

May 3, 1927.

L. O. GRONDAHL

1,626,931

ELECTRICAL RELAY

Filed Dec. 27, 1921

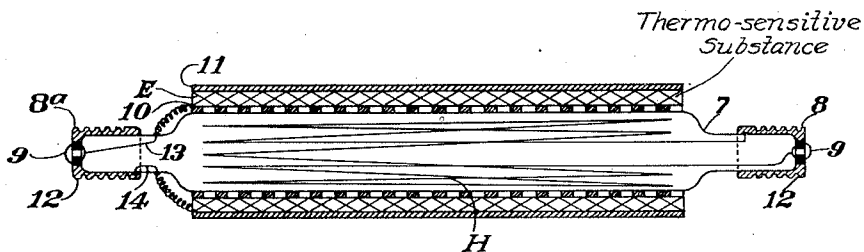


Fig. 1.

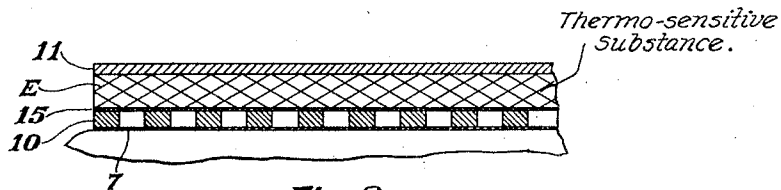


Fig. 2.

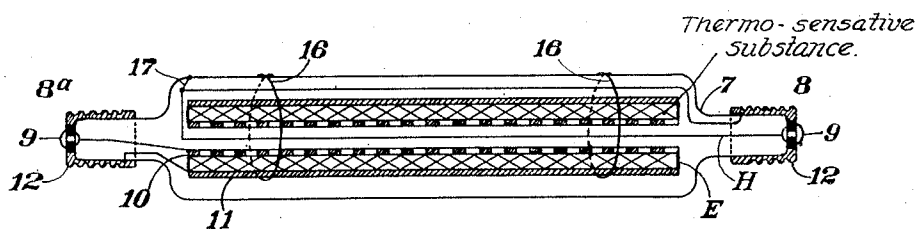


Fig. 3.

L. O. Grondahl,
INVENTOR,

BY A. L. Tensill
His ATTORNEY

Patented May 3, 1927.

1,626,931

UNITED STATES PATENT OFFICE.

LARS O. GRONDAHL, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO THE UNION SWITCH & SIGNAL COMPANY, OF SWISSVALE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

ELECTRICAL RELAY.

Application filed December 27, 1921. Serial No. 525,097.

My invention relates to electrical relays, and particularly to relays which are dependent for their operation on variations in the electrical characteristics of certain substances in response to variations in the temperature to which they are subjected.

I will describe several forms of relays embodying my invention, and will then point out the novel features thereof in claims.

In the accompanying drawing, Fig. 1 is a view showing in longitudinal cross-section one form of relay embodying my invention, the various parts thereof being located on the outer surface of the supporting bulb. Figure 2 is a fragmental view in cross-section and on an enlarged scale showing a modification of the relay shown in Fig. 1. Fig. 3 is a view similar to Fig. 1 but showing the parts of the relay located within the supporting bulb instead of on the outer surface thereof.

Similar reference characters refer to similar parts in each of the views.

Referring first to Fig. 1, the relay comprises a glass bulb 7, which, as here shown, is cylindrical in form with ends of reduced diameter. These reduced ends are fitted with lamp plugs 8 and 8^a of the screw type, each plug comprising, as usual, a shell 12 and a button 9 insulated therefrom.

Mounted within the bulb 7 is a heating element H, which, as here shown, is in the form of a fine wire filament, the terminals of which are connected with the shell and button respectively of the terminal plug 8. Surrounding the bulb 7 is an inner tube-shaped electrode 10 of electro-conductive material so formed as to obstruct only a portion of the heat rays emitted by the heating element H. This electrode may be in the form of a perforated metallic tube, such as a grid or a metallic gauze, or it may be of thin sheet metal which has sufficient cross sectional area to carry the secondary current and which at the same time is capable of transmitting a considerable portion of the heat emitted by the filament H.

Surrounding the electrode 10 is an envelope E of a substance having the characteristic of varying in electrical resistance in response to temperature variations, and which I will term the "thermo-sensitive" substance. This substance preferably has a high temperature coefficient, and as examples, it may be cupric oxide, cuprous oxide, silver sele-

nide, silver sulphide, carborundum paste, alundum cement, a fusion of copper and mica, the rare earth oxides used in the Nernst filament, and probably a number of other substances. The thermo-sensitive substance E is enclosed by a second or outer tube-shaped electrode 11, also of electro-conductive material. The inner electrode 10 is electrically connected with the button 9 of plug 8^a by a wire 13, and the outer electrode 11 is connected by a wire 14 with the shell 12 of the same plug.

When the inner electrode 10 is in the form of a perforated conductor, such as gauze or a grid, this electrode will not be in electrical contact with all points on the inner surface of the thermo-sensitive substance E, and so the efficiency of the relay will not be maximum. If desirable, the efficiency may be increased by a structure such as that shown in Fig. 2, wherein a tube-like member 15 of heat-conductive, electro-conductive material, such as thin gold leaf, is interposed between the electrode 10 and the thermo-sensitive substance E. This tube or sleeve 15, which may be termed an auxiliary inner electrode, will in effect place the main inner electrode 10 in electrical contact with substantially the entire inner surface of the substance E, and so will increase the efficiency of the relay to a maximum.

I have found that when certain thermo-sensitive substances are operated in air, a gradual change occurs in the nature of the substance and so in its characteristics. For example, cuprous oxide gradually changes to cupric oxide, with the result that a change occurs in the characteristics of a relay in which this substance is employed. This change may be avoided by operating the substances in vacuo or in a gas having no effect on the substance. In Fig. 3 I have shown a relay so constructed as to permit operation of the thermo-sensitive substance under either of these conditions. In this view, the two electrodes 10 and 11, with the thermo-sensitive substance E between them, are located within the bulb 7 instead of on the outer surface of the bulb as in Fig. 1. These members may be supported in any suitable manner, as for example by means of loops 16 welded to the bulb. The heating element H is a wire or filament which passes from button 9 of plug 8, through the inner electrode 10, and returns outside of the outer electrode

11 to the shell 12 of plug 8. This filament is supported by one or more tie wires 17 which are sealed in the bulb. The bulb 7 may be a receptacle from which the air has been evacuated to a very low pressure, or this bulb may be filled with a gas which has no effect on the thermo-sensitive substance E, such for example as nitrogen, argon or helium. A small amount of oxygen may be added to this gas to prevent discharge of oxygen from the thermo-sensitive material E when the relay is first put into service.

It is, of course, obvious that the inner electrode 10 and the thermo-sensitive substance E in Fig. 3 may, if desirable, be more intimately connected by an auxiliary inner electrode as in Fig. 2.

As a modification of the secondary portion of the relay shown in either Fig. 1 or Fig. 3, the two electrodes 10 and 11 may both be in the form of wire, preferably coils, both embedded in the thermo-sensitive substance E, the turns of one wire alternating with the turns of the other wire. One end of one wire would then be connected with the shell 12 of plug 8^a, and one end of the other wire would be connected with the button 9 of the same plug. I have not illustrated this modification in the drawings because of the difficulty of showing the two wire coils embedded in thermo-sensitive substance.

One important feature of the relays shown herein is the tube-like form of the thermo-sensitive substance E, whereby this substance is exposed to a very large proportion of the heat emitted by the filament H.

Another important feature of my invention is the provision of the two terminal plugs 8 and 8^a which are integral with the body of the relay. The primary or controlling circuit with which the heating element H is to be connected will include a socket designed to receive the plug 8, and the secondary or controlled circuit in which the electrodes 10 and 11 are to be included will include a socket designed to receive the plug 8^a. This construction greatly facilitates the insertion of the relay in the apparatus with which it is associated, as well as the removal of the relay therefrom. Although the plugs which I have illustrated herein are of the screw type, it is obvious that plugs of any other suitable type, such, for example, as the bayonet plug, may be substituted therefor.

Relays embodying my invention are well adapted for use in railway signaling systems of the type illustrated and claimed in my co-pending application for Letters Patent of the United States filed on the 16th day of April, 1921, Serial No. 461,783, for railway signaling, although they are not limited to this particular use.

Although I have herein shown and described only certain forms of relays embodying my invention, it is understood that va-

rious changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. A relay comprising two spaced electrodes, a thermo-sensitive substance between said electrodes, and a heating element for varying the temperature of said substance within limits determined by voltage applied.

2. A relay comprising two tube-like electrodes one within the other, a thermo-sensitive substance between said electrodes, and a heating element located within the inner electrode.

3. A relay comprising a bulb provided with two terminal plugs each having two contact members, a heating element located within said bulb and having its terminals connected with the two contact members respectively of one plug, two electrodes supported by said bulb and connected respectively with the two contact members of the other plug, and a thermo-sensitive substance located between said electrodes.

4. A relay comprising a bulb provided with two terminal plugs each having two contact members, a heating element located within said bulb and having its terminals connected with the two contact members respectively of one plug, two electrodes mounted within said bulb and connected respectively with the two contact members of the other plug, and a thermo-sensitive substance located between said electrodes.

5. A relay comprising a bulb provided with two terminal plugs each having two contact members, a heating element located within said bulb and having its terminals connected with the two contact members respectively of one plug, two electrodes located within said bulb and connected respectively with the two contact members of the other plug, a thermo-sensitive substance located between said electrodes, said bulb containing a gas which has no effect on said thermo-sensitive substance.

6. A relay comprising a bulb provided with two terminal plugs each having two contact members, a heating element located within said bulb and having its terminals connected with the two contact members respectively of one plug, two tube-like electrodes supported by said bulb one within the other and connected respectively with the two contact members of the other plug, the inner electrode being so constructed as to obstruct only a portion of the heat rays emitted by said heating element, and a thermo-sensitive substance located between said electrodes.

7. An electrical relay comprising a bulb provided with two terminal plugs each having two contact members, a heating element

located within said bulb and having its terminals connected with the two contact members respectively of one plug, two tube-like electrodes supported by said bulb one within the other and connected respectively with the two contact members of the other plug, the inner electrode being perforated, a thermo-sensitive substance interposed between said electrodes, and an auxiliary inner electrode of heat-conductive electro-conductive material located between said substance and said perforated electrode.

8. An electrical relay comprising two spaced tube-like electrodes one within the other, the inner electrode being perforated, a thermo-sensitive substance interposed between said electrodes, and a heating element located within the inner electrode.

9. An electrical relay comprising two spaced electrodes one of which is perforated, a thermo-sensitive substance interposed between said electrodes, and a heating element so located as to transmit heat to said substance through the perforations of the perforated electrode.

10. An electrical relay comprising two spaced electrodes one within the other, the inner electrode being perforated, a thermo-sensitive substance interposed between said electrodes, an auxiliary electrode of heat-conductive electro-conductive material between said substance and said perforated electrode, and a heating element so located as to transmit heat rays to said substance through the perforations in said one electrode and through said auxiliary electrode.

11. An electrical relay comprising a gas-filled bulb containing two spaced electrodes, a thermo-sensitive substance located between said electrodes, and a heating element for varying the temperature of said substance.

12. A relay comprising two tube-like electrodes one within the other, a thermo-sensitive substance between said electrodes, a heating element located within the inner of said electrodes, and a gas-filled bulb enclosing said electrodes as well as said substance and said heating element.

13. A relay comprising two spaced electrodes one of which is perforated, a thermo-sensitive substance interposed between said electrodes, a heating element so located as to transmit heat to said substance through the perforations of said perforated electrode, and a gas-filled bulb enclosing said electrodes as well as said substance and said heating element.

14. A relay comprising two spaced electrodes one within the other, the inner electrode being perforated, a thermo-sensitive substance interposed between said electrodes, an auxiliary electrode of heat-conductive electro-conductive material between said substance and said perforated electrode, a heating element so located as to transmit heat rays to said substance through the perforations in the inner electrode and through said auxiliary electrode, and a gas-filled bulb enclosing said electrodes as well as said substance and said heating element.

In testimony whereof I affix my signature.

LARS O. GRONDAHL.