July 9, 1935. R. HARDING, JR 2,007,940

ELECTRIC IMPULSE RELAY AND CIRCUIT

Filed Dec. 4, 1931

Fig. 1.

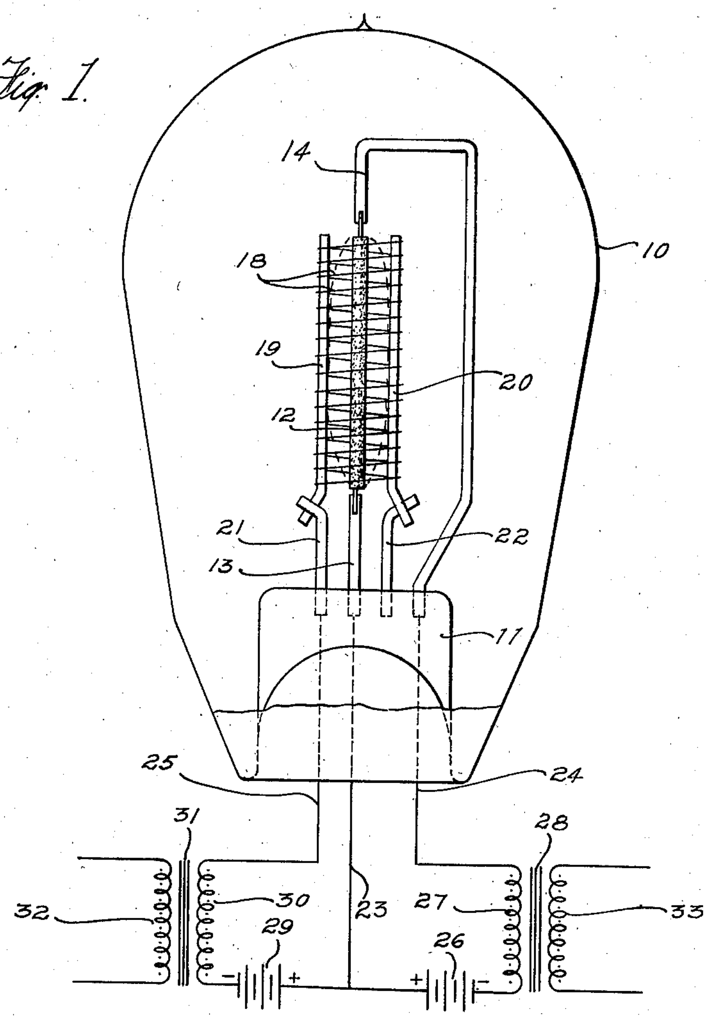
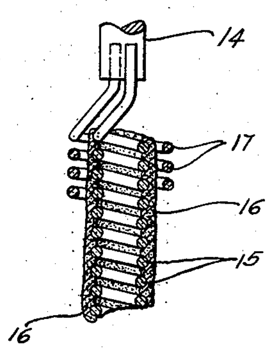


Fig. 2.



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ELECTRIC IMPULSE RELAY AND CIRCUIT

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11 Claims. (Cl. 250—27)

This invention relates to electron devices and particularly to electric impulse relays or amplifiers.

One of the objects of the invention is to provide an electric impulse relay or amplifier which has a large power output.

Another object of the invention is to provide an amplifying device in which one source of energy is sufficient for the energization of the device as well as for the output current.

Another object of the invention is to provide an amplifying device in which the filament circuit is the output circuit of the device.

Other objects and objects relating particularly to the circuit for using the amplifier will be apparent as the description thereof proceeds.

One embodiment of the invention has been illustrated in the accompanying drawing in which:

Fig. 1 is a side elevational view partly in section of my improved amplifying device; and

Fig. 2 is an enlarged longitudinal sectional view of one end of the electron emitting element of Fig. 1.

In the application of Chester H. Braselton, Serial No. 459,048, entitled Electrical discharge device, filed June 3, 1930, an electric lamp is described in which a filamentary wire having a high rate of electron emission is heated by an electric current in the presence of an inert gas having a certain pressure. When the temperature of the filament is raised above the electron emission temperature thereof a halo of ionized gas is formed adjacent the surface of the filament which apparently carries additional current longitudinally of the filament and produces considerable light.

The same type of filament is used with a grid surrounding it the potential of which may be varied causing a similar variation of the halo thereby producing modulated light. I have found that not only does a variation of potential on this grid effect the halo but that it also changes to a marked extent the current flowing through the filament. The present invention therefore is intended to make use of this fact by providing a device with an electron emitting element inside of a grid and a circuit therefore in which the variation of the filament current with the potential on the grid influences a translating device.

Referring now more specifically to the drawing the relay is shown as comprising an envelope 10 similar to the envelope of an electric lamp, mounted on the usual press 11 which is formed integral therewith to support the elements of the device. An electron emitting element 12 is shown mounted at its lower end upon a support rod 13 sealed in the press 11 and at its upper end upon a support rod 14 which extends upwardly and is bent at right angles toward the side of the bulb and then downwardly and inwardly again to be sealed in the press 11.

The electron emitting element 12 may comprise a coil 15 (see Fig. 2) of a resistance wire such as tungsten, molybdenum, tantalum, or nichrome coated with an electron emitting material 16 which may comprise any of the well known materials used for that purpose such as one of the oxides of the metals of the rare earth group or mixtures of such oxides, equal portions of barium and strontium oxides being preferable as the electron emission from these oxides is relatively high. The oxides may be mixed together and held upon the wire with a suitable binder such as is used for securing the oxides upon a cathode in a radio amplifier.

To provide a greater conductivity at the ends of the element 12 I may provide at each end of the element a coil 17 of resistance wire such as tungsten and consisting of a few turns surrounding the end of the element. The ends of these coils may be welded to the supports together with the ends of the coil 15. This coil 17 should not be so large that it cools down the end of the element and should be large enough so that it will carry the additional current which apparently flows through the gas adjacent the element.

As illustrated and described in the application first above referred to the electron emitting element 12 may consist of other constructions such as a coil of wire which is coated intermittently with electron emitting material, or which has its individual turns coated with the material, leaving a space between adjacent turns, or it may even be a single straight place of wire coated with the electron emitting material, or a wire having an electron emitting material incorporated in it such as a thoriated tungsten wire which is formed by treating a mixture of tungsten acid and thorium nitrate. It is desirable however that there be provided a relatively large potential drop between points on the surface of the element so as to produce a dense halo of ionized gas when the element is energized.

A grid 18 which may be formed of a helix of molybdenum wire or other wire capable of standing a relatively high temperature may be welded or otherwise attached to support rods 19, and 20 which extend downwardly substantially parallel to the electron emitting element 12 and may be welded to two support rods 21 and 22 respectively which are sealed in the press 11. Leading-in wires 23 and 24 may be attached respectively to support rods 13 and 14 for connecting to the outside circuit and a leading-in wire 25 may be connected to the support rod 21 for making the grid connection.

With the device mounted as indicated in Fig. 1 the envelope may be connected to an exhaust pump and an oven placed over it in the usual manner to raise the temperature thereof to 350 or 400° C. or to as high a temperature as the glass will stand without softening. A current may be run through the filament at this time to raise the temperature thereof to approximately 600° C. to drive out some of the occluded gases therein. When no more gas appears in the bulb as is evidenced by a lack of fluorescence when high tension current from an induction coil is directed against the walls of the bulb the filament current may be raised still higher to about 800° C. in order to drive out all of the binder for the electron emitting material.

When again no more gas is apparent in the bulb the temperature of the filament may be still further raised to about 1200° C. and then the pump shut off, the filament current turned off, and a slight amount of an inert gas such as neon at a pressure of about ½ mm. of mercury admitted into the bulb and the filament current turned on and gradually increased. Spots of localized discharge having a reddish color will appear on the element or support rods of the device and will gradually spread until a uniform discharge completely fills the bulb. This appears to activate the electron emitting coating on the filament and should be continued until the discharge is uniform which generally takes less than ten minutes. If white discharge spots appear on the filament or support rods it is an indication that there are more gases or vapors within the bulb and the vacuum pump should again be connected and the gases pumped out and the process of activation repeated.

When the activation is completed the temperature of the filament may be raised for a moment to about 1400° C. and the gas pumped out to remove any gases which may have been driven off during the activation process.

A high vacuum in the neighborhood of .5 micron is preferably obtained at this time and then the desired gas is admitted into the bulb. Any of the inert gases may be used in the bulb but I prefer one of the monatomic gases such as argon, neon, krypton, helium, or xenon, or mixtures of such gases. A good combination is 50 mm. of neon and 150 mm. of argon. In other words about 200 mm. of the desired gas is preferred although this pressure is not critical as other pressures may be used depending on the character of the discharge desired. A greater pressure tends to cause the halo to hug the filament more closely while a lower pressure permits it to extend outwardly with a larger diameter.

Also if desired metal vapors such as those of mercury, caesium, calcium, rubidium, or cadmium may be mixed with the gases to increase the conductivity of the gas.

A battery 26 connected in series with the primary 27 of a transformer 28 may be connected across the lead wires 23 and 24 to energize the filament coil and a halo as indicated in the dotted lines will then be formed longitudinally thereof. If a second battery 29 of relatively low potential is connected in series with the secondary 30 of a transformer 31 between the negative side of the battery 26 and the lead wire 25 a negative potential is placed on the grid 18 which can be varied by varying the input through the primary 32 of the transformer 31. As the grid potential rises and falls it influences the halo, apparently causing the gas in the vicinity of the filament to become more or less conductive so that the filament current flowing through the primary 27 of the transformer 28 varies considerably and hence the variation in the primary 31 will be amplified in the secondary 33 of the transformer 28.

While the relay has been shown connected to an input and output transformer it is evident that any desired means of connecting the device may be resorted to wherever a slight variation of potential is desired to be amplified to corresponding variations in output current.

Many modifications of the invention may be resorted to without departing from the spirit thereof and I do not therefore desire to limit myself to what has been shown and described except as such limitations occur in the appended claims.

What I desire to claim is:

1. In an electric relay an electron emitting element, an ionizable gas surrounding said element, means to connect said element in a circuit whereby current may be run through said element to energize said element and ionize said gas, means to modulate the ionization of said gas whereby the current in said circuit is modulated, and a load circuit connected to said element circuit.

2. In a relay the combination of an electron emitting element, a source of energy, a translating device, said electron emitting element, source of energy, and translating device being connected in series in a normally conductive circuit, an ionizable gas surrounding said electron emitting element, a conductor adjacent said electron emitting element, a source of variable potential connected between said conductor and the energizing circuit for the electron emitting element, and a load circuit inductively connected to said translating device.

3. A relay comprising an electron emitting element, a source of electrical energy, a translating device, said electron emitting element, source of energy, and translating device being connected in series in a normally conductive circuit, an ionizable gas surrounding said element, a conductor adjacent said element, a source of variable potential, means to connect said conductor in series with said source of varying potential and with said electron emitting element, means to bias the potential of said conductor, and a load circuit inductively connected to said translating device.

4. A relay comprising an electron emitting element, a source of electrical energy, a translating device, said electron emitting element, source of energy, and translating device being connected in series in a normally conductive circuit, an ionizable gas surrounding said element, a tubular conductor surrounding said element but spaced therefrom, a source of variable potential, means to connect said source of potential between said element and said conductor, and a load circuit inductively connected to said translating device.

5. A relay comprising an electron emitting element, a source of energy, a translating device, means to connect the electron emitting element, the source of energy, and translating device in series, an ionizable gas having a pressure such

that the intense ionization of said gas is limited to a well defined region adjacent said element, a grid surrounding said element and spaced therefrom just beyond the edge of said ionized region, means to connect said grid with said electron emitting element, means to vary the potential on said grid, and a load circuit inductively connected to said translating device.

6. A relay comprising an electron emitting element, a source of electrical energy, a translating device, means to connect said element, source of energy, and translating device in series in a normally conductive circuit, an ionizable gas containing neon surrounding said element, a grid surrounding said element, a source of variable potential, means to connect said source of variable potential between said grid and said element, and a load circuit inductively connected to said translating device.

7. A relay comprising an electron emitting element, an ionizable gas surrounding said element and having a pressure of substantially 200 mm. of mercury, a source of electrical energy, a translating device, means to connect said electron emitting element in series with said source of energy and said translating device, a grid surrounding said electron emitting element, a source of variable potential, means to connect said source of variable potential between said grid and said electron emitting element, and a load circuit inductively connected to said translating device.

8. A relay comprising an electron emitting element, an ionizable gas having a pressure of substantially 200 mm. of mercury surrounding said element, a source of electrical energy, a translating device, means to connect said source of energy and said translating device in series with said electron emitting element, a grid surrounding said element, a source of variable potential, means to connect said source of variable potential between said grid and said electron emitting element, means to bias the potential of said grid, and a load circuit inductively connected to said translating device.

9. A relay comprising a conductor of resistance wire, a coating of electron emitting material upon said wire, a source of electrical energy, a translating device, means to connect said wire, said source of energy, and translating device in series in a normally conductive circuit, a grid surrounding said wire but spaced therefrom, a source of variable potential, means to connect said source of potential between said grid and said wire, means to maintain a bias potential on said grid, and a load circuit inductively connected to said translating device.

10. A relay comprising a coil of resistance wire, a coating of electron emitting material upon said wire, an ionizable gas having a pressure of substantially 200 mm. of mercury surrounding said wire, a source of electrical energy, a translating device, means to connect said source of energy and said translating device in series with said wire, a grid surrounding said wire but spaced therefrom, a source of variable potential, means to connect said source of variable potential between said grid and said wire, means to bias the potential of said grid, and a load circuit inductively connected to said translating device.

11. A relay comprising a coil of resistance wire, a coating of electron emitting material upon the surface of said coil, an ionizable gas containing neon and argon and having a pressure of substantially 200 mm. of mercury surrounding said wire, a source of electrical energy, a translating device, means to connect said source of energy and said translating device in series with said wire, a source of variable potential, means to connect said source of potential between said grid and said wire, means to bias the potential of said grid, and a load circuit inductively connected to said translating device.

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