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2,385,530

THERMOELECTRIC DEVICE

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Fig. 1

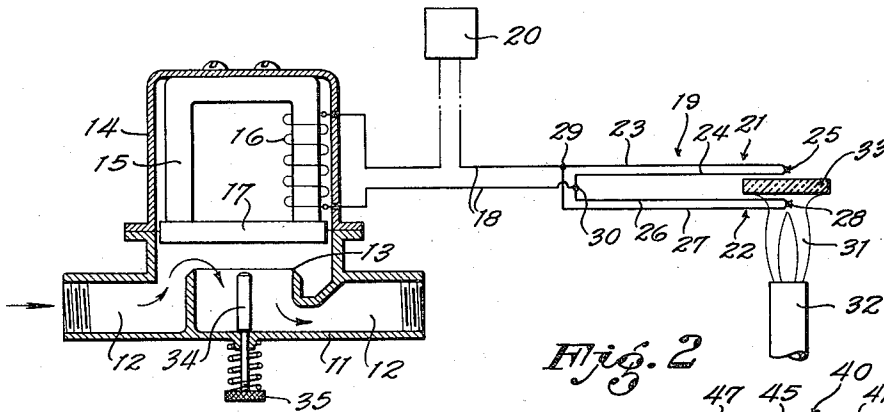


Fig. 2

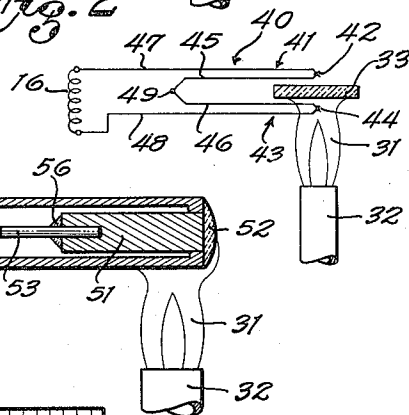


Fig. 3

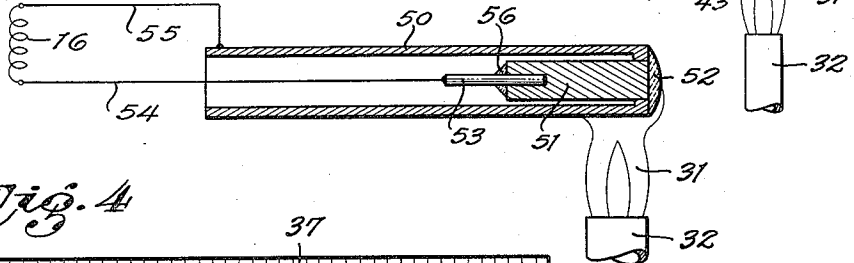
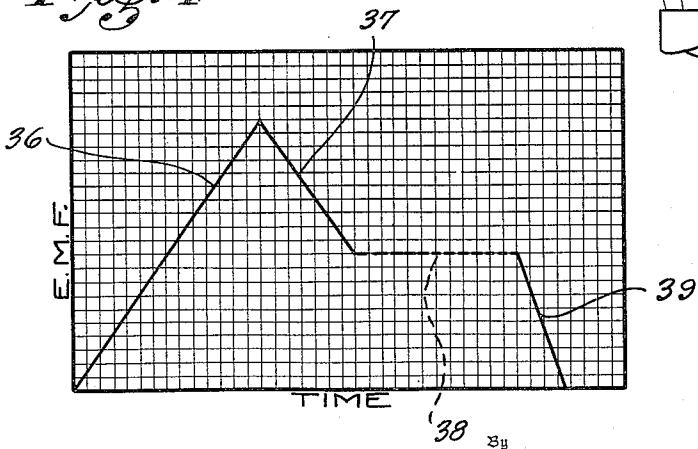


Fig. 4



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THERMOELECTRIC DEVICE

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5 Claims. (Cl. 175—335)

My present invention relates to thermoelectric devices of the type adapted to generate electricity when a suitable temperature difference exists in the device.

A main object of this invention is the provision of a device of the character described which, upon the application of heat thereto, generates a relatively high initial E. M. F. which is rapidly reduced to a constant lower value upon continued heating.

While not so limited, the device of the present invention has particular utility for the energization of the electromagnet employed in electromagnetic "manual-reset" control means for a fluid control valve or electric switch. Such control means generally comprises an armature, movable to operate the valve member or switching mechanism, and an electromagnet adapted to magnetically hold the armature only when the same is first manually brought into engagement with the core of the electromagnet—the electromagnet being incapable of attracting the armature through space. When the energization of the electromagnet is interrupted, or sufficiently reduced, the armature, being biased away from the electromagnet, operates the valve member or switching means to render the system controlled thereby "safe"—manual-resetting of the control means then being required to reinitiate operation of the system, after the abnormal condition which caused the deenergization of the electromagnet has been corrected.

When the manual-reset control means is employed in connection with gas-burning apparatus, the thermoelectric generating device is preferably arranged to be heated by the pilot burner of such apparatus, so that if the same becomes extinguished, the control means acts to shut-off the supply of gas to the main burner. Obviously, it is desirable that such safety shut-off should occur as promptly as possible. However, as is well known, the energization necessary for initial magnetic holding of the armature in the resetting operation is considerably greater than that required to maintain it in its held position; an undesirably large period therefore elapsing after extinguishment of the pilot burner flame before the thermoelectric device can cool to a temperature at which its energization of the electromagnet is sufficiently reduced to permit release of the armature. The thermoelectric device of the present invention is adapted, upon heating, to generate initially the large amount of energy necessary for readily resetting the armature—continued heating of the device effecting rapid

reduction of its output of energy to a constant amount which is only slightly more than that required to maintain the armature in its reset position, so that upon extinguishment of the pilot burner flame the armature is promptly released.

Another object of this invention is the provision of a thermoelectric device, of the character described, wherein the rate of reduction of generation upon cooling is greater than is its rate of increase upon initial heating.

Another object is the provision, in a thermoelectric device of the character described, of independent means for generating opposing E. M. F.'s, and means for delaying the operation of one of said means upon initial heating of the device.

Other objects and advantages of the invention will be found in the description, the drawing, and the appended claims; and for complete understanding of the invention, reference may be had to the following detailed description and accompanying drawing wherein:

Figure 1 is a generally diagrammatic view of a fluid control system including a thermoelectric device embodying my invention;

Figure 2 is a diagrammatic view of a modified form of thermoelectric device according to my invention;

Figure 3 is a longitudinal sectional view of a further modification of the device; and

Figure 4 is a graph illustrating typical generation characteristics of the devices shown in the other figures.

Referring first to Fig. 1 of the drawing, the numeral 11 indicates a valve casing having a passage 12 therethrough provided with a valve seat 13. Mounted in a housing 14, covering an opening in the top wall of the valve casing, is an electromagnet comprising a U-shaped core 15, around one arm of which is wound an energizing coil 16. Cooperable with the core 15 is a disk-shaped armature 17 which also serves as a closure member for the valve by cooperation with the seat 13.

Connected by leads 18 to the coil 16 is a thermoelectric device generally indicated at 19, a condition-responsive switching device 20 being inserted in one of the leads. The device 19 comprises a pair of thermocouples 21 and 22; the thermocouple 21 being composed of thermoelectrically dissimilar elements or wires 23 and 24 joined at their outer ends to form a hot junction 25, and the thermocouple 22 being similarly com-

posed of elements 26 and 27 having a hot junction 28.

The thermocouples are interconnected to form a closed circuit, in series-aiding relation, i. e., when both of the hot junctions are heated, the polarity of element 23 is opposite to that of element 27 to which it is connected, and likewise the polarity of element 24 is opposite to that of element 26. For the sake of convenience it may be assumed that the two thermocouples are constructed of the same materials, such as the well-known alloys "Chromel" and "Copel," in which case elements 23 and 26 are of one of these alloys and elements 24 and 27 of the other. However, it is to be understood that for the purpose of my invention the thermocouples may be constructed of such different materials that, under the same conditions, the generation of one thermocouple is somewhat greater than that of the other. Since the thermocouples are in series-aiding relation to each other, maximum current flows in the closed circuit consisting of elements 23, 24, 26 and 27 when both of the hot junctions 25 and 28 are heated; however, under that condition, minimum current then flows through leads 18 to the electromagnet coil 16 since the leads are connected to the "cold junction" connections 29 and 30 of the thermocouples, and hence, effectively, the coil is energized by both of the thermocouples in parallel, the voltage delivered to the coil by one thermocouple being in a sense opposite to that delivered by the other.

The thermoelectric device 19 is shown arranged to be heated by the flame 31 of a burner 32, hot junction 28 being exposed directly to the flame and hot junction 25 being shielded from direct radiation from the flame by an insulating baffle 33.

In describing the operation of the system shown in Fig. 1, it will be assumed, by way of example, that the valve casing 11 is connected to supply gaseous fuel to a main burner, for which the burner 32 serves as a pilot, an automatically or manually operated valve being inserted between the casing 11 and the main burner. The pilot burner 32 is preferably connected between the two valves so that its supply of fuel is controlled by the valve illustrated. The closure member 17 of that valve is shown in the figure in its open position, in which position it normally will remain while the pilot burner 32 is burning and the switch 20 is closed, this switch being adapted to open only when some abnormal condition exists, such as an excess of the temperature or pressure to which it may be responsive. Let it be assumed that the pilot burner flame 31 has been extinguished and that the resultant cessation of current generation by the thermoelectric device 19 has caused deenergization of the electromagnet so that the armature-closure member 17 has dropped by gravity into engagement with seat 13, obstructing fuel supply to the main burner and to the pilot burner 32. The closure member 17 is now raised from its seat, and into engagement with the pole faces of core 15, by manual operation of a reset stem 34 through its externally extending button portion 35. While thus holding the armature-closure member 17 in engagement with the core 15, the fuel now flowing to the pilot burner is lighted by a match. The temperature of the hot junction 28 of the lower thermocouple 22 is quickly raised by the flame (the hot junction 25 of the upper thermocouple 21 being initially substantially unaffected on account of the baffle 33) so that current flows

to the electromagnet in an amount soon sufficient to cause the armature 17 to be magnetically held in engagement with the core 15, whereupon the reset stem 34 may be released, the parts then being in the positions shown in Fig. 1. It will be understood that the current generated by thermocouple 22 also flows through the other thermocouple 21, in parallel with the electromagnet coil 16, but this has no useful effect. Continued heating of the baffle 33, which is preferably of ceramic material, raises its temperature to a degree at which the hot junction 25 is affected by the heat then radiated by the baffle, which causes the thermocouple 21 to generate current which tends to energize coil 16 in a sense opposite to that due to thermocouple 22, with the result that the power of the electromagnet is substantially reduced, but is still sufficient to maintain the armature in its attracted position.

If the pilot burner flame 31 should now be extinguished, both of the hot junctions 25 and 28 will rapidly assume the same temperature (or a temperature at which their individual effects are equal and opposite) since, after removal of the flame, they are substantially equally affected by radiation from the heat-retaining baffle 33, and the resultant deenergization of the electromagnet effects immediate release of the armature-closure member to render the system "safe."

The operation of the thermoelectric device 19 is graphically shown in Fig. 4: The line 36 indicates the initial generation of the device due to the effect of heating substantially only the thermocouple 22, the E. M. F. represented by the upper portion of this line being great enough to permit ready resetting of the armature; the line 37 indicates the subsequent reduction in energy (to about one-half the maximum value) due to the additional heating of thermocouple 21; the broken line 38 indicates the constant reduced value of generation by the device; and the steeply inclined line 39 indicates the accelerated equalization of generation of the opposing thermocouples, described in the preceding paragraph.

In Fig. 2, I have shown a modified form of thermoelectric device, the effective operation of which is substantially the same as that of the device 19 shown in Fig. 1. This device, generally indicated at 40, comprises an upper thermocouple 41 having a hot junction 42, and a lower thermocouple 43 having a hot junction 44, the hot junctions being separated by the baffle 33 as in the system of Fig. 1. The thermocouples are connected in series with each other (to form a cold junction 49) and with the load 16, element 45 of thermocouple 41 being of the same (or thermoelectrically-similar) material as the element 46 of thermocouple 43, and, likewise, the element 47 of the same material as element 48. The thermocouples are thus in series-opposing relation to each other so that the energy delivered to the coil 16, when both of the hot junctions are heated, is equal to the difference between that generated by the individual thermocouples; maximum energy being produced in the coil when the hot junction 44, only, is heated.

The still further modified form of thermoelectric device shown in Fig. 3 comprises an elongated tubular member 50, within which is a short rod 51 which is secured at one end, as by fusion or welding 52, to one end of the tubular member, the remainder of the rod being spaced from that member. Welded to the inner end of rod 51 is a smaller rod 53, from the free end of which a lead 54 extends to one terminal of the coil 16,

the other coil terminal being connected by a lead 55 to the free end of the member 50. The rod 51 is of metal having one thermoelectric power, such as "Chromel," and the tubular member 50 of metal having a substantially different thermoelectric power, such as "Alumel"; the small rod 53 being of the same metal as that of member 50, or of some other metal which differs thermoelectrically from that of rod 51 and in the same sense as that of member 50. The welded portion 52 forms the hot junction of the device, and the junction 56 between the rods 51 and 53 serves as an intermediate or secondary hot junction; the portions of the elements to which the coil leads are connected constituting the effective cold junction of the device. Upon initial heating, the generation of the device is due solely to the rise in temperature at the hot junction 52, the intermediate junction 56 being thermally substantially unaffected since it is shielded from the flame. Upon continued heating, the junction 56 becomes heated mainly by conduction through rod 51 and the E. M. F. thus produced opposes that generated at junction 52, with the result that the current through the coil is reduced. The device thus functions in a manner similar to that of the other devices shown in Figs. 1 and 2.

While I have herein shown and described specific embodiments 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 combination: an electromagnetically operated device comprising a core, a coil for said core, an armature adapted to be magnetically held in attracted position by said core only when it is first mechanically brought into engagement therewith and while the core is energized by current flow through said coil, said armature being biased to unattracted position, means for mechanically moving the armature into engagement with the core, and control means connected to said armature; a thermoelectric generating device for energizing said coil and connected thereto; and a source of heat for said thermoelectric generating device; said thermoelectric generating device being adapted to supply to said coil a predetermined amount of current upon initial heating by said source and a smaller amount after prolonged heating, and comprising a pair of thermocouples each having effectively a "hot" junction and a "cold" junction; said thermocouples being so electrically interconnected that the generation of the individual couples of the thermoelectric generating device, due to the heating of their hot junctions, is in opposition; one of said hot junctions being subjected directly to said source of heat; the other of the hot junctions being so arranged that it is only indirectly heated by said source, so that upon continued heating its temperature approaches but does not reach the temperature of said one of the hot junctions; the cold junctions of the generating device being so arranged that they are substantially unaffected by the heat of said source.

2. In combination: an electromagnetically operated device comprising a core, a coil for said core, an armature adapted to be magnetically held in attracted position by said core only when it is first mechanically brought into engagement therewith and while the core is energized by current flow through said coil, said armature being

biased to unattracted position, means for mechanically moving the armature into engagement with the core, and control means connected to said armature; a thermoelectric generating device for energizing said coil and connected thereto; and a source of heat for said thermoelectric generating device; said thermoelectric generating device being adapted to supply to said coil a predetermined amount of current upon initial heating by said source and a smaller amount after prolonged heating, and comprising a pair of thermocouples each having effectively a "hot" junction and a "cold" junction; said thermocouples being so electrically interconnected that the generation of the individual couples of the thermoelectric generating device, due to the heating of their hot junctions, is in opposition; one of said hot junctions being subjected directly to said source of heat; and means for shielding the other of the hot junctions from direct radiation of heat from said source; the cold junctions of the generating device being so arranged that they are substantially unaffected by the heat of said source.

3. In combination: an electromagnetically operated device comprising a core, a coil for said core, an armature adapted to be magnetically held in attracted position by said core only when it is first mechanically brought into engagement therewith and while the core is energized by current flow through said coil, said armature being biased to unattracted position, means for mechanically moving the armature into engagement with the core, and control means connected to said armature; a thermoelectric generating device for energizing said coil and connected thereto; and means for producing a flame for heating said thermoelectric generating device; said thermoelectric generating device being adapted to supply to said coil a predetermined amount of current upon initial heating by said flame and a smaller amount after prolonged heating, and comprising a pair of thermocouples each having effectively a "hot" and a "cold" junction; said hot junctions being positioned adjacent each other for heating by said flame; and a baffle interposed between said hot junctions and serving to screen one of the hot junctions from direct radiation from the flame while permitting direct subjection to the flame of the other of the hot junctions; said thermocouples being so electrically interconnected that the generation of the individual couples of the thermoelectric generating device, due to the heating of their hot junctions, is in opposition.

4. In combination: an electromagnetically operated device comprising a core, a coil for said core, an armature adapted to be magnetically held in attracted position by said core only when it is first mechanically brought into engagement therewith and while the core is energized by current flow through said coil, said armature being biased to unattracted position, means for mechanically moving the armature into engagement with the core, and control means connected to said armature; a thermoelectric generating device for energizing said coil and connected thereto; and means for producing a flame for heating said thermoelectric generating device; said thermoelectric generating device being adapted to supply to said coil a predetermined amount of current upon initial heating by said flame and a smaller amount after prolonged heating, and comprising a pair of thermocouples each having a "hot" and, effectively, a "cold" junction; said

hot junctions being located adjacent each other for heating by said flame; a baffle interposed between said hot junctions and serving to screen one of the hot junctions from direct radiation from the flame while permitting the other of the hot junctions to be exposed directly to the flame; said thermocouples being joined together at one of their respective cold-junction ends in series-aiding relation to each other, the other of the respective cold-junction ends of the thermocouples being likewise joined together; and a lead extending to said coil from each of said junctions of the cold-junction ends of the thermocouples.

5. In combination: an electromagnetically operated device comprising a core, a coil for said core, an armature adapted to be magnetically held in attracted position by said core only when it is first mechanically brought into engagement therewith and while the core is energized by current flow through said coil, said armature being biased to unattracted position, means for mechanically moving the armature into engagement with the core, and control means connected to said armature; a thermoelectric generating de-

vice for energizing said coil and connected thereto; and means for producing a flame for heating said thermoelectric generating device; said thermoelectric generating device being adapted to supply to said coil a predetermined amount of current upon initial heating by said flame and a smaller amount after prolonged heating, and comprising a pair of thermocouples each having a "hot" junction and, effectively, a "cold" junction; said hot junctions being located adjacent each other for heating by said flame; a baffle interposed between said hot junctions and serving to screen one of the hot junctions from direct radiation from the flame while permitting the other of the hot junctions to be exposed directly to the flame; said thermocouples being joined together at one of their respective cold-junction ends in series-opposing relation to each other; and a lead extending to said coil from each of the other cold-junction ends of the thermocouples; the cold junctions of the generating device being so arranged that they are substantially unaffected by the heat of said flame.

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