July 5, 1927. 1,634,420

L. O. GRONDAHL

ELECTRICAL TRANSLATING DEVICE

Filed June 29, 1923

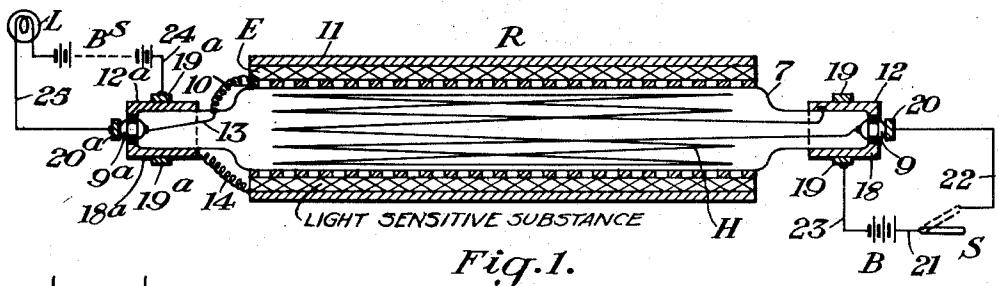

Fig. 1.

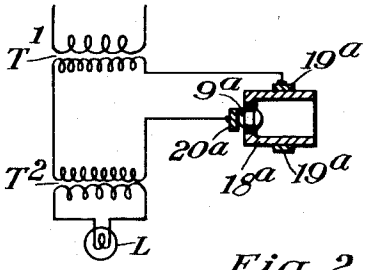

Fig. 2.

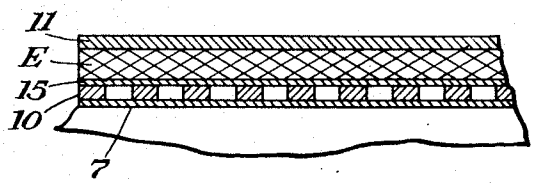

Fig. 3.

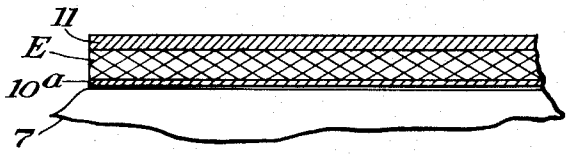

Fig. 4

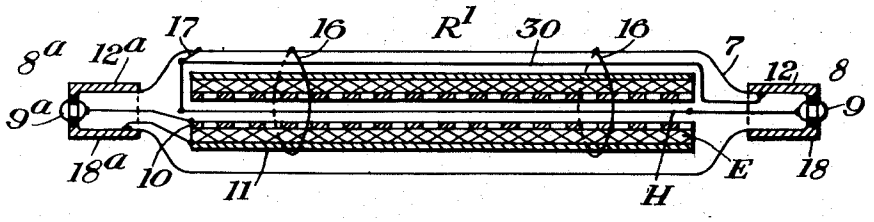

Fig. 5.

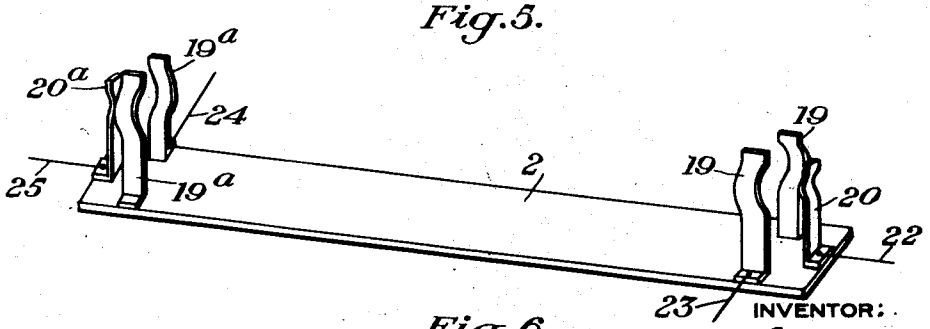

Fig. 6.

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Patented July 5, 1927. 1,634,420

UNITED STATES PATENT OFFICE.

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ELECTRICAL TRANSLATING DEVICE.

Application filed June 29, 1923. Serial No. 648,458.

My invention relates to electrical translating apparatus.

The present application is a continuation of my copending application filed on the 8th day of July, 1921, Serial No. 483,180, for electrical relays, in so far as the subject matter common to the two is concerned.

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 fragmentary view showing a modified form of secondary circuit which may be used with the apparatus shown in Fig. 1. Fig. 3 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. Fig. 4 is a view similar to Fig. 2, but showing another modification of a portion of the translating device of Fig. 1. Fig. 5 is a view showing a modification of the translating device shown in Fig. 1. Fig. 6 is a perspective view showing a base adapted to receive the translating devices shown in Figs. 1, 2, 3 and 4.

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 light-emitting element H. As here shown this element is 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 light rays emitted by the filament 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 light 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 variations in the intensity of the light to which it is exposed, and which I will term the "light-sensitive" substance. One example of a substance of this nature is selenium, the electrical resistance of which decreases with increase in the intensity of light, although I do not desire to limit myself to this particular substance. The light-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 filament 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 filament. As here shown, the primary circuit passes from a battery B, through wire 21, switch S, wire 22, contact 20, contact 9, filament H, contact 12, contact 19, and wire 23 to battery B.

The light-sensitive substance E is included in a secondary circuit which also includes 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. This secondary circuit passes from the battery B^s, through wire 24, contact 19^a, contact 12^a, wire 14, outer electrode 11, light-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, 20, 19^a and 20^a are in the form of spring contact fingers attached to a base 2 as shown in Fig. 5, 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, 20^a and 9^a are all in electrical engagement.

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

When the switch S is open, as shown in full lines in the drawing, the supply of current to the filament H is discontinued, so that this filament and the light-sensitive substance E are dark. Under this condition the resistance of the light-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 closed so that current is supplied to the filament H from the battery B, this filament becomes heated to incandescence and in turn supplies light rays to the light-sensitive substance E. The resistance of the substance E 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 filament H and the light-sensitive element E again become dark, so that lamp L becomes extinguished.

In the modification shown in Fig. 2 the secondary circuit is supplied with alternating current instead of with direct current as in Fig. 1. Alternating current from a source not shown in the drawing is supplied to the primary of a transformer T′ which is preferably of the step-up type, and the circuit for the secondary of this transformer includes the light-sensitive substance E of relay R (Fig. 1) and the primary of another transformer T^2 which is preferably of the step-down type. Lamp L is supplied with current from the secondary of transformer T^2. The parts are so proportioned that when the light-sensitive substance E is dark the current if any which is supplied to lamp L is not sufficient to light the lamp, but that when the light-sensitive substance is lighted its resistance is decreased to such value that sufficient current is supplied to the lamp to cause it to be lighted.

The advantage of providing the step-up and step-down transformers T′ and T^2 is that the amount of current which the light-sensitive substance E must carry is comparatively small, and yet this substance is able to control the supply of a comparatively large amount of current to the lamp L.

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 light-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. 3, wherein a tube-like member 15 of light-transmitting electro-conductive material, such as thin gold leaf, is interposed between the electrode 10 and the light-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 substance E, and so will increase the efficiency of the device to a maximum.

In Figs. 1 and 3 the inner electrode 10 is perforated to secure the desired light transmission. The same result may be accomplished by making this electrode of a thin light-transmitting (semi-transparent) electro-conductive material such as gold leaf, and this construction is illustrated in Fig. 4 wherein the inner electrode is designated 10^a.

When certain light-sensitive substances are operated in air, a change may occur in the nature of the substance and so in its characteristics. Any such change may be avoided by operating the substances in vacuo or in a gas having no effect on the substance. In Fig. 5 I have shown a device R′ so constructed as to permit operation of the light-sensitive substance under either of these conditions. In this view, the two electrodes 10 and 11 with the light-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 filament H passes from contact 9 through the inner electrode 10 to a heavier wire 30 which returns outside of the outer electrode 11 to the contact 12. This filament and wire 30 are 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 light-sensitive substance E, such for example, as nitrogen, argon or helium. In some instances a small amount of oxygen may be added to this gas to prevent discharge of oxygen from the light-sensitive substance E when the device is first put into service.

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

The device R′ of Fig. 5 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.

One important feature of the device shown in Figs. 1, 3 and 4 is the tube-like form of the light-sensitive substance E, whereby this substance is exposed to a very large proportion of the light rays emitted by the filament H.

Another important feature of the devices shown in the present application is the pro-

vision of the two terminal plugs 8 and 8ª which are integral with the body of the device. The primary or controlling circuit with which the filament 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 8ª. 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 8ª may be of different sizes, as shown in the drawings, and the spring contact fingers at the two ends of the base 2 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 shown only a single circuit controlled by one light-sensitive unit, it will be readily seen that more than one may be controlled and also that a single filament may act upon more than one light-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.

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. An electrical relay comprising two spaced tube-like electrodes one within the other, a substance interposed between said electrodes and having the characteristic of varying its resistance in response to variations in the amount of light to which it is exposed, and a source of light located within the inner electrode, the inner electrode being capable of retaining said substance and transmitting light to it.

2. An electrical relay comprising two spaced tube-like electrodes one within the other, the inner electrode being perforated, a substance interposed between said electrodes and having the characteristic of varying its resistance in response to variations in the amount of light to which it is exposed, and a source of light located within the inner electrode.

3. An electrical relay comprising two spaced electrodes one of which is perforated, a substance interposed between said electrodes and having the characteristic of varying its resistance in response to variations in the amount of light to which it is exposed, and a source of light so located as to illuminate said substance through the perforations of the said one electrode.

4. An electrical relay comprising two spaced electrodes one of which is perforated, a substance interposed between said electrodes and having the characteristic of varying its resistance in response to variations in the amount of light to which it is exposed, an auxiliary electrode of semi-transparent electro-conductive material between said one electrode and said substance, and a source of light so located as to illuminate said substance through the perforations in said one electrode and through said auxiliary electrode.

5. An electrical relay comprising two spaced tube-like electrodes one within the other, the inner electrode being perforated, a substance interposed between said electrodes and having the characteristic of varying its resistance in response to variations in the amount of light to which it is exposed, an auxiliary tube-like electrode of semi-transparent electro-conductive material between said main inner electrode and said substance, and a source of light located within said inner electrode.

6. An electrical relay comprising a bulb provided with two terminal plugs each having two contact members, a filament located within said bulb and having its terminals connected with the two contact members respectively of one plug, two electrodes mounted on said bulb and connected with the two contact members respectively of the other plug, and a substance interposed between said electrodes and having the characteristic of varying its resistance in response to variations in the amount of light to which it is exposed.

7. An electrical relay comprising a bulb provided with two terminal plugs each having two contact members, a filament located within said bulb and having its terminals connected with the two contact members respectively of one plug, two tube-like electrodes mounted on 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 light emitted by said filament, and a substance interposed between said electrodes and having the characteristic of varying its resistance in response to variations in the amount of light to which it is exposed.

8. An electrical relay comprising a bulb provided with two terminal plugs each having two contact members, a filament located within said bulb and having its terminals connected with the two contact members respectively of one plug, two tube-like elec-

trodes mounted on said bulb one within the other, and connected respectively with the two contact members of the other plug, the inner electrode being perforated, a substance interposed between said electrodes and having the characteristic of varying its resistance in response to variations in the amount of light to which it is exposed, and an auxiliary inner electrode of semi-transparent electro-conductive material between said substance and said perforated electrode.

9. A device comprising a bulb provided with two terminal plugs each having two contact members, a light-emitting 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 substance interposed between said electrodes and having the characteristic of varying its resistance in response to variations in the amount of light to which it is exposed.

10. A device comprising a bulb provided with two terminal plugs each having two contact members, a light-emitting 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, and a substance interposed between said electrodes and having the characteristic of varying its resistance in response to variations in the amount of light to which it is exposed, said bulb containing a gas which has no effect on said light-sensitive substance.

11. An electrical device comprising two spaced electrodes one within the other, the inner electrode being perforated, a light-sensitive substance interposed between said electrodes, an auxiliary electrode of semi-transparent electro-conductive material between said substance and said perforated electrode, and a light emitting element so located as to transmit light rays to said substance through the perforations in said one electrode and through said auxiliary electrode.

In testimony whereof I affix my signature.

LARS O. GRONDAHL.