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R. S. OHL

EQUIPOTENTIAL CATHODE VACUUM TUBE

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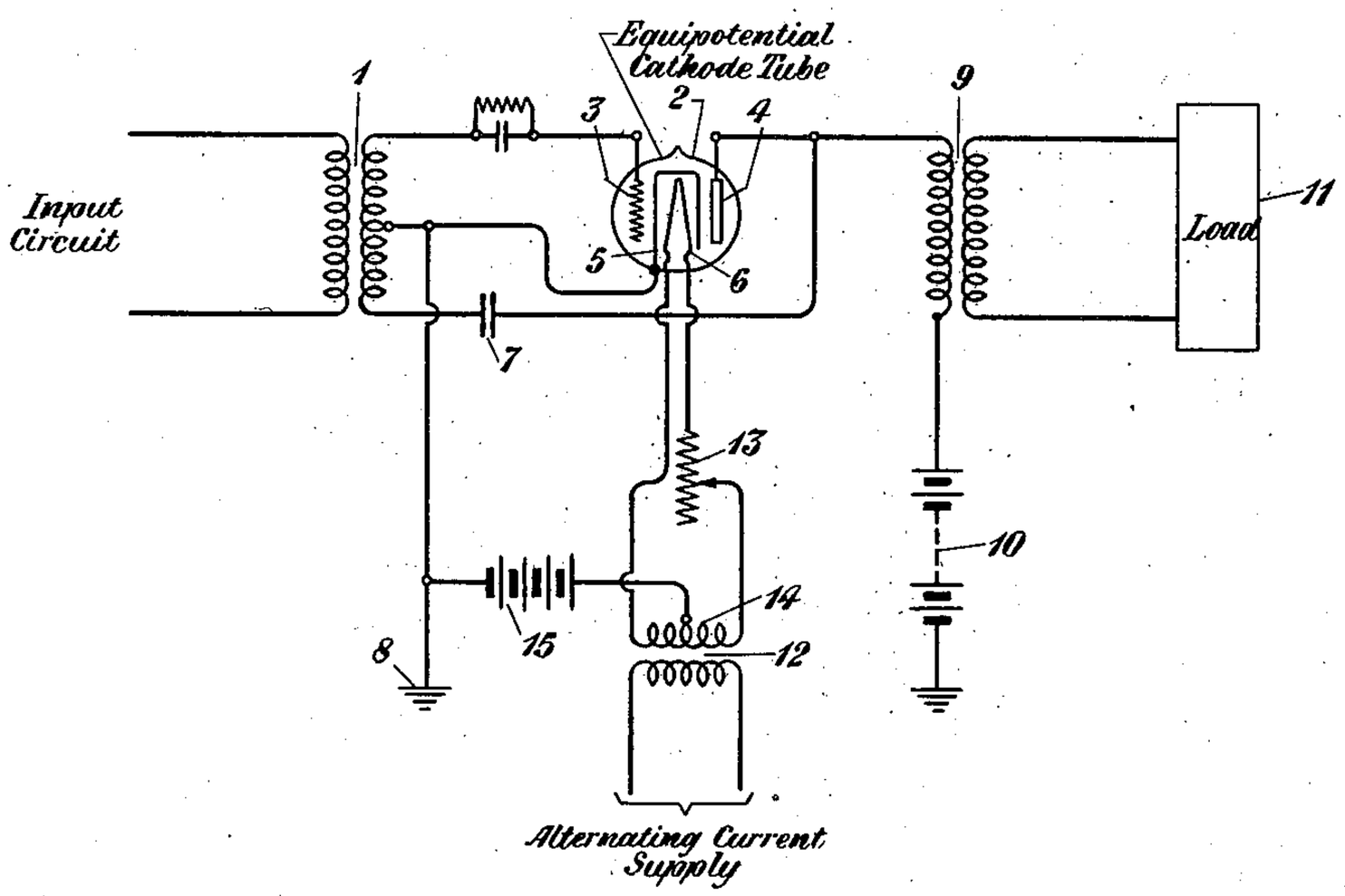

Fig. 1

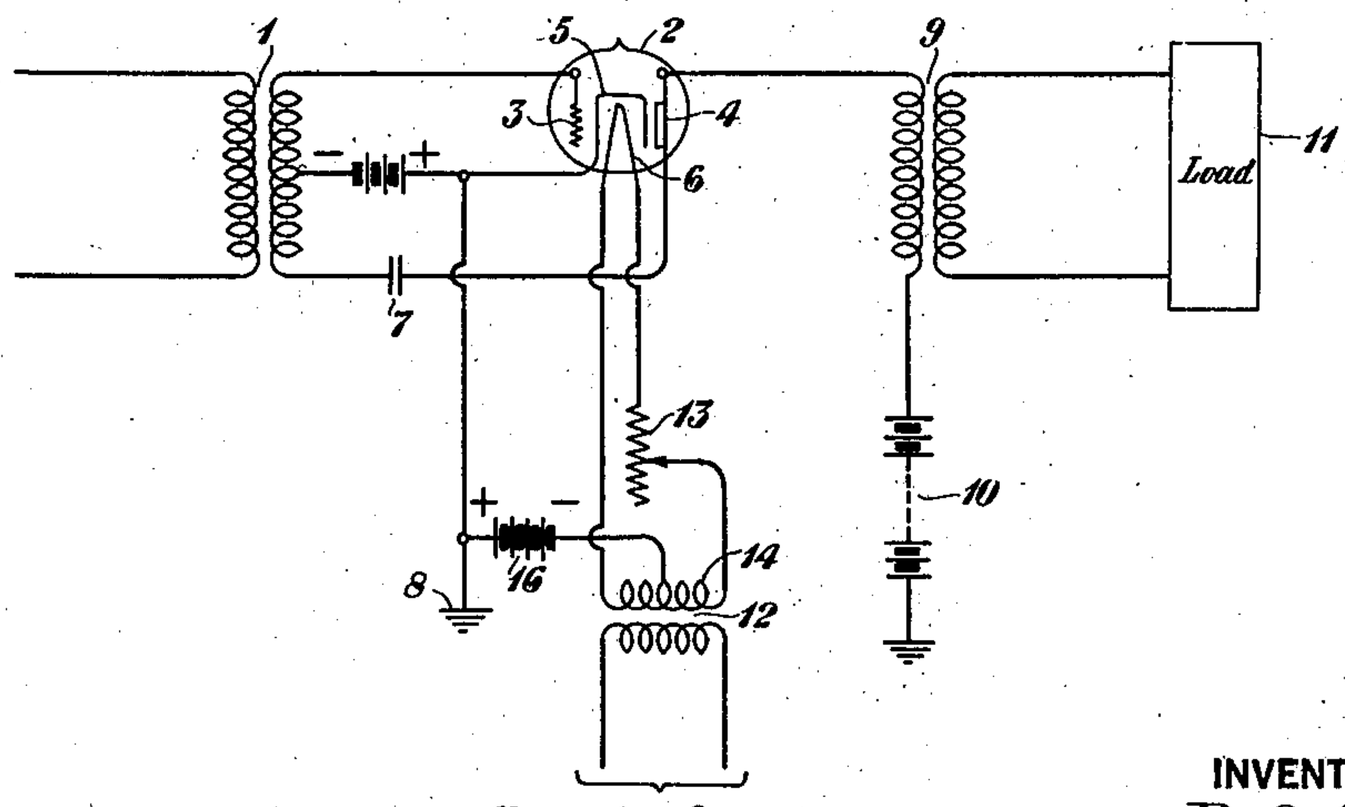

Fig. 2

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UNITED STATES PATENT OFFICE.

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EQUIPOTENTIAL CATHODE VACUUM TUBE.

Application filed November 18, 1924. Serial No. 750,642.

This invention relates to equi-potential cathode vacuum tubes and particularly to means for preventing the electrons created by the heating element per se of tubes of that type from interfering with the normal anode-cathode current of such tubes.

In vacuum tubes in which the cathode is heated by the conduction of current therethrough, there is, of course, a difference of potential between the terminals of the cathode, which difference of potential produces a detrimental effect in the operation of the tube. To eliminate this effect, there has been developed the so-called equi-potential cathode tube which is characterized by the fact that substantially all points of the cathode are at the same potential. In tubes of this type the cathode is rendered active by means external to the cathode itself. This means, which may be termed the heating element of the tube, may operate in various ways in order to produce the desired effect, viz, rendering the cathode electron-emitting. Among the possible ways are direct radiation of heat from the heating element to the cathode or bombarding the cathode with electrons so as to render it in turn electron-emitting.

My invention relates to tubes in which the cathode is rendered active by the radiation of heat from the heating element. As is well known, electrons are emitted to some extent even in tubes of the equi-potential cathode type, which depend upon the principle of radiation of heat to render the cathode active. If the source for energizing the heating element is of the alternating current type, electrons will be emitted from the heating element at a varying rate, depending upon the cyclic reversals of the alternating current. These electrons will tend to flow to the plate and the grid of the vacuum tube, together with the electrons that flow directly from the equi-potential cathode itself, and will produce a variation in the output current of the said tube which, for example, in a radio receiving apparatus, will produce a hum in the sound producing device, such as a telephone receiver or loud-speaker.

It is the object of this invention to provide means for the substantial elimination of electron emission from the heating element itself.

This invention will be clearly understood from the following description when read in connection with the attached drawing, in which Figure 1 shows schematically a form of embodiment of the invention in which the electrons created by the heating element are driven back to that element; and Fig. 2 shows means for attracting such electrons to the cathode itself.

The input circuit of Fig. 1 is coupled to the input side of the vacuum tube circuit by means of the transformer 1. This input circuit may be connected with an antenna circuit either directly or through other apparatus. The vacuum tube 2 comprises a grid 3, a plate 4, an equi-potential cathode 5, and a heating element 6. The cathode 5 is connected with the midpoint of the secondary winding of the transformer 1, of which one of the outer terminals is connected with the grid 3, and the other outer terminal is connected through the condenser 7 with the plate 4 of the tube. This condenser is intended to balance the capacity between the grid and the plate of the tube. The midpoint of the secondary winding to which the cathode is connected is grounded at 8. The plate 4 is connected with the primary winding of the transformer 9, to which is also connected the positive pole of the grounded plate battery 10. The secondary winding of the transformer 9 is connected with a load 11, which may be a receiving device or other form of apparatus. The heating element 6 is connected with one of the windings of the transformer 12, the other winding of which is connected with a source of alternating current. A rheostat 13 is inserted in series with the heating element to control the degree of heat. Connected between the midpoint of the winding 14 and the cathode 5 is a battery 15, the positive pole of which should be toward the heating element.

The manner in which this invention functions to obtain the desired result is as follows: When the alternating current energy is applied to the heating element 6 in order to produce heat therein, which in turn will heat the cathode 5 and render the latter electron-emitting, electrons would also be emitted to a varying extent from the heating element 6. There would be a tendency for these elec-

trons to travel to the plate 4 and the grid 3 of the tube, and since they result from an alternating current, the number of electrons would vary with the cyclic reversals of current. This varying stream of electrons from the heating element itself would cause a varying current in the plate circuit, which would manifest itself in the receiving device 11. This tendency for the electrons to radiate from the heating element 6 is prevented by means of the battery 15. This battery keeps the heating element 6 at such a positive potential with respect to the cathode of the tube that the tendency for the electrons to leave the heating element is checked. This, of course, results in quiet operation of the tube.

The arrangement shown in Fig. 1 is based upon the principle of keeping the cathode negative with respect to the heating element so that electrons created by the heating element per se will be prevented from escaping therefrom, and thus any interference with the normal anode-cathode current is prevented. An alternative arrangement is shown in Fig. 2 in which the same reference numerals have been used to indicate similar parts. In this arrangement the battery 16, which in position corresponds to the battery 15 of Fig. 1, is so poled as to make the cathode 5 positive with respect to the heating element 6. As thus arranged, any electrons created by the heating element 6 will be drawn to the cathode 5 which is in close juxtaposition thereto, and thus are prevented from traveling to the other electrodes of the tube and causing interference with the normal space current. The arrangement shown in this figure is particularly well adapted for use in connection with equi-potential cathode tubes in which the cathode consists of a cylinder open at the top. With tubes of that type there would normally be a tendency for electrons to escape from the heating element and to pass through the open top of the cathode to the other electrodes of the tube. By employing an arrangement similar to that shown in Fig. 2, the positive charge upon the cylindrical cathode tends to draw to it any electrons that may be freed from the heating element.

The arrangements shown in the figures and described herein are simply illustrative of the invention. It will, of course, be obvious that the invention may be applied in other and different ways without departing from the spirit and scope of the appended claims.

What is claimed is:

1. The combination with a vacuum tube having a cathode and means separate therefrom to heat the said cathode, of polarizing means connected between said cathode and said heating means to substantially prevent the radiation of electrons from the said heating means.

2. In a vacuum tube, the combination with a cathode to emit electrons when heated of a heating element to energize the said cathode, a plate, an evacuated vessel enclosing all of the aforesaid elements, means for energizing the said heating element, and polarizing means connected between said cathode and said heating element to substantially prevent the emission of electrons from the said heating element to the cathode.

3. The combination with a vacuum tube having an evacuated vessel enclosing a cathode, a plate, a grid, and a heating element to render the said cathode active, means to energize the said heating element, a circuit having a source of potential connecting the said plate and said cathode, a second source of potential connected between the said heating element and the said cathode, so polarized as to substantially prevent the emission of electrons from the heating element to the cathode.

4. In an equi-potential cathode tube, the combination with a cathode of a heating element separate therefrom to render the said cathode active, a source of alternating current to energize the said heating element, a source of potential having its positive side connected to the said heating element and its negative side to the said cathode to prevent the radiation of electrons from the heating element.

5. In an electrical translating system, the combination with a vacuum tube having an anode, a cathode, and a heating element adjacent to the said cathode to activate the latter by direct radiation, of a source of alternating current to energize the said heating element, and means to substantially prevent the emission of electrons from the said heating element to the cathode.

6. In an electric translating system employing a vacuum tube having an anode, a unipotential cathode, and a heating element adjacent to the said cathode to activate the latter, the method of preventing detrimental effects in the anode circuit by electrons produced by the energization of the said heating element, which consists in applying a potential between the heating element and the said cathode to substantially prevent the emission of the said electrons to the cathode.

7. In an electric translating system employing a vacuum tube having an anode, a unipotential cathode, and a heating element adjacent to the said cathode to activate the latter, the method of preventing detrimental effects in the anode circuit by electrons produced by the energization of the said heating element, which consists in applying a potential between the said heating element and the said cathode, the said potential being so polarized as to prevent the emission of electrons from the heating element to the cathode.

8. In an electrical translating system, the combination with a vacuum tube having an

anode, a cathode, a heating element adjacent to the said cathode, of a source of alternating current connected with the said heating element to energize the latter whereby the said cathode is activated, and a source of direct current potential connected between the said heating element and the said cathode, the said source being of such magnitude and so poled as to prevent electronic emission from the said heating element to the cathode.

In testimony whereof, I have signed my name to this specification this 17th day of November, 1924.

RUSSELL S. OHL.