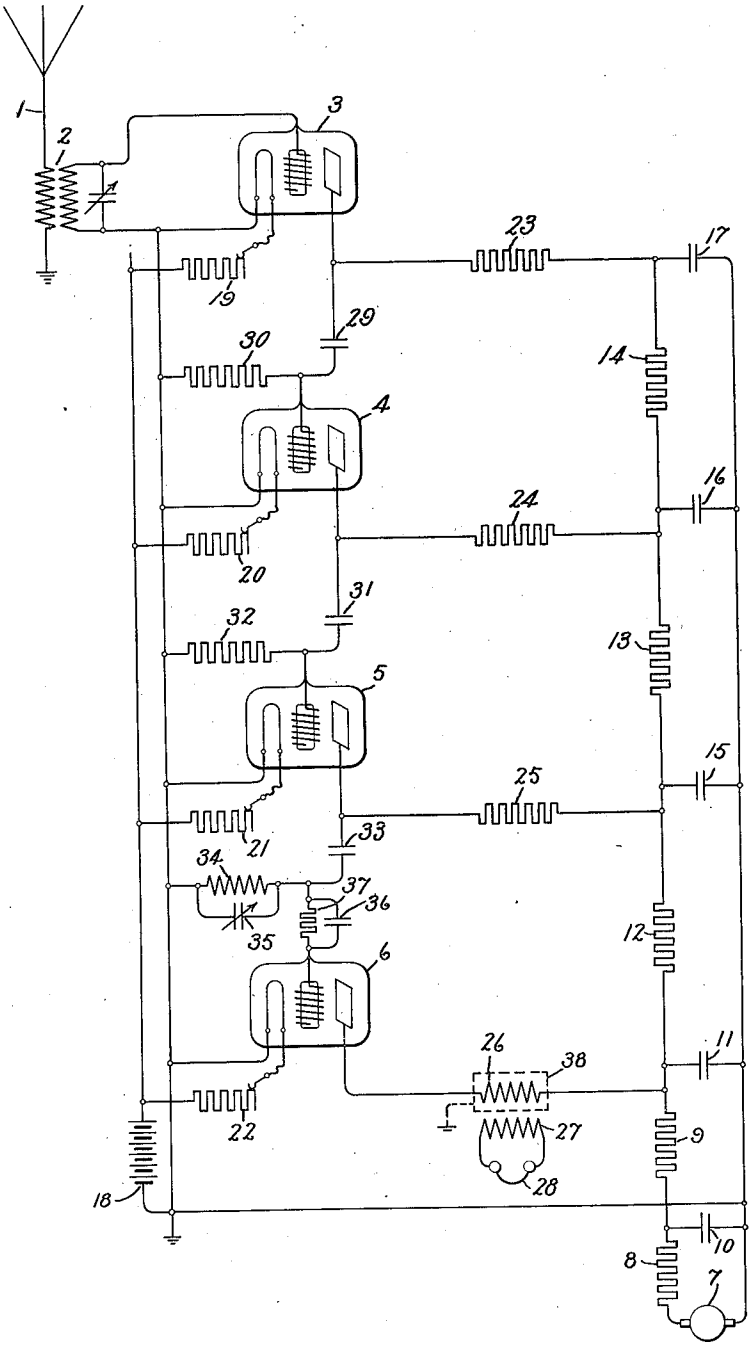
E. F. W. ALEXANDERSON.

AMPLIFYING SYSTEM.

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1,419,797. Patented June 13, 1922.



Inventor:
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UNITED STATES PATENT OFFICE.

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AMPLIFYING SYSTEM.

1,419,797. Specification of Letters Patent. Patented June 13, 1922.

Application filed February 13, 1919. Serial No. 276,852.

To all whom it may concern:

Be it known that I, ERNST F. W. ALEXANDERSON, 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 Amplifying Systems, of which the following is a specification.

My present invention relates to the amplification of electric currents of small intensity and particularly to currents such as are used for transmitting signals.

In carrying my inventiin into effect I employ a plurality of electron discharge relays or amplifiers, preferably of the high vacuum or pliotron type, and connect these relays in cascade. The plate circuits of all of these amplifiers are supplied with current from a common source and a high resistance is inserted in each plate circuit. The electric current which is to be amplified is applied to the grid circuit of the first amplifier of the series and current in the plate circuit of that amplifier is varied in accordance with the well known operation of amplifiers of the type mentioned. The result will be a variation in the potential difference between the cathode and anode of the amplifier and this variable potential is applied to the grid circuit of the second amplifier. The variable potential between the cathode and anode of the second amplifier is in turn applied to the grid circuit of the third amplifier, and so on throughout the series. The last amplifier of the series is organized to give an intelligible indication of the signals which are transmitted by means of the current which is amplified.

One of the objects of my invention is to provide means for supplying the operating current to the plate circuits of the amplifiers in such a way that a source of current of somewhat variable potential may be employed without injuriously affecting the operation of the amplifiers. Another object of my invention is to provide a connection which will prevent the transmission from one amplifier to another of potential variations of undesired frequency, which may be set up in any of the circuits. Still another object of my invention is to provide connections which will eliminate the tendency of the amplifiers to act in such a way as to generate oscillations.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. The 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 I have indicated diagrammatically one way in which my invention may be carried into effect.

As indicated in the drawing, an antenna 1 is connected by means of the usual inductive coupling 2 to the grid circuit of the amplifier 3. The plate circuit of this amplifier, as well as the plate circuits of amplifiers 4, 5 and 6, are supplied with current from the source 7. This source 7 may be a direct current dynamo or any other desired source of direct current. In order to eliminate the effects in the plate circuits of the amplifiers of potential variations of the source 7, current is supplied to these plate circuits by means of filter connections. The filter connection through which current is supplied to the amplifier 6 comprises the resistances 8 and 9 in series with the source of current and the condensers 10 and 11 in shunt thereto. This combination serves to smooth out any fluctuations of current to such a degree that the injurious effect will be eliminated in the plate circuit of the amplifier 6. In supplying current to the plate circuits of the other amplifiers additional filter connections made up of the resistances 12, 13 and 14, and condensers 15, 16 and 17, are employed for the purpose of effecting a still more complete smoothing out of potential variations of the source. Since the variations of the amplified current are much greater in amplifier 6 than in the preceding amplifiers of the series, the degree of smoothing out required in the plate circuit of amplifier 6 is not as great as that required in the preceding amplifiers of the series. The currents flowing in amplifier 6 are also greater than those flowing in the other plate circuits. Hence the insertion of the resistances 12, 13 and 14 does not unduly limit the currents which will be supplied to the other amplifiers, and the maximum of smoothing out effect is obtained in the first amplifier of the series where the current variations are the smallest. Current for heating the fila-

mentary cathodes of the amplifiers may be supplied by means of a battery 18, variable resistances 19, 20, 21 and 22, in series with the different cathodes allowing for the adjustment of the temperature of each cathode independently of the others. In plate circuits of amplifiers 3, 4 and 5, I insert high resistances 23, 24, 25.

Amplifier 6 is arranged to also serve as a detector, and the plate circuit of amplifier 6 includes the primary 26 of a transformer, the secondary 27 of which supplies current to the usual telephone receivers 28 which are employed to give an audible indication of the received signals. When current is received in the antenna the potential of the grid of amplifier 3 is varied and the current through the amplifier varies accordingly. Because of the corresponding variation in the potential drop across resistance 23 the potential of the anode of the amplifier varies with respect to the cathode. In order to impress this potential variation upon the grid circuit of amplifier 4 a shunt circuit is provided between the cathode and anode of amplifier 3, which comprises a condenser 29 in series with a resistance 30. The grid of amplifier 4 is connected to a point between the condenser 29 and resistance 30, and as a result the potential variations across resistance 30 are effective in the grid circuit of amplifier 4. The condenser 29 offers a comparatively low impedance to the high frequency currents which are to be amplified and a high impedance to currents of lower frequency. Hence the greater portion of the drop in potential of the high frequency current in the shunt circuit occurs across the resistance 30 and is effective in the grid circuit of amplifier 4. For low frequency current however, the greater portion of the drop in potential in the shunt circuit occurs across the condenser 29 and is not effective in the grid circuit of amplifier 4. The resulting potential variations between the cathode and anode of amplifier 4 are impressed upon the grid circuit of amplifier 5 in the same manner as that which has just been described by means of a similar shunt circuit made up of condenser 31 and resistance 32. In impressing the potential variations between the cathode and anode of amplifier 5 upon the grid circuit of amplifier 6 a somewhat different connection is employed. In this case a condenser 33 corresponding to the condensers 29 and 31 is used but the resistances 30 and 32 are replaced by a combination of inductance 34 and variable condenser 35 in parallel thereto. This combination of inductance and capacity is so adjusted as to be resonant to the second harmonic of the current which is being amplified. I have found that in the operation of an amplifying system of the type here involved there is a tendency toward the accentuation of the second harmonic of the current which is being amplified. As a result after several stages of amplification the second harmonic of the current may be of as great amplitude as the fundamental frequency. By selecting the second harmonic by means of the circuit described and impressing this second harmonic upon the grid circuit of the last amplifier 6, the potential variations produced in the grid circuit of amplifier 6 may be made fully as great as would be the case if this resonant circuit were tuned to the fundamental frequency.

In the operation of the amplifying system of the type here involved difficulty has been experienced by reason of the tendency of the amplifiers to act as generators of high frequency oscillations. This action takes place by reason of the coupling between the various circuits. By tuning the grid circuit of the amplifier 6 to the second harmonic this tendency of the amplifiers to oscillate is greatly reduced. The grid circuit of amplifier 6 includes the usual condenser 36 with the high resistance shunt 37 in order to enable the device to act efficiently as a detector.

In the operation of an amplifying system of the type here involved it has also been found that there is a tendency for the production of low frequency currents in the plate circuits which are often troublesome. The reason for the occurrence of these disturbances is somewhat obscure, but the filter connection which I have described for supplying current to the plate circuits also serves to eliminate to a large extent these disturbances. The filter connection between successive plate circuits prevents the transmission of these low frequency potential variations from one plate circuit to another.

In constructing an amplifying system of the type described, it is also desirable to shield the various stages of the amplifying system from each other in order to eliminate the electrostatic coupling between successive amplifiers and thereby prevent the generation of oscillations. It may also be desirable to shield the transformer windings 26 and 27 from each other by means of a grounded shield 38 interposed between the windings, and thereby eliminate the electrostatic coupling between the windings.

While I have indicated only four amplifiers connected in cascade in the manner described, it will of course be understood that as many amplifiers as desired or as may be necessary to secure the desired degree of amplification may be connected in the same manner. It also will be apparent that many other modifications may be made in a particular manner in which the circuits are connected 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 amplifying system of a plurality of electron discharge amplifiers connected in cascade, each of said amplifiers having plate and grid circuits, a common source of current for supplying current to the plate circuits of all of said amplifiers, a filter connected between said source and the plate circuit of the last of said amplifiers for eliminating the effect in said plate circuits of potential variations in said source and series resistance and shunt condensers connected in the supply circuit between successive amplifiers of the series.

2. The combination in an amplifying system of a series of electron discharge amplifiers connected in cascade, each of said amplifiers having plate and grid circuits, a common source of current for supplying current to the plate circuits of all of said amplifiers in succession from the last to the first, a filter connected between said source and the plate circuit of the last of said amplifiers for eliminating the effect in said plate circuits of potential variations in said source and resistances connected in the supply circuit between successive amplifiers of the series.

3. The combination in an amplifying system of a series of electron discharge amplifiers connected in cascade, each of said amplifiers having plate and grid circuits, a common source of current for supplying current to the plate circuits of all of said amplifiers in succession from the last to the first of said amplifiers, and filter connections between successive amplifiers of the series.

4. The combination in an amplifying system of a series of electron discharge amplifiers connected in cascade, each of said amplifiers having plate and grid circuits, a common source of current for supplying current to the plate circuits of all of said amplifiers and filter connections between successive amplifiers of the series.

5. The combination in an amplifying system of a series of electron discharge amplifiers connected in cascade each of said amplifiers having plate and grid circuits, means for impressing signaling currents on the grid circuit of the first of said amplifiers, high ohmic resistances in the plate circuits of said amplifiers, connections from the anodes of each of said amplifiers except the last to the grid of the next amplifier of the series, each of said connections including a condenser and the grid circuit of one of said amplifiers being made up of capacity and inductance in parallel and adjusted for resonance at a frequency harmonic to the frequency of the signaling currents.

6. The combination in an amplifying system of a series of electron discharge amplifiers connected in cascade each of said amplifiers having plate and grid circuits, means for impressing signaling currents on the grid circuit of the first of said amplifiers, connections from the anodes of each of said amplifiers except the last to the grid of the next amplifier of the series, each of said connections including a condenser and the grid circuit of one of said amplifiers being made up of capacity and inductance in parallel and adjusted for resonance at a frequency harmonic to the frequency of the signaling currents.

In witness whereof, I have hereunto set my hand this 12th day of February, 1919.

ERNST F. W. ALEXANDERSON.