March 17, 1925.

1,530,364

E. F. HENNELLY

AMPLIFIER

Filed June 26, 1922

Fig. 1.

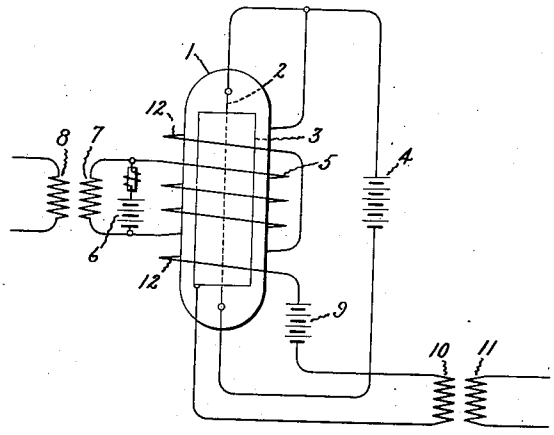


Fig. 2.

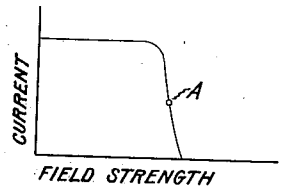
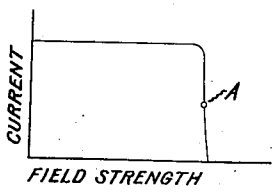


Fig. 3.



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by Albert G. Davis
His Attorny.

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UNITED STATES PATENT OFFICE.

EDWARD F. HENNELLY, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

AMPLIFIER.

Application filed June 26, 1922. Serial No. 570,966.

To all whom it may concern:

Be it known that I, EDWARD F. HENNELLY, a citizen of the United States, residing in Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Amplifiers, of which the following is a specification.

My present invention relates to amplifiers and more particularly to amplifiers of the magnetron type such as are fully described in a paper entitled "The magnetron" by Albert W. Hull, published in the September, 1921, number of the Journal of the American Institute of Electrical Engineers, page 715.

The object of my invention is to provide means whereby the degree of amplification which may be obtained with devices of the magnetron type may be greatly increased.

By the term "magnetron" as used in this specification and the claims which follow, I intend to designate a device utilizing an electron stream the flow of which is controlled by means of a magnetic field.

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, both as to its organization and method of operation will best be understood by reference to the following description taken in connection with the accompanying drawing, in which Fig. 1 shows diagrammatically a circuit arrangement whereby my invention may be carried into effect, and Figs. 2 and 3 are characteristic curves illustrating the relation between the magnetic field strength and the current in a magnetron.

As illustrated in Fig. 1, the magnetron comprises an evacuated receptacle 1, containing the filamentary cathode 2 which is surrounded by a cylindrical anode 3. The source of current 4 provides heating current for the cathode. A polarizing field for the magnetron may be provided by means of coil 5 surrounding the receptacle 1 which is supplied with current of the proper value for producing a magnetizing field of the desired strength from a source of current 6. Currents which are to be amplified may also be supplied to the coil 5 from the secondary 7 of the transformer, primary 8 of which is connected with the source of current to be amplified. The output circuit of the magnetron which is connected between the cathode 2 and the anode 3 includes a source of current 9 and primary winding 10 of a transformer by means of which amplified currents are supplied to a utilization circuit or to additional amplifiers by means of the secondary winding 11. The output circuit of the magnetron also includes the coil 12 which surrounds the receptacle 1.

In the operation of the system described the coil 12 is so wound that the magnetic field produced thereby opposes the polarizing magnetic field produced by the coil 5. The curve of Fig. 2 is a typical characteristic curve showing the relation between magnetic field strength and current in the magnetron. The degree of amplification which may be obtained depends upon the slope of the vertical part of this curve. In the normal operation of the magnetron as an amplifier the polarizing field winding is made of sufficient strength to hold the current through the magnetron at some value, as, for example, the value indicated by the point A on the curve along the vertical portion of the curve. When the additional magnetic field supplied by the current in the output circuit as illustrated and described is provided, the characteristic curve will take the form shown in Fig. 3; that is, the slope of the vertical part of the curve will be made much steeper and the degree of amplification which may be obtained will therefore be much greater. In this case the value of the polarizing field required to maintain the value of the magnetron current at the point A will be slightly larger, other factors being equal, than in the case illustrated in Fig. 2, this difference being equal to the strength of the field furnished by the coils 12. In the case illustrated in Fig. 3, an increase in the field produced by coil 5 will produce a consequent decrease in the magnetron current and this in turn will cause a decrease in the field produced by coil 12 which will result in further decrease of the magnetron current. The result of this conjoint action of the fields produced in coils 5 and 12 results in the steepening of the characteristic curve as indicated in Fig. 3.

While I have shown and described the

simplest embodiment of my invention, it will be apparent that many modifications in the circuit arrangements as well as in the form of magnetron employed 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. In an amplifying system, a magnetron having means for producing a polarizing magnetic field, input and output circuits and a coil in said output circuit connected in such a way that it produces a magnetizing field which normally opposes the polarizing magnetic field.

2. In an amplifying system, a magnetron having means for producing a polarizing magnetic field, input and output circuits and a coil in said output circuit connected in such a way that it produces a magnetizing field which normally opposes the polarizing magnetic field and which varies in accordance with variations in current supplied to the input circuit.

3. The method of operating a magnetron having input and output circuits which consists in producing a polarizing magnetic field in the magnetron and producing by means of current in the output circuit a magnetic field which opposes the polarizing magnetic field.

4. The method of operating a magnetron having input and output circuits which consists in producing a polarizing magnetic field in the magnetron, supplying a current to be amplified to the input circuit and producing by means of current in the output circuit a magnetic field which opposes the polarizing field and which varies in accordance with variations in the current supplied to the input circuit.

In witness whereof, I have hereunto set my hand this 23rd day of June, 1922.

EDWARD F. HENNELLY.