

Dec. 31, 1929.

L. O. GRONDAHL

1,741,231

ELECTRICAL TRANSLATING APPARATUS

Filed Jan. 8, 1923

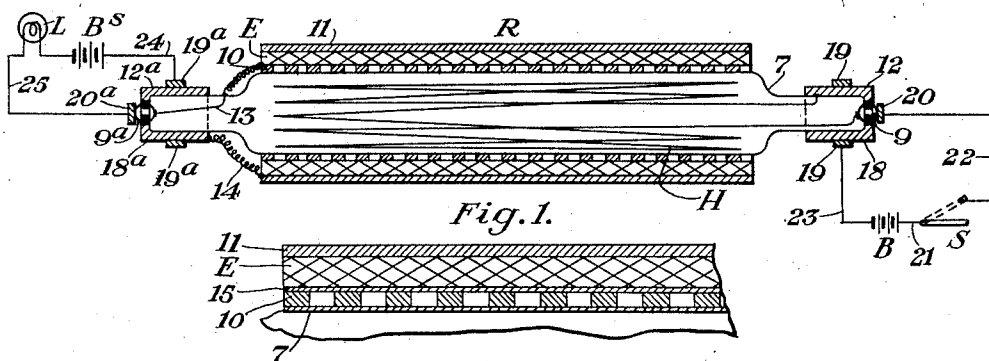


Fig. 1.

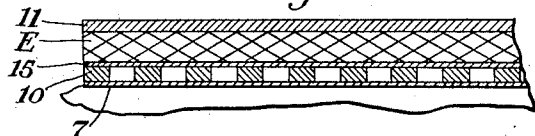


Fig. 2.

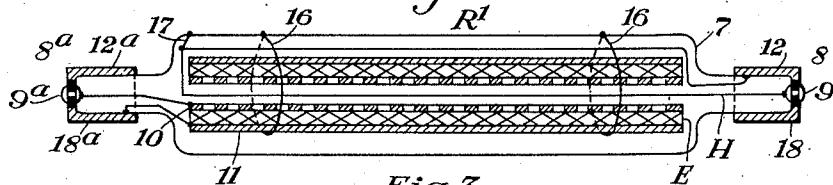


Fig. 3.

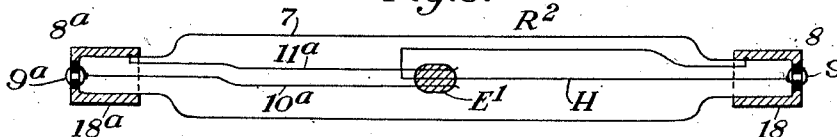


Fig. 4.

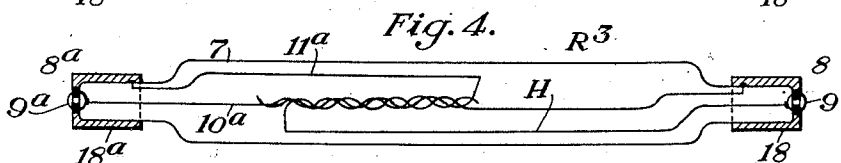


Fig. 5.

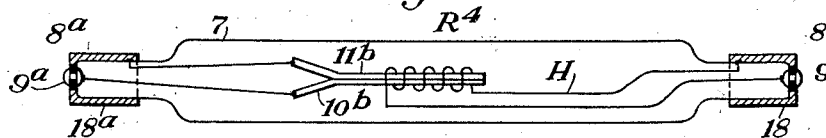


Fig. 6.

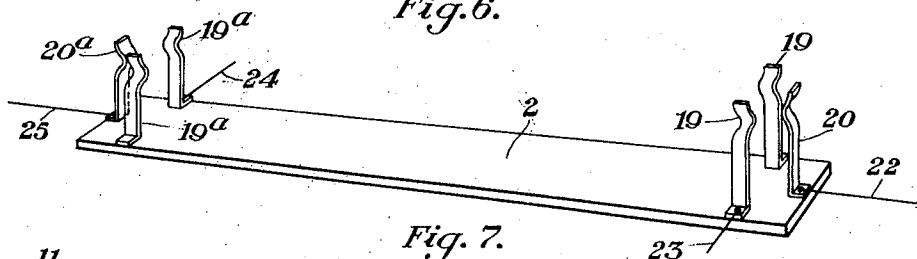


Fig. 7.

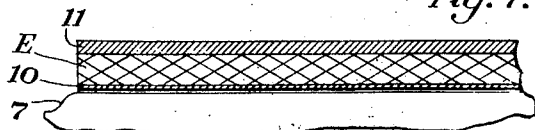


Fig. 8.

INVENTOR:
L. O. Grondahl,
BY
A. L. Vencell
His ATTORNEY

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 TRANSLATING APPARATUS

Application filed January 8, 1923. Serial No. 611,286.

My invention relates to electrical translating apparatus.

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

In the accompanying drawing, Fig. 1 is a view, partly diagrammatic and partly in cross-section, showing one form of translating apparatus embodying my invention. Fig. 2 is a fragmental view in cross-section and on an enlarged scale showing a modification of a portion of the translating device shown in Fig. 1. Figs. 3, 4, 5 and 6 are views showing in longitudinal cross-section other modified forms of translating devices which may be used with the apparatus shown in Fig. 1. Fig. 7 is a perspective view showing a base 2 adapted to receive the bulb 7 of any of the devices shown in the preceding views. Fig. 8 is a view similar to Fig. 2 but showing another modification of a portion of the translating device of Fig. 1.

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

Referring first to Fig. 1, the apparatus includes a translating device, shown here as functioning as a relay, which device is designated as a whole by the reference character R. This device comprises a glass bulb 7, within which is a heating element H. This element, as here shown, is in the form of a fine wire filament the terminals of which are connected with contacts 9 and 12. 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 section 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. As shown in the drawing this electrode is in the form of a grid. 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 negative coefficient, so that its electrical resistance decreases as its temperature increases, and rises again, upon cooling, to substantially its original value. As examples, this substance may be cupric oxide, cuprous oxide, silver selenide, silver sulphide, carborundum paste, alundum cement, a fusion of copper and mica, the rare earth oxides used in the Nernst lamp filament, and probably a number of other substances. The thermo-sensitive substance E is surrounded by a second or outer tube-shaped electrode 11, also of electro-conductive material. The inner electrode 10 is electrically connected with a contact 9^a by a wire 13, and the outer electrode 11 is connected by a wire 14 with a contact 12^a.

The heating element H is included in a primary circuit which comprises a source of current and means for controlling or modifying the flow of current in the heating element. As here shown, the primary circuit passes from a battery B, through wire 21, switch S, wire 22, contact 20, contact 9, heating element H, contact 12, contact 19, and wire 23 to battery B.

The secondary circuit comprises a source of current which as here shown is a battery B^s, and an electro-responsive device which as here shown is an electric lamp L. The secondary circuit in the form shown in Fig. 1 passes from the battery B^s, through wire 24, contact 19^a, contact 12^a, wire 14, outer electrode 11, thermo-sensitive substance E, inner electrode 10, wire 13, contact 9^a, contact 20^a, wire 25 and lamp L to battery B^s.

As here shown, the contacts 9 and 12 are included in a plug 8 which is attached to one end of the bulb 7, whereas the contacts 9^a and 12^a are included in a similar plug 8^a which is attached to the other end of the bulb. The contacts 19 and 20 are in the form of spring contact fingers attached to a base 2 as shown in Fig. 7 and the outside wires of the primary and secondary circuits are connected with these fingers. It will be seen that with this construction the bulb 7 can readily be applied to and removed from the base 2, and that when it is in place on the base the contact

members 12 and 19, 20 and 9, 12^a and 19^a, and 20^a and 9^a are all in electrical engagement.

The operation of the apparatus shown in Fig. 1 is as follows:

5 When the switch S is open, as shown in full lines in the drawing, the supply of current to the heating element H is discontinued, so that this element and the thermo-sensitive substance E are comparatively cool. Under
10 this condition the resistance of the thermo-sensitive substance E is so high that the current, if any, which flows in the secondary circuit from battery B^s is not sufficient to light the lamp L. When, however, the switch S is
15 closed so that current is supplied to the heating element H from the primary battery B, this element becomes heated and in turn raises the temperature of the thermo-sensitive substance E. The resistance of the substance E
20 is then reduced to such value that the current which flows in the secondary circuit from battery B^s is of sufficient magnitude to light the lamp L. When switch S is again opened the heating element H and the thermo-sensitive
25 element E again become cool, so that lamp L becomes extinguished.

When the inner electrode 10 is in the form of a perforated conductor, such as gauze or a
30 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 device will not be maximum. If desirable, the efficiency may be increased by the modification shown in Fig. 2,
35 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
40 termed an auxiliary inner electrode, will in effect place the main inner electrode 10 in electrical contact with substantially the entire inner surface E, and so will increase the efficiency of the device to a maximum.

45 In Figs. 1 and 2 the inner electrode 10 is perforated to secure the desired thermal conductivity. The same result may be accomplished by making this electrode thin and unperforated, and blackening the inner surface, that is, the surface next to the heating
50 element, so that this surface becomes a good heat-absorbing surface. This modification is illustrated in Fig. 8.

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 device in which
60 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 device R'
65 so constructed as to permit operation of the

thermo-sensitive substance under either of these conditions. In this view, the 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 contact 9 through the inner electrode 10, and returns outside of the outer electrode 11 to the contact 12. 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 substance E when the device 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.

The device R' of Fig. 3 may be substituted for the device R in the apparatus shown in Fig. 1 and the operation of the apparatus will be as explained hereinbefore.

Referring now to Fig. 4, the device R² shown herein comprises a tube 7 provided with terminal plugs 8 and 8^a as in the preceding views. Mounted in the tube is a heating element H in the form of a wire of suitable material such as nichrome, the terminals of which are connected with the two terminals respectively of plug 8. This heating element passes through a bead or globule E' of thermo-sensitive substance. Also embedded in the bead E' are two electrodes 10^a and 11^a which as here shown are in the form of wires and which are connected with the two contacts 9^a and 12^a, respectively of plug 8^a. The electrodes are spaced from each other and from the heating element H by the bead E'.

The bead, electrodes and heating element may conveniently be assembled by clamping the two electrodes in spaced relation, applying heat to restricted portions thereof, dipping the heated portions of the electrodes into a powdered thermo-sensitive substance so that a small portion of the substance adheres to the electrodes, and repeating the process until a sufficient quantity of the thermo-sensitive substance has adhered to the electrodes to form a bead in which they are embedded. The heating element H may be passed through this bead while the latter is still hot. As a modification of this process, the two electrodes and the heating element may all be clamped in proper spaced relation and the bead applied thereto as before. Still
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another modification is to clamp the two electrodes, or these electrodes and the heating element, in spaced relation and dipping them in molten thermo-sensitive substance thereby picking up a bead in which the wires are embedded.

The device R^2 of Fig. 4 may be substituted for the device R' in the apparatus shown in Fig. 1, and the operation of the apparatus will be as explained hereinbefore.

Referring now to Fig. 5, the device R^3 illustrated herein comprises a heating element H and two electrodes 10^a and 11^a , all in the form of wires. As an example, the electrodes may be of nickel, plated with copper. These electrodes are first twisted together or intertwined to form two helical conductors with the turns of one alternating with the turns of the other, and the heating element H is then twisted around the electrodes. The whole unit is then heated in a furnace to transform the copper coating into copper oxide which is a thermo-sensitive substance, so that each turn of each electrode is separated from the adjacent turns of the other electrode by a coating of this substance. Or to express the same thing in a different way, the intertwined electrodes are embedded in thermo-sensitive substance. Of course if desired the electrodes may be of copper wire, in which case the copper plating is unnecessary. This form of the device may be so designed as to carry relatively heavy currents.

The device R^3 , illustrated in Fig. 5, may be substituted for device R' in the apparatus shown in Fig. 1, and the operation of this apparatus will then be the same as before.

Referring now to Fig. 6, device R^4 comprises a glass bulb 7 provided with two plugs 8 and 8^a as in the preceding views. In Fig. 6, however, the electrodes 10^b and 11^b are in the form of wires or strips which are placed side by side, and the heating element H is then wrapped around these electrodes. The electrodes may be of copper, or they may be of other suitable metal, such as nickel, plated with copper. In either case, after the parts are assembled the unit is baked in a furnace to convert the copper surfaces of the electrodes into copper oxide so that these electrodes are separated from each other and from the heating element H by a thermo-sensitive substance. After this baking is finished, the parts are mounted in the tube 7 and connected with the plug contacts as shown.

The device shown in Fig. 6 may be substituted for the device R' in Fig. 1, and the apparatus shown in Fig. 1 will operate as explained hereinbefore.

In each form of the apparatus the parts are so proportioned that the changes in the conductivity of the thermo-sensitive substance are due almost entirely to changes in the temperature of the heating element H, and are sensibly independent of temperature

variations due to the secondary current carried by the thermo-sensitive substance, so that under no circumstances can the heated condition of the thermo-sensitive substance be maintained by the secondary current. That is to say, the proportioning is such that the secondary current can have relatively little effect in determining the temperature and so the conductivity of the thermo-sensitive substance. In so far as dimensions enter into this proportioning, the thermo-sensitive substance preferably has a comparatively short path of comparatively large area for the secondary current. The proper proportioning also includes, of course, the voltage applied to the secondary circuit.

One important feature of the devices shown in Figs. 1, 2 and 3 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 heating element H.

Another important feature of the devices shown in the present application is the provision of the two terminal plugs 8 and 8^a which are integral with the body of the device. The primary or controlling circuit with which the heating element H is connected includes the spring contact fingers designed to receive the plug 8, and the secondary or controlled circuit in which the electrodes 10 and 11 are included terminates in the spring contact fingers which are designed to receive the plug 8^a . This construction greatly facilitates the insertion of the device in the apparatus with which it is associated as well as the removal of the device therefrom. The two plugs 8 and 8^a may be of different sizes, as shown in the drawings, and the spring contact fingers at the two ends of the base may be differently spaced to correspond to the two plugs, in order to prevent wrong connection of the device in the circuits with which it is associated.

While I have in each instance shown the heating element as mounted in a tube and provided with terminals for attachment and detachment from a circuit, these features are not essential. Neither does the enclosure imply that the heating element is necessarily to be heated to incandescence or enclosed in a vacuum or non-oxidizing atmosphere. Any suitable enameling may be substituted, and the devices are not necessarily enclosed. Where permanence is important it is desirable that the thermo-sensitive substance be protected from change of character and for this purpose I prefer the enclosed forms shown for the reasons already stated. Also an incandescent filament forms a convenient heating element where its resistance and temperature are suited to the application to be made and in such case a vacuous or neutral gas enclosure is advantageous, but any heating element giving a suitable rise of tempera-

ture for any particular application may be used and it may or may not be enclosed and may or may not be provided with fixed terminals. Also the degree to which the temperature of the thermo-sensitive substance is to be raised and lowered depends upon the nature of the substance selected, the change of resistance desired in the secondary circuit or circuits controlled thereby and in some cases upon the current which is to flow there-through.

While I have shown only a single circuit controlled by one thermo-sensitive unit, it will be readily seen that more than one may be controlled and also that a single heating element may act upon more than one thermo-sensitive device.

Also while I have shown two batteries in Fig. 1 it will be understood that in many cases a single battery may be employed and in general the circuits may be varied to suit conditions without departing from my invention.

While in general the device will, as stated, be so proportioned that under no circumstances of its use can the secondary current continue the heating of the thermo-sensitive substance to the operative temperature it may at times be desirable to construct devices so that the conductive condition once established will continue until the circuit is interrupted. I therefore do not limit myself in this regard.

Although I have herein shown and described only certain forms of apparatus embodying my invention, it is understood that various 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 thermo-sensitive device comprising a thermo-sensitive substance, and two helical conductors embedded in said substance with the turns of one conductor alternating with the turns of the other but spaced by the thermo-sensitive substance, and a heating element intertwined with said conductors.

2. A thermo-sensitive device comprising two helical conductors arranged so that the turns of one alternate with the turns of the other, a coating of thermo-sensitive substance on each conductor, and a heating element intertwined with said conductors.

In testimony whereof I affix my signature.
LARS O. GRONDAHL.