

Sept. 1, 1925.

1,552,219

G. G. MERCER

VACUUM TUBE CIRCUITS

Filed April 23, 1920

Fig. 1.

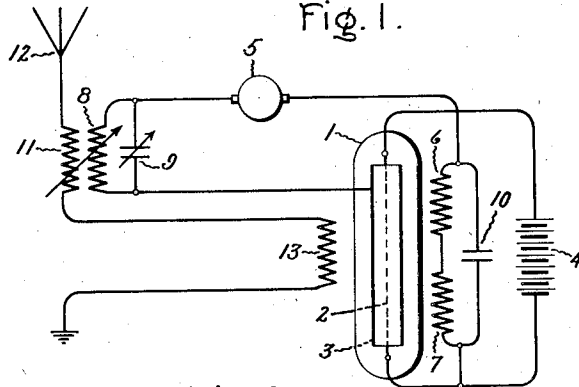


Fig. 2.

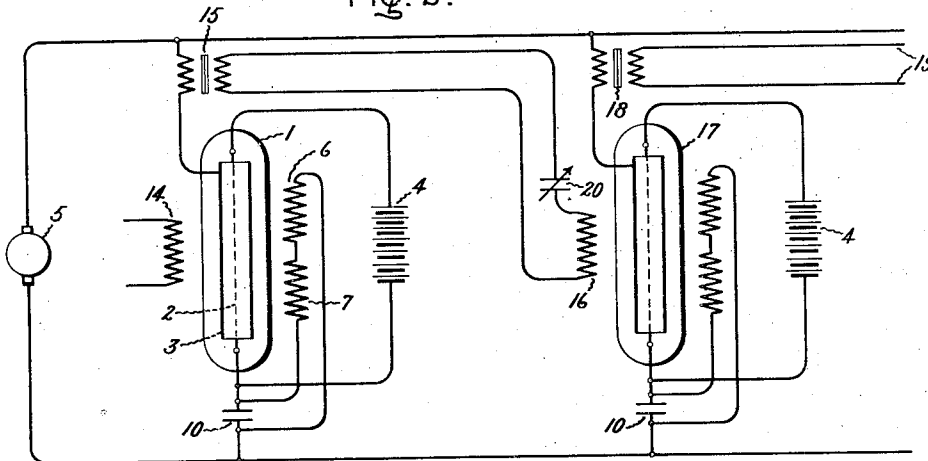
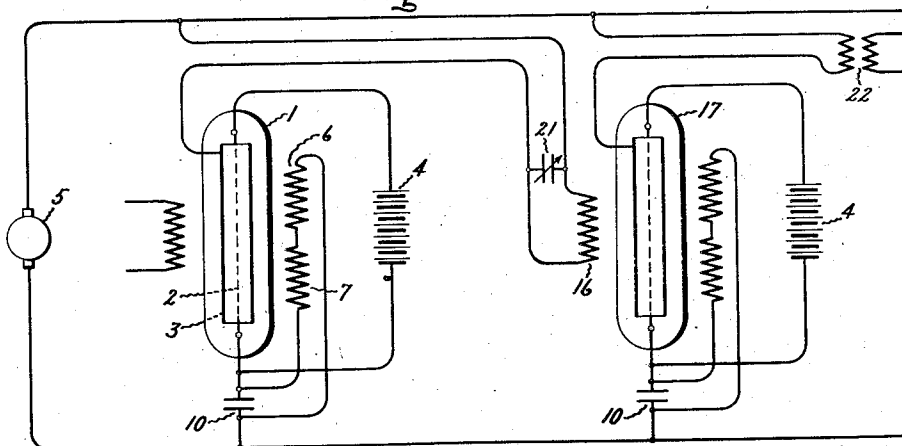


Fig. 3.



Inventor:
George G. Mercer,
by *Albert G. Davis*
His Attorney.

Patented Sept. 1, 1925.

1,552,219

UNITED STATES PATENT OFFICE.

GEORGE GLENN MERCER, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

VACUUM-TUBE CIRCUITS.

Application filed April 23, 1920. Serial No. 375,976.

To all whom it may concern:

Be it known that I, GEORGE G. MERCER, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Vacuum-Tube Circuits, of which the following is a specification.

My present invention relates to vacuum tube circuits, and more particularly to circuits for vacuum tube devices in which an electron current is controlled by means of a magnetic field.

If an electron discharge device comprising an electron emitting cathode and an anode enclosed in an evacuated receptacle has a source of potential connected between cathode and anode, a current will flow between cathode and anode which is carried by means of electrons emitted from the cathode. The current flowing between the electrodes may be controlled or varied in amplitude by means of a magnetic field set up in the receptacle in a direction at right angles to the electrostatic field between the electrodes. To control the current in this way requires a magnetic field of considerable magnitude, that is, no variation will be produced in the current unless a magnetic field of a predetermined strength is set up in the space between the electrodes. When, however, a magnetic field of the required strength is set up in the space between the electrodes a small variation in the strength of this magnetic field will produce a large variation in the strength of the current flowing between the electrodes. In the operation of such devices in the past it has been customary to provide a separate source of current for producing a constant magnetic field of such a value that a variable magnetic field superimposed thereupon will produce the desired changes in the current. This constant magnetic field is usually termed the polarizing field.

The object of my invention is to eliminate the necessity for the use of a separate source of current for furnishing the polarizing field and to permit of the production of this polarizing field by means of the electron current flowing between the cathode and anode.

In carrying my invention into effect I cause the current which flows between the electrodes to pass through a coil

or coils surrounding the tube. Altho in the usual operation of the device this current is caused to vary, I have found that by shunting these coils by means of a condenser of proper size for bypassing the variable component of the current in the circuit a substantially constant current will flow through the coils and as a result a polarizing field of substantially constant value will be produced.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, will best be understood by reference to the following description taken in connection with the accompanying drawings in which Figs. 1, 2 and 3 illustrate diagrammatically three different circuit arrangements in which my invention may be employed.

As indicated in Fig. 1, an electron discharge device is employed comprising an evacuated receptacle 1, which is preferably of tubular form and which contains a filamentary cathode 2 and an anode 3 of cylindrical form surrounding the cathode. A source of current 4 is connected to the two terminals of the cathode 2 for heating it to incandescence to cause it to emit electrons for carrying current across the evacuated space between the two electrodes. An external circuit between electrodes 2 and 3 includes a source of direct current 5, inductances represented conventionally at 6 and 7, but which actually are wound around the receptacle 1, and an inductance 8 and a variable tuning capacity 9 in shunt to inductance 8. Inductances 6 and 7 are shunted by a condenser 10. The current which flows between cathode 2 and anode 3, through coils 6 and 7, produces a constant magnetic field in the space between the electrodes which is in a direction parallel to the axis of the tube or at right angles to the electrostatic field between the electrodes. Coils 6 and 7 and source 5 are so proportioned that this constant magnetic field will have a predetermined desired value. The coil 8 is coupled to a coil 11 in series with the antenna 12, and a second coil 13, which is also in series with the antenna, surrounds the receptacle 1. This coil 13 produces a second magnetic field in receptacle 1 which is superimposed upon the constant magnetic field produced by the coils 6 and 7.

When the circuit is connected in the manner shown high frequency oscillations will be produced in the antenna 12 by reason of the coupling between coils 8 and 11, and the effect of the magnetizing field of coil 13 and the current between the electrodes 2 and 3 will be caused to vary. The current flowing in the plate circuit, however, may be considered as a constant direct current having an alternating component superimposed thereupon. Coils 6, 7, having high inductance offer a high impedance to the flow of the alternating component which is bypassed through condenser 10. As a result, the current flowing in coils 6, 7, will be substantially constant and therefore will maintain the constant polarizing field desired in the receptacle 1.

In Fig. 2 I have shown another modification of my invention in which devices of the type in question are employed as amplifiers. In this case the current which is to be amplified is supplied to the coil 14 which surrounds the receptacle 1 and the magnetic field produced by the current to be amplified produces corresponding variations in the current through the device. In this case, as in Fig. 1, the variable component of the current through the device is bypassed through the condenser 10 and the current flowing through the coils 6 and 7 is substantially constant. The variable component of the current in the plate circuit of the first device is supplied by means of a transformer 15 to the input coil 16 of a second device 17, which is connected up in a similar manner. The variable component in the plate circuit of this second device is in turn impressed by means of transformer 18 upon the output circuit 19, which may contain suitable devices for giving an indication of the amplified current or may supply amplified current in the input circuit of still another device as may be desired. The input circuit of the second device 17 may be tuned by means of a variable condenser 20 if desired.

The arrangement shown in Fig. 3 is similar to that shown in Fig. 2 with the exception that the entire current in the plate circuit of the first device is supplied to the input coil 16 of the second. In this case as in the preceding case, the input circuit of the second device may be tuned by means of the condenser 21. I have indicated in the plate circuit of the device 17 a transformer 22 for supplying the amplified current to the output circuit. This expedient may be employed if desired as there is no advantage in supplying to the output circuit of the last device the direct current component of a plate current.

While I have indicated and described only three circuit arrangements in which my invention may be utilized, it is apparent that a great variety of modifications in the cir-

cuit arrangements employed as well as in the specific form of apparatus used may be made without departing from the scope of my invention as set forth in the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. The combination in an apparatus of the class described of an electron discharge device comprising an evacuated receptacle containing a cathode adapted to emit electrons and an anode, an external circuit between said cathode and anode containing a source of current and means for producing by current flowing in said circuit a substantially constant magnetic field in the space between said electrodes.

2. The combination in an apparatus of the class described of an electron discharge device comprising an evacuated receptacle containing a cathode adapted to emit electrons and an anode, an external circuit between said cathode and anode containing a source of current, an inductive winding surrounding said receptacle and connected in said external circuit to receive current therefrom, means for varying the current in said circuit and means for maintaining a substantially constant current in said inductive winding.

3. The combination in an apparatus of the class described of an electron discharge device comprising an evacuated receptacle containing a cathode adapted to emit electrons and an anode, an external circuit between said cathode and anode containing a source of current, an inductive winding surrounding said receptacle and connected in said external circuit, means for varying the current in said circuit and a condenser in shunt to said inductive winding for bypassing the variable component of the current in said external circuit.

4. The method of operating an electron discharge device having an electron emitting cathode and an anode enclosed in an evacuated receptacle, which consists in applying a potential to said electrodes to produce a flow of current between said electrodes; producing by means of current flowing between said electrodes, a substantially constant magnetic field between said electrodes in a direction substantially at right angles to the electrostatic field between said electrodes and producing a variable magnetic field which is superimposed upon said constant magnetic field.

5. The method of operating an electron discharge device having an electron emitting cathode and an anode enclosed in an evacuated receptacle which consists in applying a potential to said electrodes to produce a flow of current between said electrodes, producing a variable magnetic field in the space between said electrodes for vary-

ing the current between said electrodes, and producing by means of a constant component of the current between said electrodes a substantially constant magnetic field in the space between said electrodes.

6. The combination in an apparatus of the type described of an electron discharge device comprising a cathode adapted to emit electrons and a cooperating anode, an external circuit between said cathode and anode containing a source of current, means for varying the current flowing in said circuit, and means for producing by current flowing in said circuit a substantially constant magnetic field in the space between said electrodes.

7. The combination in an apparatus of the type described of an electron discharge device comprising a cathode adapted to emit electrons and a cooperating anode, an external circuit between said cathode and anode containing a source of current, means for varying the current flowing in said circuit, an inductance included in said circuit, and means for maintaining a substantially constant current in said inductance, and producing by such current a substantially constant magnetic field in the space between said electrodes.

8. The combination in an apparatus of the type described of an electron discharge device comprising a cathode adapted to emit electrons, and a cooperating anode, an ex-

ternal circuit between said cathode and anode containing a source of current, means for varying the current flowing in said circuit, an inductive winding included in said circuit, means for maintaining a substantially constant current in said inductive winding and thereby producing a substantially constant magnetic field in the space between said electrodes, said means comprising a connection in shunt to said inductive winding for by-passing the variable component of the current in said external circuit.

9. The combination in an apparatus of the type described of an electron discharge device comprising a cathode adapted to emit electrons, and a cooperating anode, an external circuit between said cathode and anode containing a source of current, means for varying the current flowing between said cathode and anode, an inductive winding included in said circuit, means for maintaining a substantially constant current in said inductive winding and producing by such current a substantially constant magnetic field in the space between said electrodes, said means comprising a shunt connection in the circuit between cathode and anode for carrying the variable component of the current flowing between cathode and anode.

In witness whereof, I have hereunto set my hand.

GEORGE GLENN MERCER.