March 2, 1937. A. F. HENNINGER, JR 2,072,622

CIRCUIT FOR NEGATIVE GLOW DEVICES

Filed Feb. 16, 1931

Fig. 1

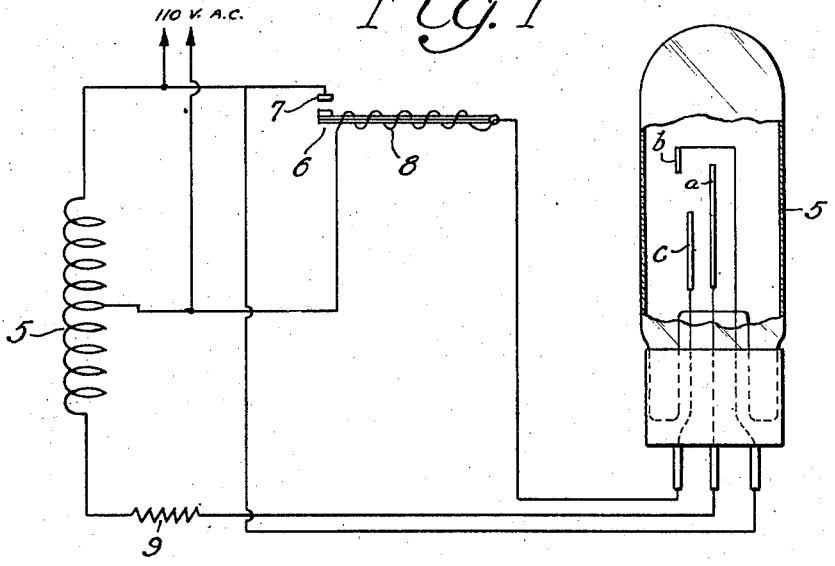


Fig. 2

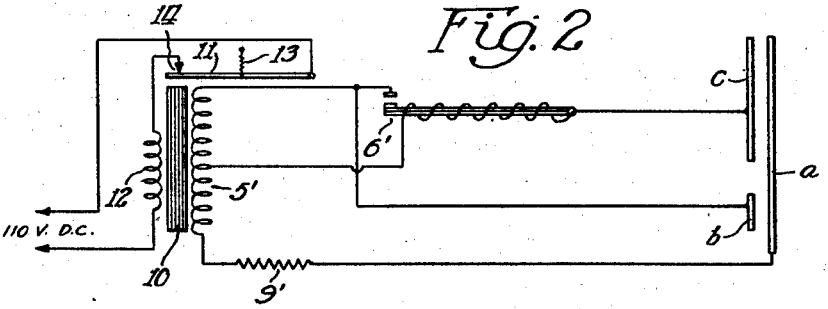


Fig. 3

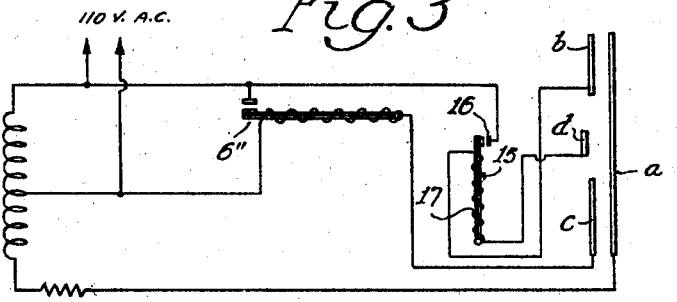
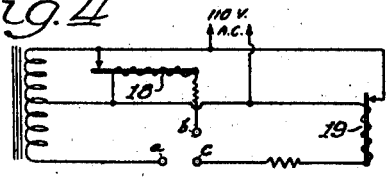


Fig. 4



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2,072,622

CIRCUIT FOR NEGATIVE GLOW DEVICES

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Application February 16, 1931, Serial No. 516,079

3 Claims. (Cl. 177—346)

My invention relates to circuits for negative glow devices such, for example, as are shown in my Patent No. 2,002,775, dated May 28, 1935.

Primarily my invention is directed to providing, in combination with three or more electrodes of the negative glow device, a control means for selectively causing the glow discharge to take place between different combinations of the electrodes.

My invention contemplates among other things the provision of means whereby a negative glow device having three or more electrodes of distinctive design for display purposes may be so operated for example as to cause different pairs of said electrodes or different groups including more than two of said electrodes to glow by selectively changing the current flow from between one pair or group of electrodes to another different group which may include one or more of the first group.

My invention also contemplates a system whereby changes of this character may be successively and continuously accomplished without the necessity of any manual regulations.

I find that by the utilization of this system I can obtain many desirable effects when combined with the three electrode device shown in my prior application.

I will describe the preferred forms of my invention by reference to the accompanying drawing wherein—

Fig. 1 is a diagrammatic showing of the circuit connections for a three electrode device;

Fig. 2 illustrates a similar device as applied to a direct current source of potential;

Fig. 3 is a modification illustrating the invention as applied to a device including four electrodes; and

Fig. 4 is a further modification for use with three electrode devices.

Referring now in detail to the drawing, I show at 5 an envelope having a gaseous filling preferably of one of the noble gases such as neon, helium, argon, etc., or a mixture of gases. Within this envelope, I provide a plurality of electrodes *a*, *b*, and *c*, which are relatively closely spaced to each other. In this figure, it will also be noted that the small electrode *b* is spaced farther away from the large electrode *a* than the intermediate electrode *c*. These electrodes may be and preferably are arranged in some distinctive design which may take the form of a letter, number, or other symbol or which may be in the form of an image of some particular article or person. The electrodes together are, of course, designed to display information of some character when illuminated.

For illumination purposes, I preferably employ what is generally termed a negative glow. By this I mean the glow that appears at or near the cathode of a gaseous conduction device when the device is subjected to sufficient potential to render the gas conducting. In order that the glow may appear to be continuous when the discharge is taking place between electrodes and that it may appear on both the electrodes, I utilize alternating current of a sufficiently high frequency to give the effect to the eye of a substantially constant illumination. I find that ordinary 60 cycle current works very nicely for this purpose.

Referring now to the control means, a source of potential is indicated as the auto transformer at 5 which receives its energy from an ordinary 110 volt alternating current source. One side of the auto transformer is connected through the contacts 7 of the thermostat 6 to electrode *c*. The other side of the transformer is connected through a suitable current limiting resistance shown at 9 to electrode *a*. Electrode *b* is connected to the opposite side of the transformer from electrode *a* by direct connection. A further resistance 8, which is in the form of a heating coil for heating the thermostat 6, is connected from a substantially central tap off of the transformer to one end of the thermostat. The 110 volt source is preferably connected to the same tap from the transformer as resistance 8. The function of the resistance 9 is to limit the total amount of current flowing as it is well known that gaseous conduction devices such as this has a negative resistance characteristic and so the current must be limited in some fashion. It is, of course, obvious that any other current limiting device may be used instead of the resistance 9 such devices being often part of the inherent design of the transformer.

The operation of the system shown in Fig. 1 is as follows: Assuming that the source of current has been cut off and it is desired to start the system, thermostat 6 will be cold and in this form it is preferable that when the thermostat 6 is cold the contacts at 7 are closed. This makes the voltage drop across electrodes *a* and *c* substantially the full voltage across the terminals of the transformer 5. I have found that this voltage may be in the neighborhood of 220 volts for efficient operation although, of course, this may be varied depending upon the ionization voltage of the gas employed in the tube 5.

The voltage between electrodes *a* and *b* is the same as between *a* and *c*. It is obvious, therefore, that there will be a tendency for discharge from *a* to the other two electrodes. However, owing to the positioning of *b* and *c* relative to *a* and their relative size, the resistance is greater over the path including *a* and *b* than over the path including *a* and *c*.

The current, therefore, will flow preferably between *a* and *c*, and, since the amount is limited by the current limiting device *a* and *c* will be caused to glow while *b* remains dark. During this time, however, a certain amount of current is flowing through the resistance **8** since it is connected directly across the line from which the current is obtained. This will heat up the thermostat **6** and, depending upon the characteristic of the thermostat, will after a greater or less time open the circuit at **7** and connect electrode *c* through resistance **8** to substantially the mid point of transformer **5**. This reduces the potential across electrodes *a* and *c* to such a point as to substantially prevent enough current flowing between them to have any illuminating effect upon *c*. Current will then flow between *a* and *b* in preference to *a* and *c* due to the high potential drop between *a* and *b*. Since there is no current flowing through **8**, the resistance to keep it hot, the thermostat cools off and again closes the circuit at **7** which causes the cycle to be repeated.

Referring now to Fig. 2, this system in operation is substantially the same as Fig. 1 with the exception that the source of power is received in this case from a direct current source which operates a make and break vibrator device the core of which is indicated at **10** and the armature at **11**.

The operation of this system is as follows: When the current is turned on, the initial surge through the coil **12** causes the core **10** to attract the armature **11** against the spring **13** and this in turn breaks the circuit at **14** which permits the spring **13** to retract its armature and again close the circuit. In this fashion, pulsating current is set up in the primary coil **12** which causes an alternating current in the secondary coil **5'** which corresponds to the auto transformer **5** of Fig. 1.

The electrode arrangement is the same in Fig. 2 as in Fig. 1 with the exception that the spacing between *b* and *a* is substantially the same as between *c* and *a*. However, owing to the relative sizes of the electrodes *c* and *b*, *c* will take practically all the current when the thermostat **6'** is closed, and, of course, *b* will receive the current when the thermostat is open.

In Fig. 3, a further modification is shown in which an additional electrode *d* is used in conjunction with the electrodes *a*, *b*, and *c*, and an additional thermostat **15** having the contacts at **16**, and a resistance **17** for heating the same is employed. In this construction, the two thermostats may be so timed as to cause varied effects in the cycle of lighting of the electrodes. For example, if both thermostats are closed, electrode *c* will be glowing in conjunction with *a*, and, if thermostat **6''** then opens while thermostat **15** is closed, electrode *d* will glow brightly while electrode *b* having resistance **17** in series with it will have only a half tone or dim glow. Then, if both **15** and **6''** are open, the entire device will be dark.

By proper positioning of the electrodes and arranging of the thermostats many very unusual effects can be obtained in flashing of one or more pairs or groups of the electrodes.

In Fig. 4, a further modification is shown. In this case, however, merely the terminals of electrodes *a*, *b*, and *c* have been shown. A pair of thermostats indicated by the numerals **18** and **19** are connected in such a fashion that either one or both may be on at the same time without any interference from each other. As for example, when thermostat **18** is closed, the discharge between *a* and *b* will take place. When thermostat **19** is closed, the discharge between *a* and *c* will take place. By making the heating coils with these thermostats of proper design, the time of opening and closing them may be so shifted as to cause combinations that will cause both *a* and *b* to glow while *c* is dark or all three of the electrodes to glow at the same time or *a* and *c* to glow while *b* is dark or both thermostats may open at the same time causing the device to go dark entirely.

From the above description, it is believed that the construction and operation of this device will be clear to those skilled in the art, and the advantages thereof readily apparent It is also obvious that various minor modifications may be made without departing from the scope of the invention.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A negative glow display device consisting of an envelope having a gaseous filling and at least three electrodes including a back electrode and two front electrodes, a source of current, circuits, each including said source, said back electrode and one of said front electrodes respectively, one of said circuits being of higher resistance than the other, and a circuit controlling device associated with the circuit of lower resistance for intermittently interrupting said lower resistance circuit to cause an increased flow of current thru said higher resistance circuit.

2. A negative glow display device consisting of an envelope having therein a gaseous filling and at least three electrodes, including a back electrode and two front electrodes, a source of alternating current supply, circuits, each including said source, said back electrode and one of said front electrodes, respectively, one of said circuits being normally of higher resistance than the other, a pair of contacts included in said circuit of least resistance capable of being opened or closed for opening and closing the last said circuit and means for intermittently opening and closing said contacts.

3. A negative glow display device consisting of an envelope having therein a gaseous filling and at least three electrodes, including a back electrode and two front electrodes, a source of current supply, circuits, each including said source, said back electrode and one of said front electrodes, respectively, one of said circuits being normally of higher resistance than the other, a coil in a branch from the said circuit of least resistance and circuit make and break means operable by change in current conditions in said coil for alternately opening and closing said circuit of least resistance to cause glow discharge successively between the electrodes of said circuits, respectively.

ANDREW F. HENNINGER, JR.