Sept. 30, 1952 E. W. HULLEGÅRD 2,612,625

GASEOUS DISCHARGE TUBE

Filed Nov. 6, 1947 3 Sheets-Sheet 1

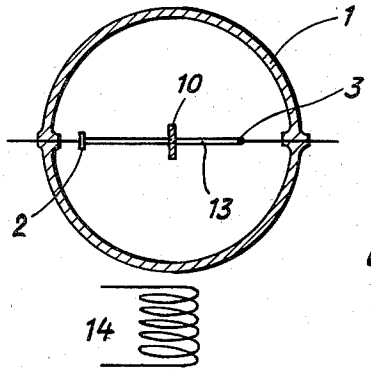


Fig. 1

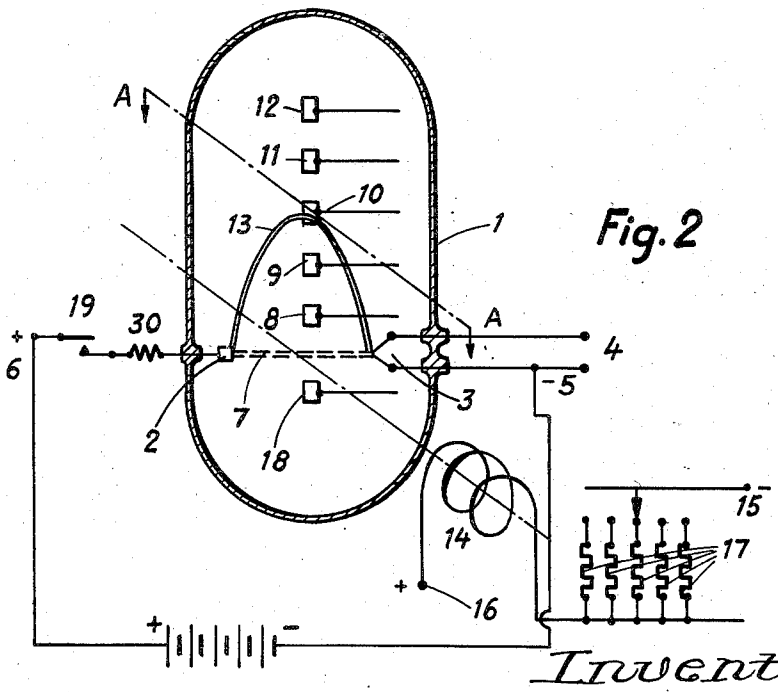


Fig. 2

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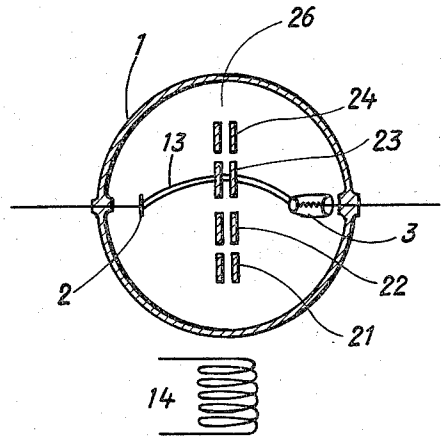


Fig. 3

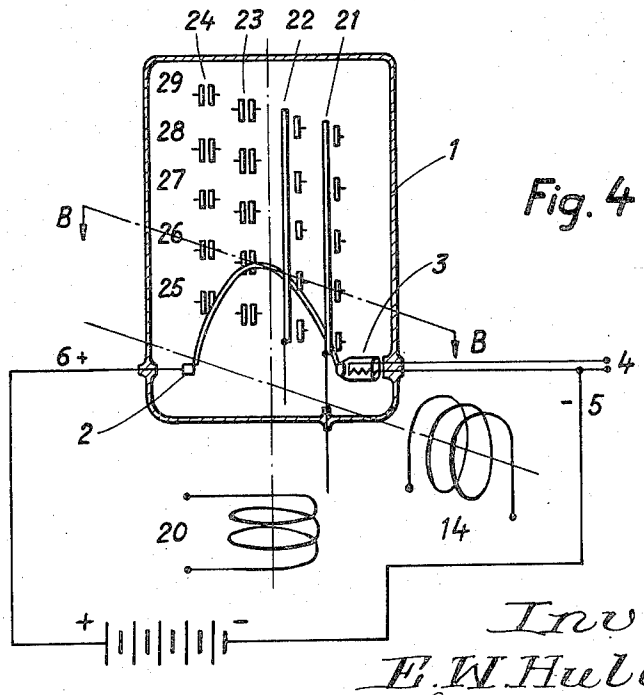


Fig. 4

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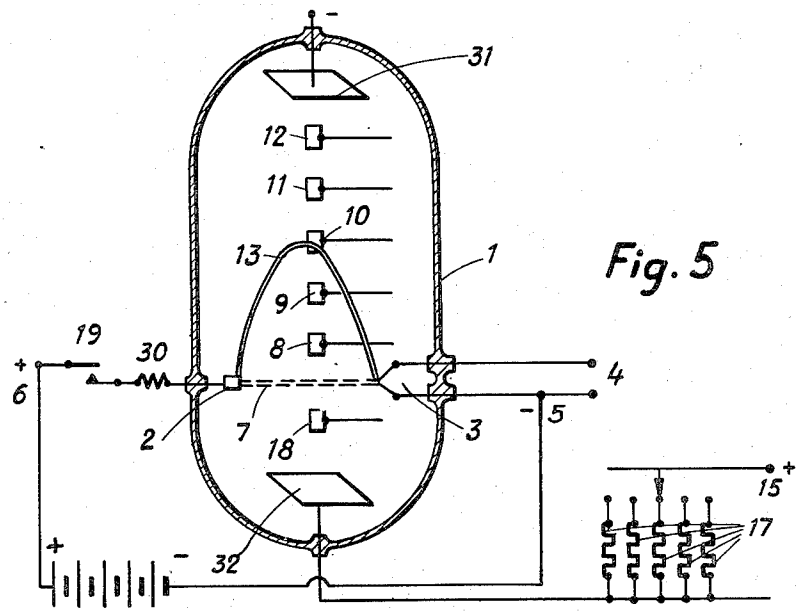


Fig. 5

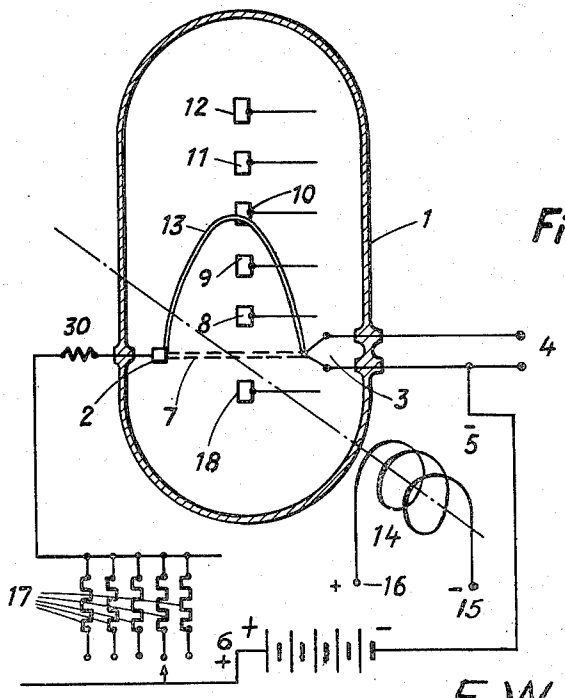


Fig. 6

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GASEOUS DISCHARGE TUBE

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6 Claims. (Cl. 315—338)

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The present invention relates to a selector device including a gaseous discharge tube, by the aid of which optional connections between two or more conductors connected to electrodes within the tube may be produced. The function of the arrangement is based on the knowledge that a gaseous discharge between two electrodes in a discharge tube may be given a thread shaped path through the gas. It is possible through suitable dimensioning of the electrodes and suitable choice of the gas pressure and the voltage between the electrodes to produce an arc discharge following a very narrow path, outside which only an unimportant ionization of the gas is obtained. The arc between the two electrodes, the anode and the cathode, hereinafter called arc electrodes, may then be directed to different places within the tube, where it may produce contact with other electrodes or between a plurality of such electrodes. Such further electrodes are hereinafter called contact electrodes and their number may be arbitrary. In the principal cases, magnetic fields or electric fields are used to produce the desired effect and the description therefor relates chiefly to said cases, the use of magnetic fields thereby being taken as a basis.

The path of an arc discharge in a tube of the said type can be affected by means of a magnetic field, the lines of force of which form an angle with the arc, suitably a right angle with the plane, in which the arc is proceeding. If an element of length of the arc is dl, the force dF in the plane of the arc tending to move this element of the arc will be equal to the product of the magnetic induction B, the current i, and dl thus:

$$dF=[B\times i]dl$$

The path of the arc may therefore be altered by changing the induction of the arc current. The induction may naturally be changed arbitrarily, for instance, by displacing a magnet, by shunting the magnetic field in the tube or by changing a magnetizing current. In a similar way, the position of the arc in the space may be influenced by means of an electric field arranged in a way known per se for similar purposes.

In order to produce a connection between electrodes in the tube and thereby between conductors connected to the electrodes, the discharge arc is displaced within the tube envelope to such a position, that it will touch the said electrodes.

In the simplest case the arc itself constitutes the conducting path to the contact electrodes. One of the arc electrodes (the cathode or the anode) will then naturally be one of the contacting electrodes, whilst the other one of the contact electrodes is connected to an exterior circuit, in which also the arc electrode in question forms a part. As soon as the arc has been brought into contact with a contact electrode, part of the current can be withdrawn at said electrode.

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It is however possible to arrange a plurality of contact electrodes in the tube in the vicinity of each other for each exterior circuit to be actuated by the tube, and by means of the conductable arc to produce a conducting connection between the electrodes in such groups of corresponding electrodes. The advantage with such an arrangement is in the first place that different circuits can be wholly separated from each other, although they can be actuated through the same tube having a plurality of group electrodes. Furthermore, the voltage drop in the discharge arc between the electrodes comprised in the actuated circuit can be considerably reduced, owing to the fact that in such a case with a great number of electrodes in the tube, it is possible to arrange corresponding electrodes near each other.

When there are more contact electrodes for each exterior circuit at suitable choice of the distance between the electrodes, the other tube data and the available voltage in the circuits, it is however also possible to ionize the gas between such contact electrodes by means of the discharge arc. An independent discharge between said electrodes, which remains after the original discharge arc has been quenched or directed to another place in the tube, may be started in this way. It is thus possible to make the arc ionize discharge paths in different groups of contact electrodes, which may be placed in such a way, that several groups may be actuated simultaneously, and thereby produce closing of several circuits independent of each other. It is further possible to make one electrode common to a number of contact electrodes, so that a number of electrodes in arbitrary combinations can be brought into conducting connection with said common electrode.

The discharge arc may also be influenced by further magnetic or electric fields making is possible to deflect the arc into two directions independent of each other. In this way, the arc can be directed to electrode systems, the position of which is determined by two coordinates (e. g. xy-selectors).

The invention and the foregoing will be understood more clearly from the following descrip-

tion with reference to the accompanying drawing, in which

Fig. 1 is a top plan view and Fig. 2 is a side view of a tube in which the arc itself constitutes the conducting member between a contact electrode and an arc electrode, and

Fig. 3 is a top plan view and Fig. 4 is a side view, mainly in section, with group electrodes between which a secondary discharge may be started by means of the deflectable arc.

Fig. 5 is a side view showing electric means for deflecting the arc, and Fig. 6 is a side view showing means for altering the current intensity of the arc discharge itself.

In the figures, 1 indicates an envelope, in which an anode 2 and a thermionic cathode 3 are arranged. In Figs. 1 and 2 the cathode 3 is shown as directly heated, in Figs. 3 and 4 it consists of an indirectly heated electron emitting point electrode. It is naturally possible to use any known electron emitting system as cathode, even such as do not require a current source, which in the cathodes according to the figures is connected at 4. A discharge arc 7 between the anode and the cathode of the tube containing gas at a suitable pressure is maintained by means of a supply voltage connected between 5 (−) and 6 (+). The ignition of said arc can take place directly on the connection of the supply voltage between 5 and 6, if this is high enough, or by ionization of the gas from outside for instance by means of a spark discharge. Suitable impedances are arranged in the anode circuit in order to control the current of the arc discharge. Without influence from an exterior field, the arc will progress as indicated at 7 in Fig. 2.

In Fig. 2 a number of contact electrodes are indicated, 8–12 and 18, the lead-in wires of which are shown only partly in the figure, as being of no importance for the understanding of the invention. These lead-in wires may suitably be provided with insulating sleeves. The arc between the anode and the cathode may be forced to move towards these electrodes under the influence of an exterior field. In the figure, a magnetic field perpendicular to the path of the arc and to the intended movement of the arc is for this purpose generated by means of a coil 14 connected to a current source at 15 and 16, the current flow through said coil being determined for instance by means of resistances 17 so dimensioned, that a certain resistance corresponds to a position of the arc at a predetermined contact electrode. In the figure, the arc 13 makes contact with the contact electrode 10 and a suitable point in the circuit of the arc, for instance the cathode. The arc remains between the anode and the cathode all the time, during which the contact electrode is actuated. By changing the poles of the magnetic field, the arc can be brought downwards in the figure, for instance to the contact electrode 18.

In Figures 3 and 4, an embodiment of a tube according to the invention is shown, which is provided with groups of electrodes comprising two electrodes, between which it is possible, at suitable dimension of the corresponding circuits, to start, with the arc, a secondary gas discharge, which is maintained as long as the said circuits meet the requirements necessary to make is possible. If, for some reason, a circuit closed in such a way is broken, the secondary gas discharge ceases, and a new closing of the circuit can take place only by the aid of the arc between the anode 2 and the cathode 3. The arc can thus be used for closing an arbitrary number of circuits, which can be quite independent of each other. In Fig. 4, twenty groups of electrodes arranged in 4 columns, 21–24, and 5 rows, 25–29, are shown, to which the arc can be directed by deflection into two directions. Such a deflection can be produced by two magnetic fields controlled in the same way as the field shown in Fig. 2, which fields form a certain angle, suitably a right angle with the arc discharge and each other. The deflection can take place so, that only the desired contact group or contact groups is affected by the arc. It is, of course, also possible to arrange two or more groups of electrodes so that they may be actuated simultaneously by the arc, thus closing two or more independent circuits at the same time.

In the figure, the groups of electrodes in the columns 21 and 22 respectively are made with a common electrode rod for one of the electrodes in each group.

The arc is shown when in contact with the group of electrodes in the column 23 and the row 26, where it starts a secondary discharge and thereby a closing of a circuit, if the data of said circuit allow it.

The embodiment of the tubes can naturally vary considerably with regard to the purpose, for which the tubes are to be used. The magnetic fields can likewise be replaced by electric fields as shown in Fig. 5, in which an electric field is produced between the plates 31 and 32. The field intensity is varied by means of a device of the same kind as that shown in Fig. 2 for varying the current intensity in coil 14.

The arc can furthermore be directed in another manner than by changing the intensity of a field, for instance by changing the current in the arc as indicated in Fig. 6, wherein the positive potential of the anode 2 is altered by means of a device similar to that shown in Figs. 2 and 5 for varying the field intensities.

I claim:

1. A selector device including in combination an envelope comprising a gaseous discharge tube and an anode and a cathode in said gaseous discharge tube, a plurality of contact electrodes positioned between said anode and said cathode, a current source connected to said anode and cathode for producing a string shaped arc discharge normally occupying a predetermined zero position in the space between same, and magnetic means positioned adjacent said discharge tube for selectively deflecting the path of said arc discharge from said predetermined zero position to any one of a number of other positions in which said arc discharge simultaneously contacts one of said contact electrodes, in addition to the anode and cathode.

2. A selector device including in combination an envelope comprising a gaseous discharge tube and an anode and a cathode in said gaseous discharge tube, a plurality of contact electrodes positioned between said anode and said cathode and each consisting of two plates mounted adjacent each other, a current source connected to said anode and cathode for producing a string shaped arc discharge normally occupying a predetermined zero position in the space between same, and magnetic means positioned adjacent said discharge tube for selectively deflecting the path of said arc discharge from said predetermined zero position to any one of a number of other positions in which said arc discharge

simultaneously contacts the plates of a contact electrode, in addition to the anode and cathode.

3. A selector device including in connection an envelope comprising a gaseous discharge tube and an anode and a cathode in said gaseous discharge tube, a set of contact electrodes positioned between said anode and said cathode, and a counter electrode common to said contact electrodes, a current source connected to said anode and cathode for producing a string shaped arc discharge normally occupying a predetermined zero position in the space between same, and magnetic means positioned adjacent said discharge tube for selectively deflecting the path of said arc discharge from said predetermined zero position to any one of a number of other positions in which said arc discharge simultaneously contacts one of said contact electrodes and the counter electrode while at the same time maintaining the electrical connection between the cathode and the anode during the operation of the device.

4. A selector device including in combination an envelope comprising a gaseous discharge tube and an anode and a cathode in said gaseous discharge tube, a set of contact electrodes positioned between said anode and said cathode, a source of current the poles of which are adapted to be connected to said anode and cathode for producing a string shaped arc discharge normally occupying a predetermined zero position in the space between same, means for generating a first magnetic field within the gaseous discharge tube, means for generating a second magnetic field within the gaseous discharge tube with the lines of force of said second magnetic field at an angle to the lines of force of the first magnetic field, means for changing the direction of said first magnetic field to selectively direct the path of said arc discharge in one direction from the predetermined zero position, means for changing the direction of said second magnetic field to simultaneously and selectively deflect the path of said arc discharge in another direction from said predetermined zero position to any one of a number of other predetermined positions in each of which said arc discharge simultaneously touches one of said contact electrodes in addition to the anode and cathode.

5. A selector device including in combination an envelope comprising a gaseous discharge tube and an anode and a cathode in said gaseous discharge tube, a set of contact electrodes positioned between said anode and cathode, a current source connected to said anode and cathode for producing a string shaped arc discharge normally occupying a predetermined zero position in the space between same, means for generating an electric field within said gaseous discharge tube, means for changing the direction of said electric field in order to selectively deflect the path of said arc discharge from the predetermined zero position to one of a number of other predetermined positions in which said arc discharge is diverted to simultaneously touch one of said contact electrodes, in addition to the anode and cathode.

6. A selector device including in combination an envelope comprising a gaseous discharge tube and an anode and a cathode in said gaseous discharge tube, a selected number of contact electrodes positioned between said anode and cathode, a current source connected to said anode and cathode for producing a string shaped arc normally occupying a predetermined zero position in the space between same, means for generating a magnetic field within said gaseous discharge tube, means for varying the intensity of the current of the arc discharge to selectively deflect the path of said arc discharge from said predetermined zero position to one of a number of other predetermined positions in each of which said deflected arc discharge simultaneously touches one of said contact electrodes, in addition to the anode and cathode.

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