

June 10, 1930.

L. O. GRONDAHL

1,763,097

POWER SUPPLY MEANS

Filed July 19, 1923

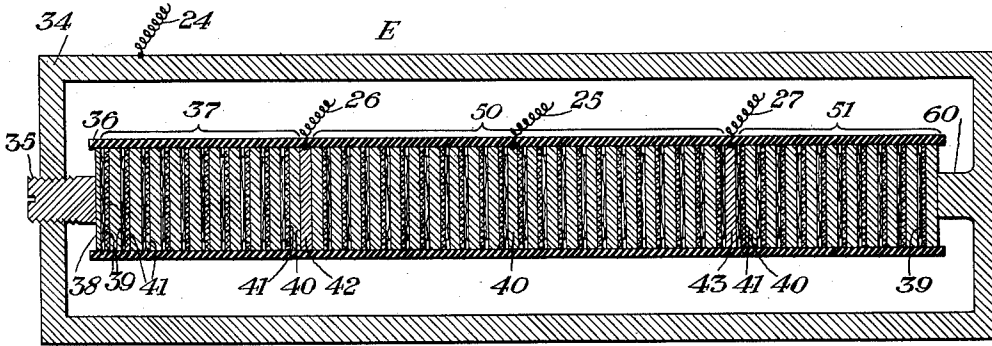
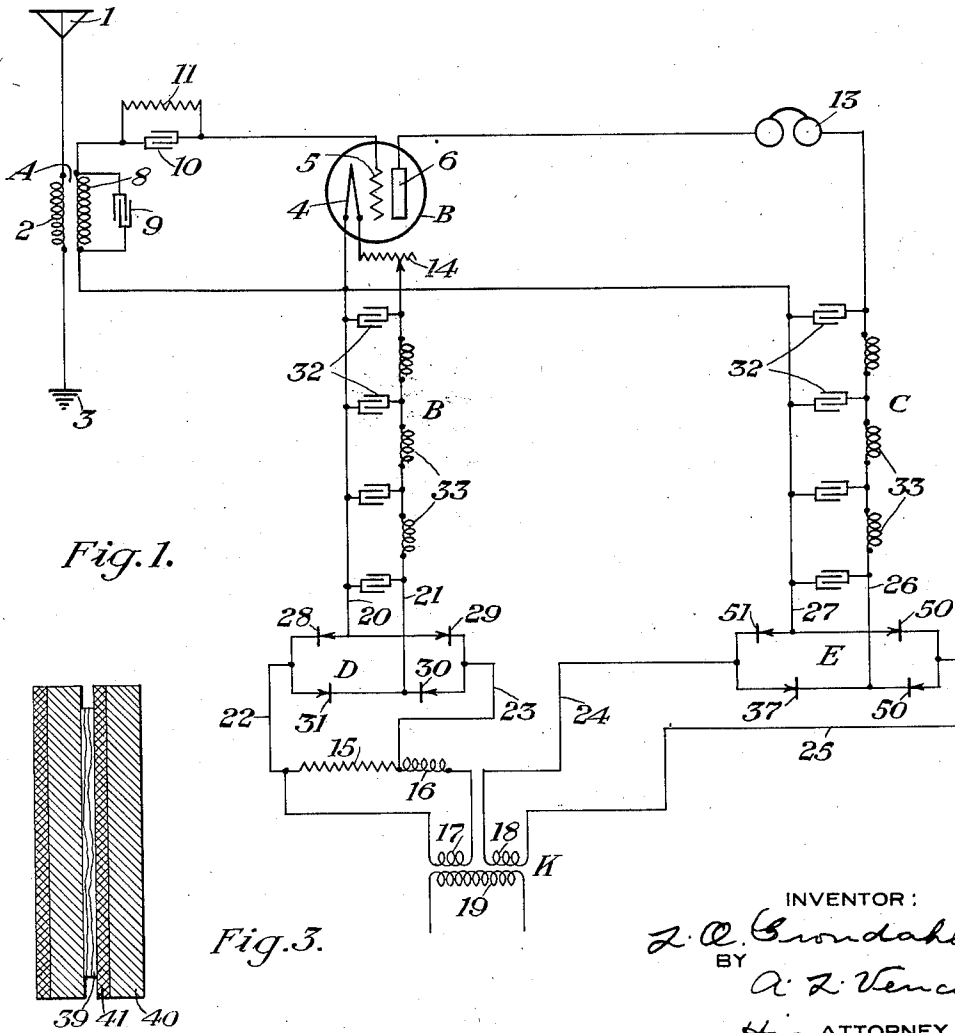


Fig. 2.



INVENTOR:
Z. O. Grondahl,
 BY
A. Z. Vencill
 His ATTORNEY

UNITED STATES PATENT OFFICE

LARS O. GRONDAHL, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO THE UNION SWITCH & SIGNAL COMPANY, OF SWISSVALE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA

POWER-SUPPLY MEANS

Application filed July 19, 1923. Serial No. 652,524.

My invention relates to apparatus for the electrical communication of intelligence, and particularly to apparatus of this character involving electron tubes.

I will describe one form and arrangement of apparatus embodying my invention, and will then point out the novel features thereof in claims.

In the accompanying drawings, Fig. 1 is a diagrammatic view showing one form of apparatus embodying my invention. Fig. 2 is a view showing, in vertical cross section, one form of rectifying device illustrated diagrammatically in Fig. 1 and also embodying my invention. Fig. 3 is a detail view drawn to a large scale and showing a portion of the rectifying device illustrated in Fig. 2.

Similar reference characters refer to similar parts in both views.

Referring first to Fig. 1, the receiving apparatus here illustrated comprises an electron tube B containing as usual, a filament 4, a grid 5, and a plate 6. This tube is provided with a grid circuit including one winding 8 of an oscillation transformer A, a grid condenser 10, and the filament 4 and grid 5 of the tube B. The winding 8 may be tuned to resonance by means of the condenser 9 connected across the terminals of the winding. A high resistance or grid leak 11 is shunted around the grid condenser 10 in the customary manner. The remaining winding 2 of transformer A is connected with a suitable antenna 1 and a ground connection 3 in the usual manner.

The electron tube B is also provided with a plate circuit including the filament 4 and plate 6 of tube B, an electro-responsive device such as a telephone receiver 13, and a source of alternating energy such as the secondary 18 of a transformer K. The primary 19 of transformer K is constantly supplied with alternating current from some source not shown in the drawing. As is well known to those skilled in the art, alternating current in the plate circuit causes an audible "hum" in the telephones 13 which interfere with the reception of the incoming signals. To transform the alternating current supplied by the transformer secondary

18 into a uni-directional current I interpose between this secondary and the tube 7, a rectifying device E one form of which will be described in detail hereinafter, and a wave filter C.

Referring now to Fig. 2 the rectifying device E comprises three sections 37, 50 and 51, each comprising a plurality of rectifying units. Each of these rectifying units is preferably in the form of a disk of copper having an intimate contact with one side thereof a coating of cuprous oxide which is preferably formed directly upon the disk by some suitable means such as by subjecting the disk to a high temperature in the presence of a limited amount of air. During this process a thin film of cupric oxide is formed upon the outside of the cuprous oxide coating and this film is subsequently removed by some suitable means such as abrasion with emery cloth or sand blast, or by corrosion as with nitric acid. As shown in the drawing the copper disks are designated by the reference characters 40 and the oxide coatings by the reference characters 41. It has been found that units prepared in this manner offer lower electrical resistance to current flowing from the oxide coating 41 to the copper disk 40 than to current flowing in the opposite direction, and hence these units are called rectifying units. One or more sheets 39 of some relatively soft conducting material such as lead foil are interposed between each two adjacent units to insure good electrical contact. Two rectifying units constructed in accordance with my invention are illustrated on a larger scale in Fig. 3. The section 50 is so assembled as to allow current to pass the more readily from right to left and sections 37 and 51 are so assembled as to allow current to pass the more readily from left to right. Section 37 is separated from section 50 by means of a conducting disk 42 provided with a terminal wire 26. Similarly, section 50 is separated from section 51 by means of a conducting disk 43 provided with a terminal wire 27. The middle unit of section 50 is connected with a terminal wire 25. The entire series of units is contained in a tube 36 of

fibre or other insulating material and is mounted in a frame 34 of some suitable conducting material. This frame is provided with a boss 60 which is arranged to engage the right hand unit of section 51, and with a set screw 35 threaded in the frame 34 and arranged to engage the left hand unit of section 37 whereby the units may be pressed into intimate relation thus insuring perfect electrical contact.

Referring now also to Fig. 1, wires 24 and 25 are connected with the secondary 18 of transformer K and wires 26 and 27 are connected through the wave filter C to the plate and filament of the tube 7. When the left hand terminal of secondary 18 is positive, current flows from this terminal through wire 24, rectifying section 37 of device E, wire 26, filter C, phone 13, plate and filament of tube 7, filter C, wire 27, right hand portion of section 50 of device E, and back to the other side of transformer secondary 18 through wire 25. When the right hand terminal of secondary 18 is positive, current flows from this terminal through wire 25, left hand portion of section 50 of device E, wire 26, filter C, phone 13, plate and filament of tube 7, filter C, and wire 27, rectifying section 51, and wire 24 back to transformer secondary 18. As a result the current supplied to the plate circuit is a unidirectional current which fluctuates with the electromotive force in the secondary winding 18. To reduce these pulsations and eliminate any alternating current which might pass the rectifiers I prefer to interpose between the rectifying device E and plate 6 a wave filter designated by the reference character C. This filter may be of any suitable form and in the present instance comprises a plurality of reactors 33 connected in series with the filament 4 and a plurality of condensers 32 connected in parallel with the filament 4 and interposed between adjacent reactors as shown in the drawing.

I have found that rectifying devices such as shown in Fig. 2 may be conveniently constructed with very high resistances, and I have also found that this is of especial advantage since the plate resistance of the tube, that is, the resistance from plate to filament, is very high. Furthermore, I have found that if the rectifier E has a resistance equal to the plate resistance of the tube, the efficiency of the rectifier is about 33%. If the resistance of the rectifier is twice the plate resistance, the efficiency of the rectifier is increased to about 50%. Rectifiers built in accordance with my invention may be conveniently made having resistances of many thousands of ohms and are therefore highly efficient for use in connection with electron tubes. Moreover, rectifiers embodying my inven-

tion do not distort the wave form appreciably and are therefore particularly adapted for such use.

As shown in the drawing, the filament 4 of tube B is heated by means of an electric current which is furnished by the secondary winding 17 of transformer K. It is well known that periodic variation in the current through filament 4 would cause a "hum" in the receivers just as explained in connection with the plate circuit. This is undesirable, and to prevent its occurrence, I interpose a rectifying device D between the filament 4 and the secondary winding 17 of transformer K.

The rectifying device D may be of any suitable type, such for example, as the device shown in Figs. 7, 8, and 9 of an application for Letters Patent of the United States filed by Lars O. Grondahl and Frank H. Nicholson on March 7, 1922, Serial No. 541,733. In brief, this device comprises four rectifying elements 28, 29, 30 and 31, each of which may be copper in intimate contact with cuprous oxide. An element of this character offers a lower electrical resistance to current passing from the oxide to the copper than to current flowing in the opposite direction, and so the element may properly be termed a "rectifier". The four elements are so connected between the transformer and the filament that when the left hand terminal of the secondary 17 of transformer K is positive, current flows from that terminal through wire 22 and rectifier element 31, wire 21, filament 4, wire 20, and through rectifier element 29 and wire 23 back to the transformer; whereas, when the right hand terminal of the secondary winding 17 is positive, current will flow through wire 23 and rectifier element 30, wire 21, filament 4, wire 20, and rectifier element 28 back to secondary winding 17 over wire 22. As a result, the current supplied to the filament is a unidirectional current which fluctuates or pulsates in response to alternations in the electromotive force in the secondary winding 17. These pulsations are further reduced by a filter B similar to filter C. A variable resistance 14 is connected in series with the filament to regulate the temperature of this element to any desired value.

It will be clear from the foregoing that telephonic or telegraphic signals which are transmitted to the apparatus by transformer A are rendered audible by the telephones 13. But the slight periodic variations in the current through the filament 4 of the tube, resulting from imperfect or incomplete rectification by device D may cause an audible sound in the receiver which sound will be confused with the signals which it is desired to hear. To prevent this occurrence I interpose between transformer secondary 17 and

the rectifying device D a resistance 15 and a reactance 16. The resistance and reactance are connected in series with the secondary 17 and the rectifier D is connected by means of wires 22 and 23 with the terminals of the resistance. The effect of the combination is to displace the phase of the current flowing in the rectifiers with respect to the voltage across the transformer secondary 17. By suitably proportioning resistance 15 and reactance 16, the phase of the filament current may be displaced any required amount so that its maximum points are in phase with the point of minimum plate current, thus tending to balance the irregularities in these two currents.

My invention, though here shown applied to a "single stage" detector is readily applicable to receiving apparatus comprising one or more stages of amplification in addition to a detector tube.

Although I have herein shown and described only one form and arrangement of apparatus embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In combination, an electron tube comprising a filament, a plate circuit for said tube including a source of alternating current, means for supplying to said filament a uni-directional current having periodic points of maximum value, and means for displacing the phase of such points with respect to the maximum points of said alternating current.

2. In combination, an electron tube comprising a filament, a plate circuit for said tube including a source of alternating current, means for supplying to said filament a uni-directional current having periodic points of maximum value, and means for causing said points to be approximately in phase with the minimum points of said alternating current.

3. In combination, an electron tube comprising a filament, a plate circuit for said tube, means for supplying to said circuit a uni-directional current having periodic points of maximum value, means for supplying to said filament a uni-directional current having periodic points of minimum value, and means for causing said maximum points and said minimum points to be approximately in phase.

4. In combination, an electron tube comprising a filament, a plate circuit for said tube, means for supplying to said circuit a uni-directional current having periodic points of maximum value, means for supplying to said filament a uni-directional cur-

rent having periodic points of minimum value, and means for regulating the phase relation of said maximum points and said minimum points.

In testimony whereof I affix my signature.

LARS O. GRONDAHL.

70

75

80

85

90

95

100

105

110

115

120

125

130