April 16, 1935. E. R. THOMAS 1,997,986

ELECTRIC CIRCUIT CONTROLLING APPARATUS

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Fig. 1.

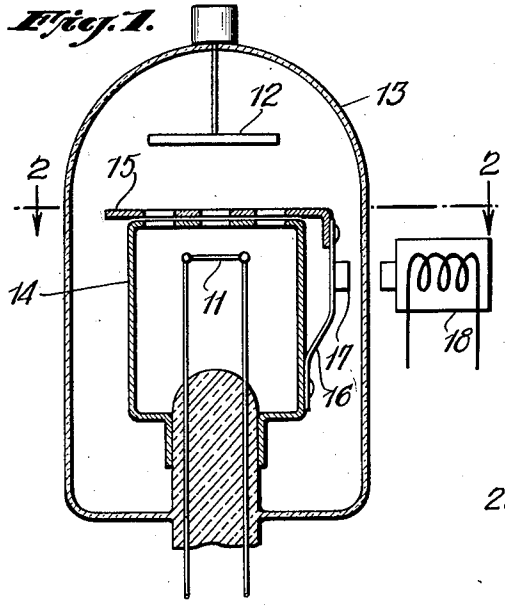


Fig. 3.

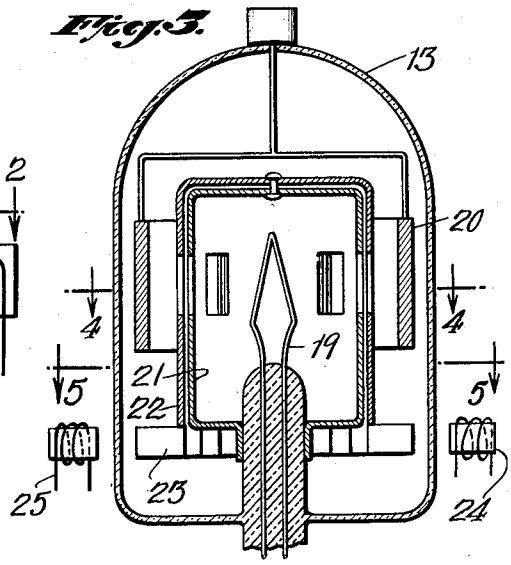


Fig. 2.

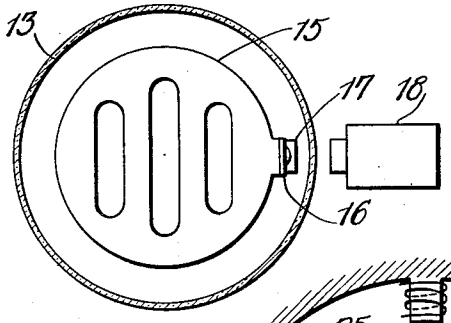


Fig. 4.

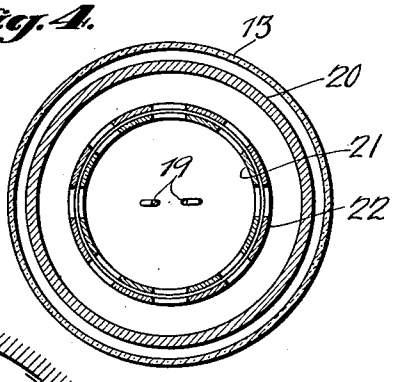
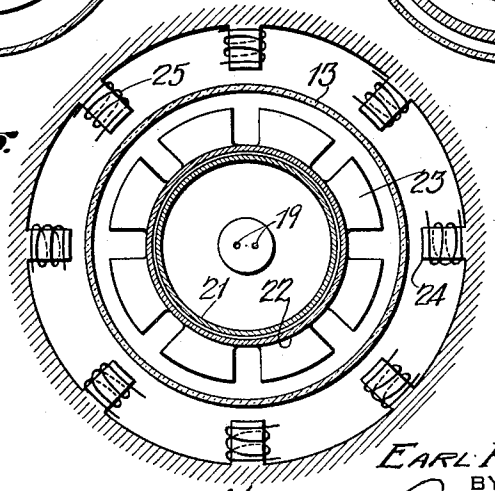


Fig. 5.



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Fig. 6.

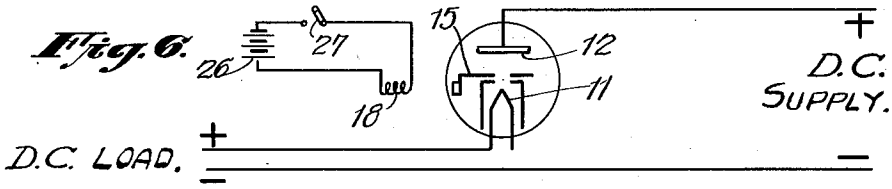


Fig. 7.

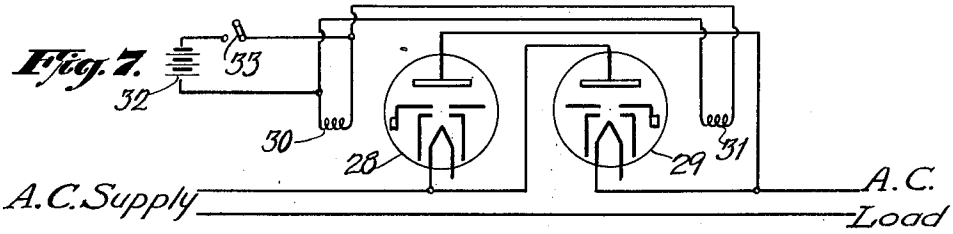


Fig. 8.

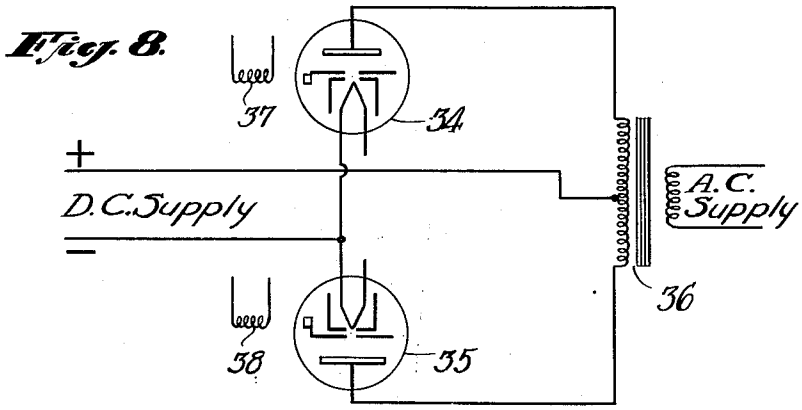
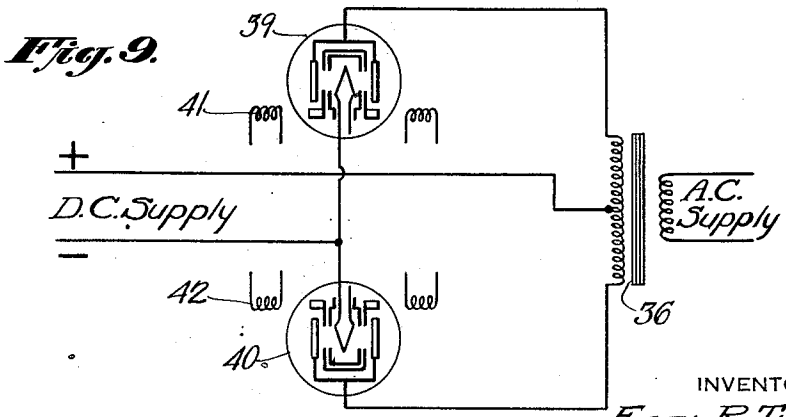


Fig. 9.



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UNITED STATES PATENT OFFICE

1,997,986

ELECTRIC CIRCUIT CONTROLLING APPARATUS

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Application June 24, 1930, Serial No. 463,496

6 Claims. (Cl. 250—27.5)

The invention aims to provide a simple and effective electron relay for breaking or similarly controlling electric circuits. The accompanying drawings illustrate the embodiments of the invention.

Fig. 1 is a vertical section of one type of relay, of which Fig. 2 is a section on the line 2—2;

Fig. 3 is a vertical section of another type, of which Figs. 4 and 5 are vertical sections on the correspondingly numbered lines;

Figs. 6, 7, 8 and 9 are diagrams showing the use of the relay in different circuits.

Referring first to Fig. 1, there is a cathode 11 above which is an anode 12, these being enclosed in a sealed shell 13. These parts may be of any usual or suitable design of construction, in which, for example, the hot cathode emits a stream of electrons to the anode. The space within the shell or tube may contain gases such as mercury vapor, for example, which are subject to ionization.

A mechanical barrier is arranged to be moved into and out of position to control the passage of electrons. This has the advantage over the ordinary electrically controlled arrangement that it can be used to stop the passage of current in a shell containing mercury vapor or like gases after the stream of electrons is established, which cannot be done with the ordinary electrical control.

In Fig. 1, a shell 14 is arranged about the cathode or filament containing openings in the line between the two electrodes, but closing the remainder of the space around the cathode. This cathode shell is probably best made of iron or other metal, though this is not theoretically essential. A reciprocable shutter 15 is arranged to slide to the right or left over the apertured portion of the cathode shell 14 and has openings placed to register with those in the shell 14 or to be moved wholly or partially out of register, when the shutter is shifted to the right, so as to partially or to completely cut off the passage of electrons and the passage of current. The shutter 15 may be mounted in various ways. It is illustrated as mounted on the end of a spring 16, the opposite end of which is fixed to the cathode casing 14. A pole-piece 17 is carried by the spring in line with a solenoid 18 arranged outside of the relay shell 13, but in juxtaposition to the pole-piece 17 so that the latter is within its magnetic field. By means of the solenoid, therefore, the shutter can be moved to the right or to the left as desired.

An alternative arrangement is shown in Figs. 3, 4 and 5. The cathode 19 is located within an annular anode 20 supported as shown from the sealed shell 13 of the relay. A casing 21 surrounds the cathode and has openings in its cylindrical wall in the line between the two electrodes. It is surrounded by a shutter 22 pivotally supported at the top on the shell 21 and with openings corresponding to those through the shell. It is thus adapted to be oscillated or rotated about the shell and to open or close the passage way between the two electrodes.

For operating the cylindrical shutter 21, various means may be used. As illustrated, the shutter has a series of pole-pieces 23 arranged around its lower edge and these are within the magnetic fields of stationary pole-pieces 24 arranged externally to the relay shell and carrying coils 25 through which alternating current is passed. When the actuating current passes, the shutter will be rotated, alternately opening and closing a passage for the electrons.

The relay described may be used for controlling various electric circuits and in various ways. It is useful chiefly for low-cycle circuits, such for example as circuits using 25 or 60 cycles; as compared with radio circuits using from 500 to 10,000 kilocycles. To operate a 60 cycle circuit, for example, the shutter of Fig. 1 would have to make 3600 complete reciprocations per minute. It may be made so light as to be worked at this speed easily. In the design of Fig. 2, however, it would only be necessary to operate the rotating shutter at 450 revolutions per minute.

Fig. 6 shows an arrangement for using the relay to control the switching on and off of current in a direct current circuit. The filament 11 is connected to the positive terminal of the load and the plate or anode 12 to the positive side of the direct current supply. The control of the circuit is obtained by moving the shutter 15 to either open or closed position by means of the magnetic field produced by the external solenoid 18 which is supplied with current from an auxiliary source such as a battery 26. The circuit being opened or closed by a switch 27.

For similarly controlling an alternating current circuit, the arrangement of Fig. 7 may be used. There are two electron relays indicated as a whole at 28 and 29 in order to permit the current to flow during both the positive and the negative parts of the cycle. One side of the alternating current supply is connected to the filament of the relays 28 and to the anode side of the relay 29. The alternating current load is connected to the anode of the first relay 28

and to the filament of the second relay 29. The circuit is controlled by the simultaneous opening and closing of the shutters in both relays. The two solenoid coils 30 and 31 for actuating the shutters are energized from a common battery 32 through a control switch 33.

The relay may be used also for converting a direct current supply to an alternating current supply, as shown in Fig. 8. Here the negative side of the direct current supply is connected to the filaments of both relays 34 and 35, and the positive side of the direct current supply to the center point of one winding of a transformer 36, which has the respective ends of this winding connected to the anodes of the two relays. The current through the two relays is controlled by opening and closing the shutters which are actuated by the respective solenoids 37 and 38. The solenoids are excited by impulses so timed that when the shutter of relay 34 is in the open position, the shutter of relay 35 is in the closed position.

This allows an impulse of direct current to flow through one half of the winding of the transformer 36 in one direction and, when the positions of the shutters, of the two relays are reversed, to flow through the other half of the transformer winding in essentially the opposite direction. The impulses in the primary winding of the transformer 36 induce a voltage in the secondary winding and appear on the latter as an alternating current supply. The frequency and the wave shape of the alternating current appearing at the secondary winding of the transformer are governed by the impulses of control current supplied to excite the solenoids for the respective relays.

The relays shown in Fig. 8 may be replaced by relays of the rotary shutter type as shown in Fig. 9 at 39 and 40. In this case, the rotating shutters would run synchronously at speeds depending upon the number of poles and the frequency of the supply control voltage used to energize the stationary pole-pieces 41 and 42. Both shutters would rotate at the same speed. But, they would be so positioned that when the shutter of relay 39 is in the open position the shutter of relay 40 would be in the closed position, and vice versa. The alternate impulses of current thus obtained through the two halves of the primary winding of the transformer 36 would induce an alternating current supply in the secondary winding.

Various other modifications and applications of the invention may be made by those skilled in the art without departing from the invention as defined in the following claims.

What I claim is:—

1. A gaseous conduction discharge device comprising a sealed envelope enclosing a thermionically active cathode, an anode, an ionizable gas and a barrier element enclosing said cathode and isolating the same from the said anode, the said barrier element being provided with a plurality of openings adapted to permit the free flow of electrons therethrough, a reciprocable shutter element superposed over said openings and means to mechanically operate said shutter to periodically open and close the said openings to thereby periodically interrupt the flow of electrons from the cathode to the anode.

2. A gaseous conduction discharge device comprising a sealed envelope enclosing a thermionically active cathode, an anode, an ionizable gas and means to periodically interrupt the flow of electrons from said cathode to the anode, said means comprising a shell surrounding and isolating the cathode from the said anode, a plurality of openings in said shell through which electrons from the cathode may freely pass, a superposed shutter element over said openings and electromagnetic means to periodically operate said shutter to close and open said shell openings to thereby periodically interrupt the flow of electrons from the cathode to the anode.

3. A gaseous conduction discharge device comprising a sealed envelope enclosing a thermionically active cathode, an anode, an ionizable gas and means to periodically interrupt the flow of electrons from said cathode to the anode, said means comprising a shell surrounding and isolating the cathode from the said anode, a plurality of openings in said shell through which electrons from the cathode may freely pass, a superposed shutter element over said openings and electromagnetic means disposed externally of said envelope to periodically operate said shutter to close and open said shell openings to thereby periodically interrupt the flow of electrons from the cathode to the anode.

4. A gaseous conduction device including a sealed envelope having an ionizable gas, a thermionically active cathode and an anode contained therein, means to periodically interrupt the flow of electrons from the cathode to the anode, said means comprising a barrier disposed within said container to completely isolate the cathode from the anode, said barrier having a plurality of openings therein to permit the free passage of electrons therethrough and a superposed mechanically operative shutter element for said openings and means to periodically actuate said shutter to open and close said openings thereby periodically interrupting the flow of electrons therethrough to the anode.

5. A gaseous conduction device including a sealed envelope having an ionizable gas, a thermionically active cathode and an anode contained therein, means to periodically interrupt the flow of electrons from the cathode to the anode, said means comprising a barrier disposed within said container to completely isolate the cathode from the anode, said barrier having a plurality of openings therein to permit the free passage of electrons therethrough and a superposed mechanically operative shutter element for said openings, and electromagnetic means operable externally of said envelope to periodically actuate said shutter to open and close said openings thereby periodically interrupting the flow of electrons therethrough to the anode.

6. A gaseous conduction device including a sealed envelope having an ionizable gas, a thermionically active cathode and an anode contained therein, means to periodically interrupt the flow of electrons from the cathode to the anode, said means comprising a barrier disposed within said container to completely isolate the cathode from the anode, said barrier having a plurality of openings therein to permit the free passage of electrons therethrough and a superposed shutter element for said openings adapted to be mechanically operated to open and to entirely close said openings and electromagnetic means to periodically actuate said shutter thereby periodically interrupting the flow of electrons from the cathode to the anode.

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