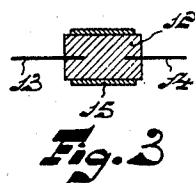
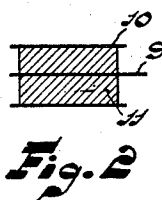
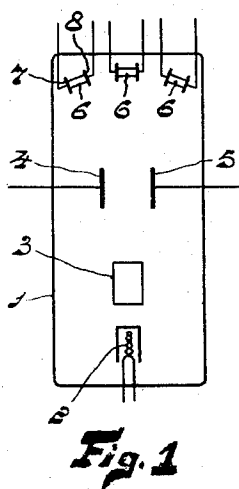


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ELECTRIC DISCHARGE TUBE

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ELECTRIC DISCHARGE TUBE

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This invention relates to an electric discharge tube having an electrode system which comprises an electrode consisting of a material having a high negative temperature coefficient, and to a circuit arrangement comprising such a tube.

In electro-engineering switches and relays are used for very diverse purposes. The constructions are such as to fulfill their function best for each different purpose. A common condition which is nearly always imposed is that the relay or the switch should open and close rapidly and with the use of as little energy as possible, in other words little control energy. In mechanical constructions great achievements have been made but, naturally, a limit is set both to the rate of opening and closing and to the energy required. A means which has been resorted to for reducing the energy required in opening and closing and for speeding up these operations consists in the construction of relays and switches on electronic lines. Thus, for instance, it is known to use deflection tubes to this end. In such a tube the electron current is adapted to be controlled very rapidly and with little energy. A disadvantage is, however, that the current travels by way of the electron beam. The resistance thus introduced into the electric circuit is high, which may sometimes be very objectionable, for instance if such a tube should pass speech currents in a telephone circuit. Another disadvantage, which is at least as serious, consists in that such a tube passes current only in one direction.

In electric discharge tubes it is furthermore known to direct an electron current on to a material having a negative temperature coefficient. This material is heated by the electron current striking it, due to which its resistance decreases. Since the material comprises two electrodes, it is possible in this manner to cause a current to flow between these two electrodes through the material having a negative temperature coefficient. In this event the relay is, for instance, controlled by means of a control-grid surrounding the cathode which emits the electron current. This yields, as it were a normal triode-construction, wherein the anode consists of the material having a negative temperature coefficient. As a material for this anode cuprous oxide has been proposed.

One of the disadvantages from which this known relay tube suffers is that the time elapsing before switching the current on is still very considerable, since the anode has a high thermal inertia. This might be avoided by using a high energy, but in this event special steps must be taken to carry off this energy in a short time,

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and these steps, in turn, require to supply more energy, and so on. Finally a limit is set to the energy per sq. cm. which the cathode is capable of delivering. In addition the direct radiation of heat from the cathode tends to become disadvantageous since this entails an increase in anode temperature.

The present invention meets these drawbacks by providing a body consisting of materials having a negative temperature coefficient, which body comprises at least two conductors, in combination with an electron current which is formed into a beam in such manner that on striking the body having a negative temperature coefficient it increases the conductivity of this body at least a thousandfold in 5 seconds at the most.

In this manner an electric discharge tube resembling a cathode beam tube is obtained. However, the electrode finally struck by the electron current is not a luminescent screen or metal electrode but a material having a negative temperature coefficient.

Naturally, the operation of the tube is materially improved with the use of a material having a very high negative temperature coefficient.

Such materials are, for instance, cobalt oxide with lithium oxide, and zinc titanate or magnesium chromite with magnetite and manganese oxide (Mn_3O_4) with nickel oxide.

As is known, electric discharge tubes, wherein the electron current is formed into a beam, are adapted to be controlled with comparatively little energy.

It is possible to control a tube according to the invention by means of deflection in which, consequently, the beam, in accordance with the deflection voltage, is either directed or not directed on to the body consisting of a material having a negative temperature coefficient. Alternatively, however, the beam may either or not be suppressed, for instance by means of a grid or a so-called Wehnelt-cylinder to which a negative voltage may be applied.

Furthermore it is possible to introduce into a single discharge tube a plurality of bodies having a negative temperature coefficient and to direct the beam by deflection now to one body now on the other. Such a tube may advantageously be used in a circuit-arrangement for automatic telephone exchanges, wherein it is adapted to replace mechanical relays or selectors.

In a particular form of construction of a tube according to the invention the electron current is continuously directed to the body made from a material having a negative temperature co-

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efficient, but is not exclusively concentrated thereon. In this manner the body is continuously heated, it is true, but the value both of the intensity of the electron current and of the size of the body are such that this heating does practically not involve any conductivity. By applying a definite control voltage to a concentrating electrode provided in the tube, the beam is adapted to be concentrated on the body so that the latter is strongly heated and becomes conductive.

To gain an idea of the size of the body having a negative temperature coefficient, and of the required energy and the results obtained, the following example is given.

In a cathode-beam tube permitting 0.2 watt to be directed on to the body having a negative temperature coefficient, this body had a volume of 0.07 cu. mm. This body consisted of cobalt oxides with lithium oxide. By means of 0.2 watt this body could be heated to 300° C. in one second which resulted in increasing its conductivity 10,000 times.

Body consisting of zinc titanate with magnetite or of manganese oxide and nickel oxide would require a volume of 0.1 cu. mm.

In order that the invention may be clearly understood and readily carried into effect it will now be explained more fully with reference to the accompanying drawing, given by way of example.

Fig. 1 represents diagrammatically an electric discharge tube according to the invention, in which the electron current formed into a beam is adapted to be directed, by means of deflection electrodes, on to three bodies provided in the tube which bodies consist of a material having a negative temperature coefficient.

Figures 2 and 3 represent forms of the body having a negative temperature coefficient.

In Fig. 1 the wall of the discharge tube is designated 1. The reference numeral 2 denotes the cathode. The system by means of which the concentrated beam is obtained is represented diagrammatically and designated 3. The deflection electrodes are designed 4 and 5. The reference numeral 6 denotes the bodies which have a negative temperature coefficient and each of which is clamped between two electrodes 7 and 8. In accordance with the voltage on the deflection electrodes 4 and 5, the beam strikes one of the bodies 6. In this event the heating of these bodies causes the passage of a current between electrodes 7 and 8. These electrodes are naturally connected to a circuit comprising a source of current.

In Fig. 2 the body having a negative temperature coefficient consists of two concentric conductors 9 and 10 between which the material 11 having a negative temperature coefficient is sandwiched. This body may for instance, be obtained by drawing out a corresponding body of larger size to the desired size.

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Fig. 3 represents a body which is indirectly heated. In this figure the material having a negative temperature coefficient is designated 12 and the electrodes between which the current passes bear the reference numerals 13 and 14. The material 12 having a negative temperature coefficient is externally provided with a conductive coating 15 which may be connected to the positive end of a source of potential, of which the negative end is connected to the cathode of the discharge tube.

What we claim is:

1. An electron discharge device comprising an envelope, a cathode source of a beam of electrons within said envelope, means to concentrate said electrons into a beam of given energy content, means to control said concentrated electron beam, a pair of electrodes positioned in said envelope and spaced from said cathode, said concentration means and said control means, and a mass of an electrically conductive material having a negative temperature coefficient supported between and electrically connected to said pair of electrodes, said control means being adapted to direct said electron beam to said mass, said mass having a thermal inertia at which impingement of said beam of given energy content thereon produces a thousandfold increase in the conductivity thereof in approximately 5 seconds.

2. An electric discharge device as claimed in claim 1, characterised in that the material having a negative temperature coefficient consists of cobalt oxide with lithium oxide.

3. An electric discharge device as claimed in claim 1, characterised in that the material having a negative temperature coefficient consists of zinc titanate with magnetite.

4. An electric discharge device as claimed in claim 1 characterised in that the material having a negative temperature coefficient consists of manganese oxide with nickel oxide.

5. An electric discharge device as claimed in claim 1, characterised in that the discharge device comprises a plurality of bodies having a negative temperature coefficient on to which the beam may be directed by means of deflection control.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,237,671	Kallmann	Apr. 8, 1941
2,357,922	Ziebolz et al.	Sept. 12, 1944
2,374,666	Cunniff	May 1, 1945