when the wires 31 were each more than 7.5 feet in length. Obviously, by increasing the cross-sectional area of the shunt wires, the controlling distance can be extended. However to do so is usually impracticable due to the requirement for wire of a size greater than that employed in house wiring. The most convenient size wire for thermostatic control circuits, and that almost universally employed, is No. 18 A. W. G. In order to effectively extend the simple shunt circuit, described, to a distance of 45 feet, it would be necessary to employ copper wire of about No. 10 A. W. G.

Similar tests were then made with the additional thermocouple 32 connected as shown, and it was found that when the wires 31 were each 45 feet in length (0.575 ohm total resistance) the

voltage across the coil dropped to 17 mv.—just low enough to effect drop-out of the armature. When the wires were shorted at 32 feet, the voltage was 15.5 mv.; and at 12 feet, 10 mv. It is thus seen that when the opposing E. M. F. produced by a single thermocouple is introduced into the simple shunt circuit, the effective range of control of the same is increased six times. If it is desired to extend the control circuit still farther, a plurality of thermocouples can be employed to produce a higher opposing E. M. F.

While I have herein shown and described a specific embodiment of my invention, I wish it to be understood that modifications may be made without departing from the spirit of the invention, and that I intend therefore to be limited only by the scope of the appended claims.

I claim as my invention:

1. In a thermoelectric control system: an electrically operable device having an operated and an unoperated position, and biased to said unoperated position; thermoelectric generating means permanently connected to said device and normally capable of so energizing the device that it is moved to said operated position; and means for selectively controlling the energization of said device so that it is moved between said positions, comprising a circuit shunted across said device and said generating means and including additional thermoelectric generating means for producing an E. M. F. opposing that generated by said first-mentioned thermoelectric means, the resistance of said shunt circuit being so high that the shunt circuit is ineffective, without the aid of said opposing E. M. F., to reduce the amount of electrical energy received by the device to a value at which the device is moved to its unoperated position by said bias, and switching means for opening and closing said shunt circuit; both of said thermoelectric generating means being continuously active during normal operation of the system.

2. In a thermoelectric control system: an electrically operable device having an operated and an unoperated position, and biased to said unoperated position; thermoelectric generating means permanently connected to said device and normally capable of so energizing the device that it is moved to said operated position; and means for selectively controlling, from a position remote from the device and the generating means, the energization of said device so that it is moved between said positions, said controlling means comprising a circuit shunted across said device and said generating means and including additional thermoelectric generating means for producing an E. M. F. opposing that generated by said first-mentioned thermoelectric means, and switching means at said remote position for opening and closing said shunt circuit, the resistance of said shunt circuit being so high that the shunt circuit is ineffective, without the aid of said opposing E. M. F., to reduce the amount of electrical energy received by the device to a value at which the device is moved to its unoperated position by said bias; both of said thermoelectric generating means being continuously active during normal operation of the system.

3. A thermoelectric control system, as defined in claim 2, wherein the magnitudes of the E. M. F.'s produced by the thermoelectric generating means are substantially equal.

4. In a thermoelectric control system for a fluid-fuel consuming burner: an electrically operable valve for controlling fuel supply to said

burner and biased to closed position; thermoelectric generating means subjected to the heat of combustion of fuel adjacent said burner and permanently connected to said valve, said generating means being normally capable of so energizing said valve as to open it against the force of said bias; and means for so controlling the energization of said valve as to operate it between its open and closed positions, comprising a circuit shunted across said valve and said generating means and including additional thermoelectric generating means for producing an E. M. F. opposing that generated by said first-mentioned thermoelectric means, said additional thermoelectric generating means being continuously heated during normal operation of the system, and switching means for opening and closing said shunt circuit, the resistance of said shunt circuit being so high that the shunt circuit is ineffective, without the aid of said opposing E. M. F., to reduce the amount of electrical energy received by the valve to a value at which the valve is closed by the force of said bias.

5. In a thermoelectric control system for a fluid-fuel consuming burner: an electrically operable valve for controlling fuel supply to said burner and biased to closed position; thermo-

electric generating means normally continuously subjected to the heat of combustion of fuel adjacent said burner and permanently connected to said valve, said generating means being normally capable of so energizing said valve as to open it against the force of said bias; and means for selectively controlling, from a position remote from the valve and the generating means, the energization of said valve so as to operate it between its open and closed positions, said controlling means comprising a circuit shunted across said valve and said generating means and including additional thermoelectric generating means, also normally continuously subjected to the heat of combustion of fuel adjacent said burner, for producing an E. M. F. opposing that generated by said first-mentioned thermoelectric means, and switching means at said remote position for opening and closing said shunt circuit, the resistance of said shunt circuit being so high that the shunt circuit is ineffective, without the aid of said opposing E. M. F., to reduce the amount of electrical energy received by the valve to a value at which the valve is closed by the force of said bias.

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