March 12, 1940. S. A. BOKOVOY 2,192,960

HEAT RESPONSIVE DEVICE

Filed April 30, 1936

Fig. 1.

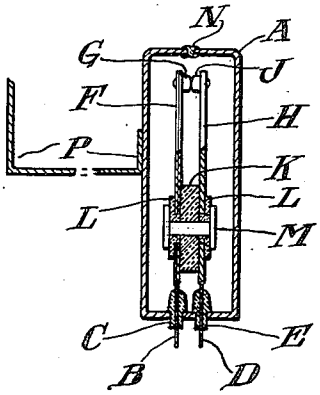


Fig. 2.

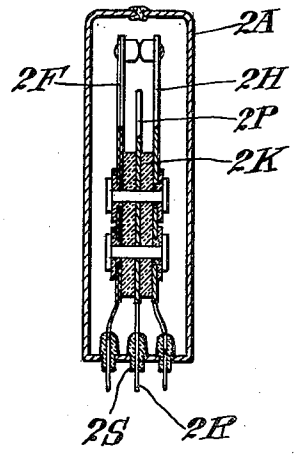


Fig. 3.

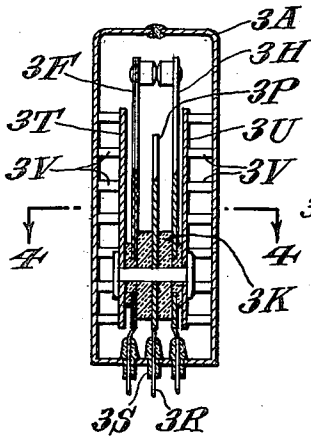


Fig. 4.

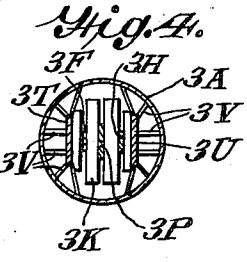


Fig. 5.

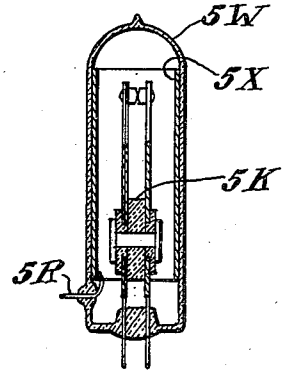
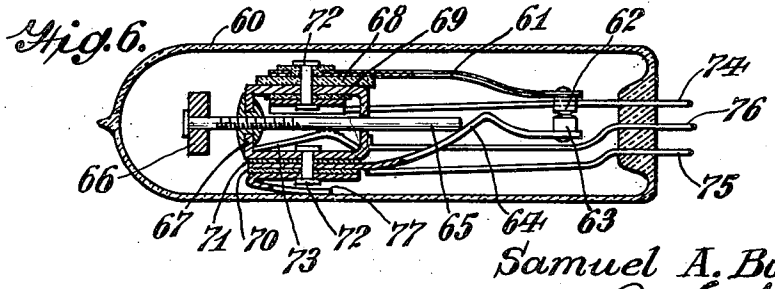


Fig. 6.



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UNITED STATES PATENT OFFICE

2,192,960

HEAT RESPONSIVE DEVICE

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Application April 30, 1936, Serial No. 77,245

4 Claims. (Cl. 200—138)

This invention relates to heat-responsive devices and particularly to thermostats, thermocouples, etc., operating in vacuo or in an attenuated atmosphere of gas.

The prior art is replete with thermostats and like heat responsive devices contained in sealed glass envelopes. Usually the glass envelope or tube is highly evacuated or it contains a rarefied gas, such mode of construction having been found effective in reducing sparking between the circuit closing members. One disadvantage of prior art thermostats of the type described, which is especially apparent when the thermostat is used in connection with apparatus requiring rapid and accurate response to variations in the temperature of the ambient medium, is the fact that the vacuum (or rarefied gas) within the envelope inhibits the transmission of heat to the thermal responsive elements within the tube at a rapid rate. Prior art tube-type thermostats may therefore be said to exhibit an inherent "time lag".

An object of the invention is to provide a hermetically sealed heat responsive device, the operation of which is characterized by minimum time lag.

Another object of the invention is to provide a heat responsive device contained in a sealed envelope wherein the transmission of heat from the ambient medium to the area immediately adjacent the active elements within the envelope is effected at a rapid rate.

Another object of the invention is to provide a sealed heat responsive tube having an ambient thermal compensator incorporated therein.

Another object of the invention is to provide an extremely accurate, rapid-acting, inexpensive and trouble-free thermostat.

The above and other objects are accomplished in accordance with the invention by providing a metallic heat-conducting member in heat exchange relation with the thermal responsive element and the exterior of the envelope containing the element. The metallic heat-conducting member may constitute at least a portion of the envelope or tube. It may be a rod or ribbon-like member or it may be a metal sheath, positioned adjacent the heat responsive element, and provided with an extension passing through glass or metal wall of the tube. Again, if the device is provided with an interior electrode supporting frame the frame itself may be provided with an external heat-conducting lead. If desired a number of spokes or fins radiating from the "compensator" to the tube wall may be provided for increasing the heat exchange ratio between the exterior wall and the heat responsive element.

Certain details of construction together with other objects and advantages will be apparent and the invention itself will be best understood by reference to the following description and to the accompanying drawing, wherein

Figure 1 is a sectional elevation of a thermostat enclosed in a metal tube,

Fig. 2 is a sectional elevation of a thermostat enclosed in a metal tube and including an auxiliary thermal compensator and external connection therefor,

Fig. 3 is a sectional elevation of a thermostat enclosed in a metal tube and including a plurality of thermal compensators connected directly to the wall of the tube,

Fig. 4 is a cross-sectional view taken on the line 4—4 of Fig. 3,

Fig. 5 is a sectional elevation of a thermostat enclosed in a glass tube and including a thermal compensator in the form of a sheath within the tube, and

Fig. 6 is a sectional view of an adjustable thermostat of a known type wherein the thermal compensator of the present invention is constituted in part by the electrode-supporting structure.

Referring now in detail to Fig. 1 which shows a simplified form of the invention. An envelope or tube formed of steel or other excellent heat conducting metal is designated A. The tube contains a pair of inwardly extending leads B and D, which enter the tube through ceramic beads C and E in the base of the tube and support a pair of parallelly arranged contact arms F and H. Arm F is the heat-responsive element; it is constituted by a bi-metallic laminated strip which changes its contour under varying temperatures to open or close, as the case may be, the contact members G and J. The contact arms F and H are maintained in spaced relation by means of an electrical insulator K, washer L and screw or rivet M. The tube A may be highly evacuated or it may contain a filling of hydrogen gas or the like, at an attenuated pressure. Evacuation is effected and the gas sealed in the tube through a later sealed orifice N in the tube wall. The improved operating characteristics of the device of Fig. 1 over glass enclosed thermo-regulators may be attributed to the fact that the metal wall of the tube is a far better conductor of heat than is the glass of prior art devices, consequently the temperature adjacent the bi-metallic strip F and the actuation of this strip,

will follow temperature variations in the ambient medium exterior of the tube more rapidly and closely. When it is required that operation of the strip F be affected in part by the temperature of an ambient medium remote from the immediate proximity to the tube A, a heat conducting lead P may be provided from the remote point to the outer wall of the tube, and joined thereto as by a weld or by solder. One such use is described in copending application Serial No. 61,834, (RCAV–4353) to Samuel A. Bokovoy, filed January 31, 1936, and assigned to Radio Corporation of America.

In Fig. 2 the heat transfer member, here designated 2P, is sealed within the metal tube 2A, instead of being fixed to the outside of the tube as in Fig. 1. Member 2P is in the form of a strip or ribbon of metal positioned between and in close heat exchange relation with the contact arms 2F and 2H. It is supported on the insulator 2K which carries the circuit closing current carrying arms 2F and 2H and has an external heat conductive connection 2R which enters the tube through a ceramic seal 2S. The provision of this auxiliary heat transfer member 2P within the tube aids in varying the temperature immediately adjacent the bi-metallic strip 2F in accordance with temperature variations in the external ambient medium.

The tube thermostat of Figs. 3 and 4 is provided with three ambient thermal compensator strips. The center strip 3P may be similar in all respects to that described in connection with Fig. 2, that is to say, it is mounted within a metal tube 3A on an insulator 3K; it is parallelly arranged with respect to the contact arms 3F and 3H and has an external connection 3R which extends through a ceramic seal 3S in the base or wall of the tube. The other compsenator strips are designated respectively, 3T and 3U and like strip 3P are mounted on the insulator 3K. Unlike strip 3P they are provided with no external leads but are maintained in heat transfer relation with the inner wall of the tube by means of a plurality of heat conducting metal spokes or fins 3V. Heat transmitted or dissipated through compsenator strip 3P, through lead 3R, and strips 3T and 3U through fins 3V, ensure a temperature adjacent the thermal responsive arm 3F closely approximating that of the external ambient medium.

The thermostat of Fig. 5 is enclosed in a glass tube 5W which like the metal tubes of Figs. 1 to 4 may contain a rarefied gas or it may he highly evacuated. Here the ambient thermal compensator takes the form of a metal sheath 5X surrounding the electrodes 5F and 5H within the tube. This sheath may be contiguous the inner wall of the tube, as shown, or it may be mounted on the insulator 5K in a manner similar to that by which the strips 3T and 3W of Fig. 3 are mounted. A heat conducting lead 5R, which may be in the form of a metal ribbon, sealed through the glass envelope, is provided for connecting the compensator 5X to the wall of a temperature control cabinet, for example, in the manner described in the previously mentioned application Serial No. 61,834.

Fig. 6 shows the invention as applied to a magnetically adjustable, glass enclosed, Edison type bi-metallic thermostat. Here the electrode supporting structure forms a part of the ambient thermal compensator.

The glass envelope is designated 60, the bi-metallic thermal responsive element 61, its contact point 62. The other contact 63 is fixed on a bent arm 64 against which the end of a threaded adjusting rod 65 rests. Fixed on the other end of threaded rod 65 is a disc 66 of magnetic material which, when subject to the field of an external magnet (not shown), may be moved to vary the spring action of the bent contact arm 64 and to thereby alter the spacing of the contacts 62, 63. The contact arms 61 and 64 and the adjusting rod 65 are mounted on a frame 67 as by means of insulating pieces 68, 69, 70 and 71 and rivets 72. A friction spring 73 on the frame presses against the adjusting rod 65 to prevent undesired movement thereof. The insulating pieces 68 to 71 forming part of the frame 67 fit against the curved inner walls of the tube 60 and are maintained thereagainst by the action of a holding spring 7 which prevents dislocation and shock movement of the assembly.

The current carrying leads for contacts 62 and 63 are designated 74 and 75, respectively. The third external lead 76 is the heat transfer lead; it connects the frame 67 within the tube, with the external ambient medium and, as in the previously described embodiments of the invention ensures a desired heat-transfer-ratio between this medium and the thermal responsive element within the tube.

While the invention has been described as applied to a thermostat, it is to be understood that it is not to be limited by such application as the disclosure in this respect is merely illustrative for purposes of explaining the inventive concept. Obviously, the thermal compensator of the invention may be embodied in tubes containing mercury relays, thermocouples and other known types of heat responsive devices. Further, the invention is not to be limited to the use to which the complete instrument is put. The use described in application Serial No. 61,834, (which discloses a thermal ambient compensator embodied in a constant temperature cabinet) is but one of many uses to which the invention may be put.

Another very useful application to which the invention may be put is in connection with control systems for house-heating oil-burners and the like. When so applied the thermostat or other instrument embodying the invention may be placed, for instance, on the cellar wall and the ambient thermal compensator connected by a comparatively short heat conducting insulated lead to the exterior of the building. By a proper selection of the material and mass of the lead and compensator any desired heat transfer ratio may be established between the outer ambient medium and the thermostatic (or other) control and the operation of the burner controlled in accordance with variations in the external ambient temperature.

Air conditioning systems may likewise employ temperature responsive tubes embodying the ambient thermal compensator of the present invention to advantage.

Other modifications and applications of the invention will suggest themselves to those skilled in the art. It is to be understood, therefore, that the foregoing is to be interpreted as illustrative and not in a limiting sense except as required by the prior art and by the spirit of the appended claims.

What is claimed is:

1. The combination with a thermal responsive element enclosed in a sealed glass enevelope of an electrically separate heat conducting member

in the form of a metallic sheath at least partially surrounding said thermal responsive element and having a permanent heat conductive connection thereof communicating with the exterior of said envelope which heat conducting member is in close proximity of said element and having a portion thereof in direct heat exchange relation with the ambient medium outside of said envelope for maintaining a predetermined ratio between the temperature of said element and the temperature of the external ambient medium.

2. The combination with a thermal responsive element enclosed in a sealed metal envelope of an electrically separate heat conducting member in close proximity to said element within said metal envelope, and a heat conductive connection connecting said member to the inner wall of said metal envelope for maintaining a predetermined ratio between the temperature of said thermal responsive element and the temperature of the external ambient medium.

3. The combination with a thermal responsive element enclosed in a sealed metal envelope, of an electrically separate heat conducting member mounted in close proximity to said element within said envelope, a ceramic seal in said metal envelope and a connection extending from said heat conducting member through said ceramic seal to the exterior of said envelope for maintaining a predetermined ratio between the temperature of said thermal responsive element and the temperature of the external ambient medium.

4. The combination with a thermal responsive device supported upon a metal frame within a sealed envelope of a ribbon of heat conducting material connected to said frame and communicating with the exterior of said envelope.

SAMUEL A. BOKOVOY.