

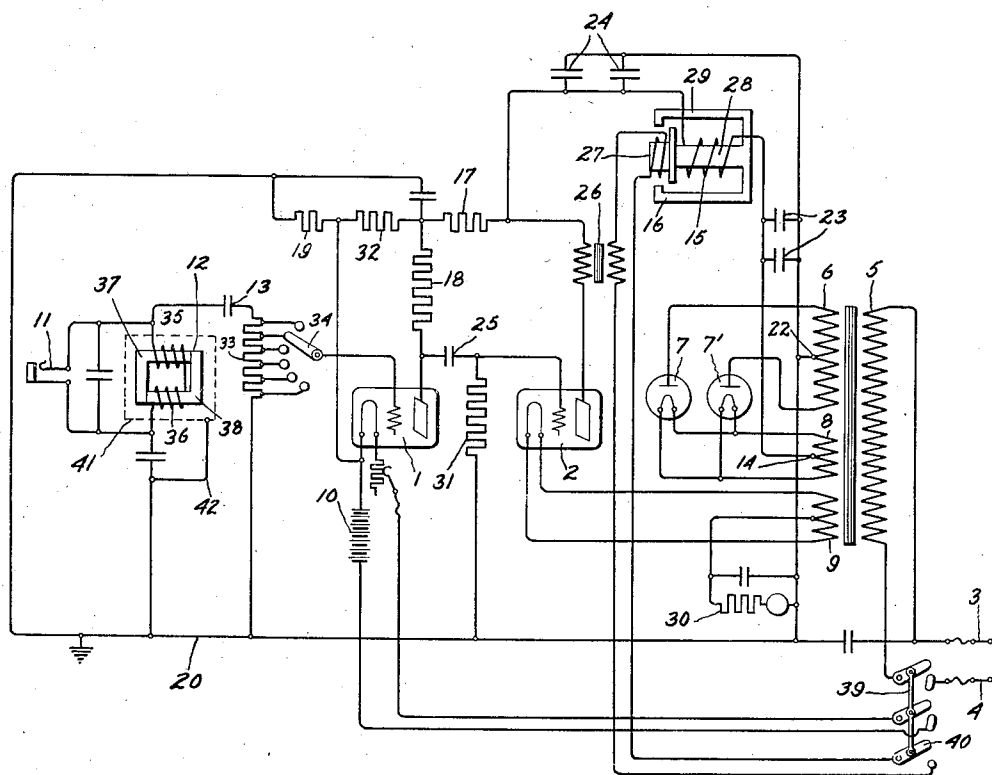
Sept. 17, 1929.

C. W. RICE ET AL

1,728,879

AMPLIFYING SYSTEM

Filed March 3, 1925



Inventors:
Chester W. Rice,
Edward W. Kellogg,
by *Alexander S. Zent*
Their Attorney

UNITED STATES PATENT OFFICE

CHESTER W. RICE AND EDWARD W. KELLOGG, OF SCHENECTADY, NEW YORK, ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK

AMPLIFYING SYSTEM

Application filed March 3, 1925. Serial No. 12,977.

Our present invention relates to thermionic amplifying apparatus, and especially to an apparatus which is particularly adapted to furnish an appreciable amount of power for the operation of sound producing apparatus.

One of the objects of our invention is to provide an amplifying apparatus which may be supplied with current for its operation from an alternating source such, for example, as an ordinary house lighting circuit.

A further object of our invention is to provide an effective means for smoothing out the rectified current supplied to the amplifying apparatus to such an extent that no disagreeable noise will be produced in the circuits by reason of the fact that an alternating source of supply is employed.

Still another object of our invention is to provide a means for eliminating the undesired effects of magnetic coupling in an amplifying apparatus between the output and the input circuits.

The novel features which we believe to be characteristic of our invention are set forth with particularly in the appended claims. Our 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 we have shown diagrammatically a circuit arrangement whereby our invention may be carried into effect.

We have indicated in the drawing an amplifying system which comprises two thermionic amplifying tubes 1 and 2. Current for the operation of these tubes is furnished from alternating current supply mains 3 and 4 to the primary 5 of a transformer. This transformer has a secondary winding 6, the terminals of which are connected to the anodes of two thermionic rectifiers 7 and 7'. Another secondary winding 8 furnishes current for heating the cathodes of rectifiers 7 and 7', and a third secondary winding 9 furnishes heating current for the cathode of amplifying tube 2. If desired the cathode of amplifying tube 1 also may be supplied with heating current from this source, although in the present case we have shown a

battery 10 for this purpose. The voltages to be amplified are supplied to a jack 11 and applied through a coupling condenser 13 to the input circuit of amplifier tube 1. The choke 12 provides a path for the direct current of the circuit from which the voltages are supplied. Current for the operation of the plate circuit of tube 1 is supplied by the rectifiers 7 and 7'. This plate circuit may be traced from the mid point 14 of the secondary 8 through the magnetizing winding 15 of a sound reproducing device 16 through resistances 17 and 18 to the plate or anode of amplifying tube 1, to the cathode of this tube, from thence through a resistance 19 to the ground bus 20 and from thence to the mid point 22 of secondary winding 6 and through the rectifiers 7 and 7' back to the point 14. Smoothing condensers 23 and 24 are connected across the circuit on either side of the inductance 15. The potential variations produced at the anode of device 1 are impressed through a coupling condenser 25 upon the input circuit of amplifying tube 2. The amplified currents produced in the plate circuit of device 2 are supplied by transformer 26 to the coil 27 of the sound-reproducing device 16.

The sound-reproducing device 16 is of the type in which the diaphragm is operated by means of a coil located in a strong magnetic field. For convenience of illustration the diaphragm of the sound-reproducing device has not been shown. The magnetic field for the operation of the sound-reproducing device is furnished by the winding 15 which is wound upon a central portion of a magnetic core, the armature coil 27 being located in an angular air gap formed between the central leg 28 of the magnetic core and the outer portion 29, which may be of cylindrical form.

We have found in practice that the field winding 15 serves as an efficient choke for assisting in smoothing out the fluctuations in the rectified current, and at the same time, it furnishes the strong magnetic field required for the operation of the sound-reproducing device.

Negative bias for the grid of amplifier tube 2 is furnished by a resistance 30 connected in

the plate circuit, the grid of the amplifier tube being connected through a grid leak 31 to the end of this resistance remote from the cathode. By reason of the drop of potential across this resistance 30 produced by the plate current the cathode will always be positive with respect to the grid. This method of providing a bias for the grid has the advantage that if for any reason the plate current tends to become unduly large the negative bias on the grid will be increased and prevent an excessive rise in the plate current. Similarly, the resistance 19 serves to provide a negative bias for the grid of amplifier tube 1. Since the current required to produce the desired magnetic field for the operation of the sound-reproducing device may be greater than that taken by the plate circuits of the amplifying tubes, a shunt path is provided around the amplifying tubes which includes a resistance 32. By proper choice of this resistance the current flowing through winding 15 may be made of any desired value.

As a convenient means for regulating the current supplied to the sound-reproducing apparatus we have provided in the input circuit of tube 1 a resistance 33 with variable taps to be connected to the grid of tube 1 by means of a switch 34. In this way the voltage applied to the grid of tube 1 can be adjusted to any desired value.

The choke coil 12 comprises two separate windings 35 and 36 which are wound upon separate L shaped iron cores 37 and 38. These cores are fitted together as indicated to form a closed magnetic circuit having air gaps at the points where the cores come together. By this arrangement it is possible to avoid the effect of any magnetic coupling between the output of the amplifying apparatus and the input. Any potentials induced in the input choke coil will be induced in opposite directions in the two halves of the coil and thus be neutralized.

If the sound-reproducing apparatus is connected to the circuit at the time that the filament circuits are closed, an objectionable noise may be produced. To prevent this the switch 39, by means of which the current sources are connected to the apparatus, is provided with an extra pole 40 which does not close until after the other poles of the switch are closed. This extra pole 40 closes the circuit of the operating coil 27 of the sound-reproducing apparatus. The choke 12 is preferably provided with a metal case indicated by dotted lines 41, and this case is grounded by connection 42 to prevent any electrostatic coupling from the output of the amplifier to the input. If desired, the transformer 26 may be provided with a grounded case also.

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

1. The combination in an amplifying sys-

tem of an electron discharge amplifier having an electron emitting cathode, an anode and a controlling grid and having plate and grid circuits associated therewith, a sound-reproducing device associated with the plate circuit, a source of alternating current and a rectifier for supplying current for the plate circuit and means for smoothing out the current supplied to the plate circuit including a reactance which also serves to produce a constant magnetic field for the operation of the sound-reproducing device.

2. The combination in an electron discharge amplifying system of an input circuit, an output circuit, and a choke comprising coils wound upon opposite portions of a magnetic core and connected in said input circuit in series with one another whereby the effect of magnetic coupling between said output and input circuits is eliminated.

3. The combination of current supply means, a sound producing device provided with field and armature windings, a rectifier, impedance elements conductively connected to said supply means through said rectifier and said field winding, amplifying means provided with a cathode connected to an anode through one part of said elements and with a grid connected to said cathode through a different part of said elements for controlling the current transmitted between said cathode and anode and means connected between said cathode and anode for energizing said armature winding.

4. The combination of current supply means, a rectifier, impedance elements connected to said supply means through said rectifier, and amplifying means comprising a plurality of amplifiers, one of said amplifiers being provided with a cathode connected to an anode through said elements and another of said amplifiers being provided with a cathode connected to an anode through one part of said elements and with a grid connected to said last mentioned cathode through a part of said elements.

5. The combination of current supply means, a rectifier, an impedance device connected to said supply means through said rectifier, amplifying means provided with a cathode connected to an anode through one part of said device and with a grid connected to said cathode through another part of said device for controlling the current transmitted between said cathode and anode, and a translating device conductively connected between said cathode and anode in series with said impedance device.

6. The combination of an amplifying apparatus including an output circuit, a sound producing device provided with field and armature windings, a source of rectified current conductively connected to said output circuit through said field winding, and means

connected in said output circuit for energizing said armature winding.

7. The combination of a pair of concatenated amplifiers each provided with an output circuit, a sound producing device including armature and field windings, a source of rectified current conductively connected to one of said output circuits through said field winding, and means for coupling the other of said output circuits to said armature winding.

In witness whereof, we have hereunto set our hands this 2nd day of March, 1925.

CHESTER W. RICE.

EDWARD W. KELLOGG.