July 25, 1944. W. L. LUDWICK 2,354,529

CONTROL DEVICE

Filed June 3, 1942

Fig. 1

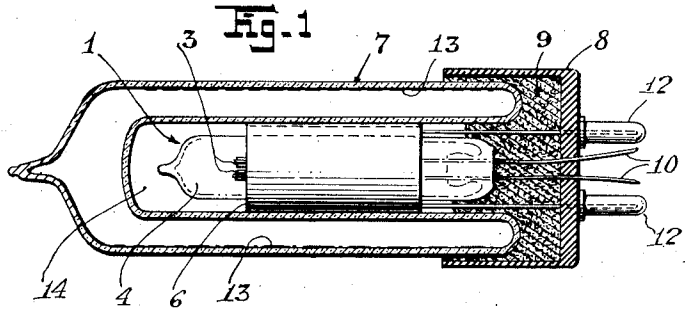


Fig. 2

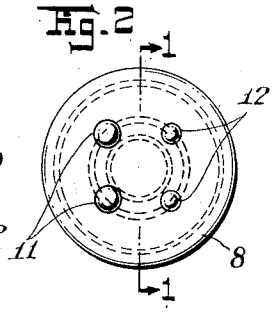
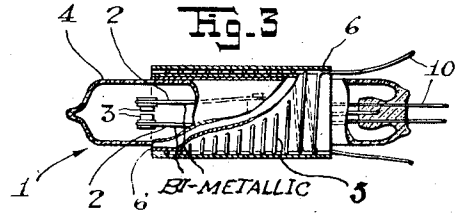


Fig. 3



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2,354,529

CONTROL DEVICE

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5 Claims. (Cl. 200—122)

My invention relates to controlling the thermal characteristics of control devices, and has particular relation to electrically operated relays of the thermal type.

It has been very difficult in thermal relays of conventional design to obtain a wide control over the actuating and restoring periods of the relays—that is, over the operating periods between the times of starting and stopping of energization of the relays and the respectively responding opening or closing of the relay contact points. Moreover, there has been a difficult problem in obtaining relays having operating periods which are substantially independent of variations in the ambient temperature. For instance, it has been standard practice to use a housing consisting of a single glass bulb which is evacuated or filled with a suitable inert gas. A thermal relay with such a housing is fast-acting; when energizing voltage is applied to its heating coil its thermal elements reach very quickly their temperature for full actuation—hereinafter termed the actuating temperature; also the thermal elements cool off fairly rapidly once the energizing voltage is removed. When substantially longer operating periods are desired, as of the order of several minutes, it has been customary to encase the relay in a block of metal having large heat capacity. This has the effect of delaying the rise in temperature of the thermal elements, but in these arrangements the operating periods for the relays are in practice limited to a maximum of about four or five minutes. This limitation in the operating periods arises from the fact that these relay arrangements have a high rate of heat loss which operates to stabilize the temperature of the thermal elements at a value below that required to actuate the relay. In many control systems however there are desired thermal relays having much longer operating periods as of a substantial fraction of an hour or as long as several hours. I have found that such long operating periods can be obtained. As a generality I find that the operating periods of thermal relays can be very accurately and flexibly controlled over wide ranges while yet realizing a sensitive and reliable relay operation, and that this can be accomplished by very simple means.

It is accordingly an object of my invention to provide new and improved means for controlling the thermal characteristics of control devices and, particularly, the operating periods of thermal relays.

Another object is to provide improvements in thermal relays which are adapted to permit the operating periods for the relays to be set at any value over a wide range and to be substantially independent of variations in ambient temperature.

Another object is to provide an improved thermal relay having a substantially longer operating period than has been heretofore obtained.

Still another object is to accomplish the above objectives inexpensively by simple structure and arrangement.

Still other objects of my invention will more fully appear from the following description and appended claims.

In the description of my invention reference is had to the accompanying drawing of which:

Figure 1 is a view of a thermal relay incorporating my invention, wherein the outer housing of the relay is in section substantially on the line 1—1 of Figure 2;

Figure 2 is an end view of the base portion of the relay shown in Figure 1; and

Figure 3 is a view, partly in section and partly broken away, of the relay proper.

Reference being had to the accompanying drawing, there will be seen a standard thermostatic unit 1 which, for purposes of illustration, may comprise a pair of thermal or bi-metal arms 2 carrying contact points 3 and mounted in cantilever fashion within a glass bulb 4, the contact points being for example held in open positions when the unit is in a cool state. The thermal arms are temperature-actuated by a heating coil 5 which in my invention is preferably mounted externally of the bulb 4, on the outer periphery thereof, and interposed between insulating wrappings 6. This bulb and coil assembly is encased in a highly efficient heat conservator comprising a closed double-walled glass jacket or casing 7, known otherwise as a Dewar tube, and the assembly and enveloping casing are seated and cemented to a socket or standard tube base 8. As so mounted there is formed a chamber 14 between the bulb 4 and the casing 7 in which is disposed the heating coil 5. The socket is heat-insulated from the assembly and casing by heat insulation 9, which may be rock wool or other suitable insulating material. Lead wires 10 serve to connect the thermal arms 2 and heating coil 5 to respective pairs of terminal pins 11 and 12 provided on the tube base.

For best heat conservation, the casing 7 is evacuated to retard any heat escape by conduction or convection and the walls of the jacket are silvered as at 13 to prevent escape of heat by radiation. The space chamber 14 between the casing and the bulb 4 is preferably filled with a gas having large heat-storage capacity, which may for example be air. The inner bulb 4 is evacuated or filled with a gas having high heat conductivity, such as hydrogen, the pressure of filling depending upon the particular thermal characteristics desired as will hereinafter appear.

In this arrangement of my invention the air chamber 14 acts as a heat storage medium for actuating the relay. This medium is very highly

thermally insulated from the outside ambient by the double-walled casing 7 and thus the relay has inherently a very long restoring period. Of course the restoring period can be made shorter, as may be desired, by reducing the amount of vacuum in the space between the walls and the casing, by filling the space with gases having particular conductivity characteristics and by providing the jacket without silvering.

The great amount of heat insulation provided the relay by the double-walled casing 7 enables the actuating period of the relay to be made very long or, if desired, very short. For instance, for a given wattage expenditure in the heating coil the actuating period can be made shorter or longer by selection of the conductivity between the air chamber 14 and the thermal arms 2. For a maximum heat conductivity to get a short actuating period, the heating coil may be applied directly to the bulb 4 and the bulb may be filled to a substantial pressure, say to that of the atmosphere, with a gas having high heat conductivity, such as hydrogen. For a minimum heat conductivity, to get a long actuating period, the heating winding may be interposed between one or more layers of heat insulating material, such as is here shown, and the bulb 4 may be evacuated. Of course, intermediate values for the actuating period can be obtained by introducing hydrogen in the bulb 4 to more or less pressure and by using more or less thickness in insulating wrapping inside and outside the heating coil.

For good heat conductivity between the air chamber 14 and the thermal arms, the actuating period may also be varied through wide limits with my invention merely by varying the wattage expenditure in the heating coil. For example, when a high wattage is expended in the heating coil the thermal arms will heat up and be actuated very rapidly because of the very small heat loss from the system. On the other hand, when a low wattage is expended in the heating coil, the thermal arms will heat up very slowly but will definitely reach their actuating temperature, so long as the rate of heat input of the coil just exceeds the very slow rate of heat loss from the relay container.

As typical values for the ranges of the operating periods of the relay herein described, I find that by the expedients above-noted the actuating period may be varied from a few seconds to a substantial fraction of an hour, as of thirty minutes or more; and that the restoration period may be varied from a few minutes to several hours. The longer restoration periods are here obtained reliably, but it will be understood that as the restoration period is made longer better regulation for the energizing voltage of the heating coil is required.

While I preferably place the heating coil outside the inner bulb 4 which contains the thermal arms, and fill the intervening space 14 between the bulb 4 and the outer casing 7 with air to serve as a heat storage medium, it will be understood that these particular conditions may be varied to obtain special operating characteristics. For example, I may fill the space 14 with one or another fluids having particular heat-conducting ability and heat-storing capacity. Also, I may mount the heating coil inside the bulb 4 to obtain extremely rapid actuating periods. By these and the other expedients hereinabove noted I may also exercise a substantial relative control over the actuating and restoring periods of the relay.

It is seen that by my invention I obtain a wide control over the actuating characteristics of thermal relays and that these characteristics are rendered substantially independent of the ambient temperature. Yet I obtain these improvements very inexpensively at only a small increase in the over-all size of the relay.

While my invention has especial utility in connection with relays of the thermal type, I intend no unnecessary limitation thereto as my invention has also advantageous application with relay and control systems generally wherein a high degree of heat insulation of particular operative elements of the systems is required to rule out errors from variations in ambient temperature and to obtain wider temperature-controlling effects. Also, it may be understood that many changes and modifications may be made in the particular embodiment of my invention herein shown and described without departing from the scope of my invention, which I endeavor to express according to the following claims.

I claim:

1. A thermal relay comprising a thermally-responsive element, a bulb enclosing said element, a heating coil surrounding said bulb, and a housing for said bulb and heating coil comprising a double-walled casing having the space between the walls thereof substantially evacuated of air, said housing being sealed to said bulb to form therewith a closed chamber for said heating coil, said chamber containing gas.

2. A thermal relay comprising thermally-responsive means; a glass bulb enclosing said responsive means; a heating element applied externally to said bulb; and an outer double-walled casing covering said bulb and heating element, said casing being sealed to said bulb to form an enclosed chamber for said heating element, said chamber containing a fluid adapted to serve as a heat-storage medium for the heating element.

3. A thermal relay comprising a temperature-responsive element, a bulb enclosing said element and substantially evacuated of air, a heating coil surrounding said bulb, and an enveloping double-walled glass casing sealed to said bulb to form an enclosed chamber for said heating coil, said chamber containing air and said heating coil being heat insulated from said bulb.

4. A thermal relay comprising a temperature-responsive element; a bulb enclosing said element and containing a relatively high conductive gas at predetermined pressure; a heating element applied externally to said bulb; and an outer covering sealed to said bulb to form an enclosed chamber for said heating element, said chamber containing a gas serving as a heat-storing medium for said heating element, and said outer covering being double-walled and having the space between the walls thereof substantially evacuated.

5. A thermal relay comprising a temperature-responsive element, a bulb enclosing said element and containing a fluid of predetermined conductivity; heating means for said element; a double-walled casing enclosing said bulb and having the space between the walls thereof substantially evacuated of air, said casing forming a closed chamber about said bulb; and a heat-storing medium in said chamber.

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