

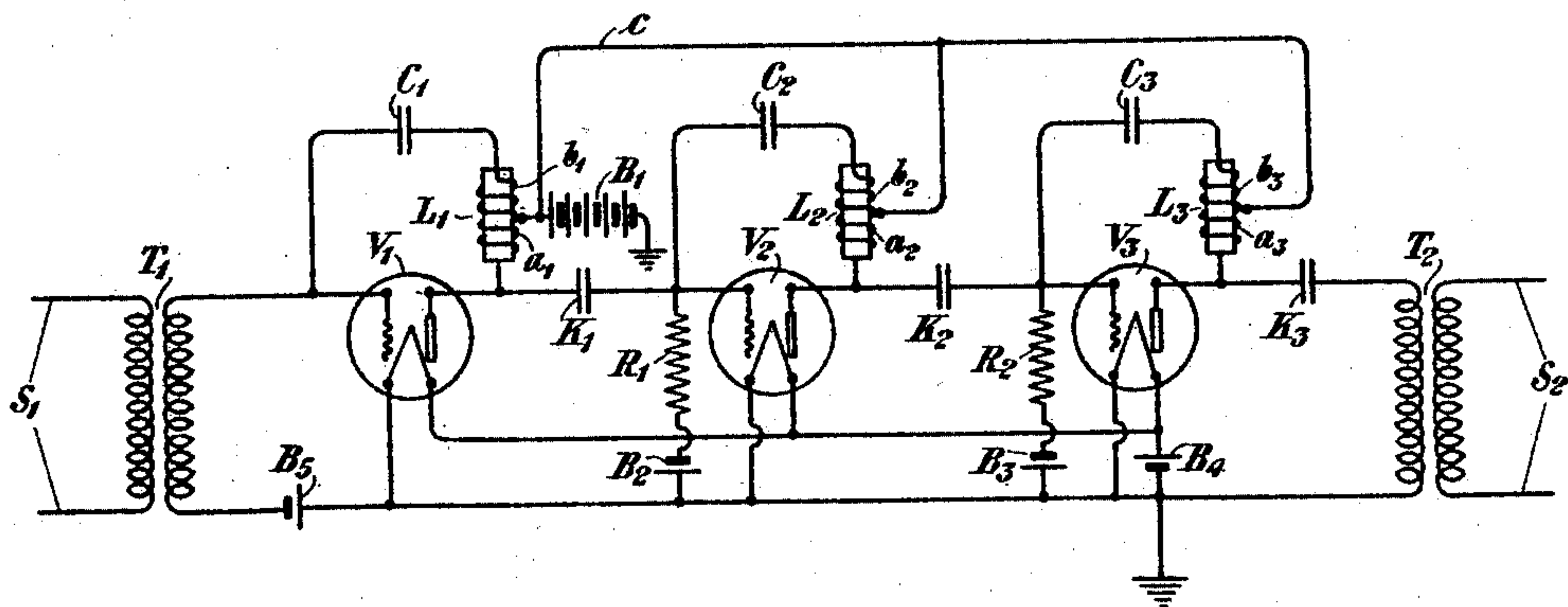
Jan. 7, 1930.

W. H. T. HOLDEN

1,742,251

AMPLIFYING SYSTEM

Filed May 26, 1926



INVENTOR
W. H. T. Holden
BY *g. y. h.*
ATTORNEY

UNITED STATES PATENT OFFICE

WILLIAM H. T. HOLDEN, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

AMPLIFYING SYSTEM

Application filed May 26, 1926. Serial No. 111,841.

This invention relates to vacuum tube amplifying systems, and particularly to arrangements in such amplifying systems for eliminating the effects due to the inherent capacity existing between the plate and grid electrodes of the vacuum tubes thereof.

In a three-element vacuum tube having a plate, a filament and a grid, there is an inherent capacity between the plate and grid of said vacuum tube, which, of itself, brings about a flow of current from plate to grid thereof. In some cases, this current, which is fed back in a direction opposite to the normal transfer of energy therethrough, is desirable, yet in other cases, particularly in amplifiers, such current may be very undesirable, as it may completely mask the signals to be faithfully amplified by the system.

It is therefore one of the objects of this invention to associate neutralizing means with a multi-stage amplifier in order to make it possible to secure higher gains in amplification per stage, and also to permit the use of tubes having a higher amplification factor. By providing suitable neutralizing means, it is also possible to use tubes having a higher inter-electrode capacity than used heretofore in a multi-stage amplifier.

It is another object of this invention to provide an untuned or aperiodic, impedance coupled amplifier so arranged as to eliminate the effects of inter-electrode capacity in the vacuum tubes employed in the amplifier.

While the nature of the invention will be pointed out with particularity in the appended claims, the invention itself will be better understood from the detailed description hereinafter following, when read in connection with the accompanying drawing showing one embodiment of the invention.

A source of signals is connected to the leads S_1 . A transformer T_1 connects the source of signals with a plurality of vacuum tubes V_1 , V_2 , and V_3 of a multi-stage amplifier. These tubes V_1 , V_2 , V_3 are of the three-element type each having a plate, a grid and a filament. These tubes are arranged in tandem, so that each of these tubes amplifies the current transmitted by the previous tube. Condensers K_1 and K_2 couple tubes V_1 and V_2 and

V_2 and V_3 , respectively. The condenser K_1 is connected between the plate of the tube V_1 and the grid of the tube V_2 . The condenser K_2 is connected between the plate of the tube V_2 and the grid of the tube V_3 . A transformer T_2 connects the output of the tube V_3 with an output circuit S_2 . A condenser K_3 connects the plate of the tube V_3 with the primary winding of the transformer T_2 .

Three condensers C_1 , C_2 and C_3 , and three auto-transformers L_1 , L_2 and L_3 are associated with the vacuum tubes V_1 , V_2 and V_3 , respectively, the condenser C_1 and the auto-transformer L_1 being associated with the vacuum tube V_1 , the condenser C_2 and auto-transformer L_2 being associated with the vacuum tube V_2 , and the condenser C_3 and the auto-transformer L_3 being associated with the vacuum tube V_3 . A battery B_1 supplies the necessary potential to the plates of these vacuum tubes, the circuit to the plate of the vacuum tube V_1 including the lower winding a_1 of the auto-transformer L_1 , the circuit to the plate of the vacuum tube V_2 including the conductor c and the lower winding a_2 of the auto-transformer L_2 , and the circuit to the plate of the vacuum tube V_3 including conductor c and the lower winding a_3 of the auto-transformer L_3 .

A resistance R_1 and a battery B_2 are in series relationship with each other between the grid and filament of the vacuum tube V_2 . A resistance R_2 and a battery B_3 are in series relationship with each other between the grid and filament of the vacuum tube V_3 . A battery B_4 supplies current necessary to heat the cathodes of the vacuum tubes V_1 , V_2 and V_3 , these cathodes being in parallel relationship with each other. The alternating current output circuit of the vacuum tube V_1 , which supplies energy to the input circuit of vacuum tube V_2 , includes the plate of the vacuum tube V_1 , the condenser K_1 , the resistance R_1 , the battery B_2 and the filament of the vacuum tube V_1 . The input circuit of the vacuum tube V_2 also includes the resistance R_1 and the battery B_2 , the resistance R_1 being of a magnitude sufficient to produce the necessary bias for the grid of the vacuum tube V_2 . The alternating current output cir-

cuit of the vacuum tube V_2 supplying energy to the input circuit of vacuum tube V_3 , includes the plate of the vacuum tube V_2 , the condenser K_2 , the resistance R_2 , the battery B_3 , and the filament of the vacuum tube V_3 . The input circuit of the vacuum tube V_3 similarly includes the resistance R_2 and the battery B_3 , the resistance R_2 also being of a magnitude sufficient to produce the necessary bias for the grid of the vacuum tube V_3 .

In accordance with this invention, a condenser C_1 and an auto-transformer L_1 are associated with the vacuum tube V_1 . Condensers and auto-transformers are similarly connected to the vacuum tubes V_2 and V_3 . Each condenser and auto-transformer are in series relationship with each other between the plate and grid of the associated vacuum tube. The auto-transformer L_1 is so arranged with respect to the condenser C_1 that the flow of current through the circuit including the auto-transformer L_1 and the condenser C_1 is of a magnitude equal to that flowing in the vacuum tube by virtue of the capacity between the plate and the grid thereof, but is opposite in phase to the current flowing within the vacuum tube. More specifically the current flowing in the winding a_1 of the auto-transformer L_1 is equal in magnitude and opposite in phase to that flowing in the winding b_1 . Inasmuch as the current flowing through the condenser C_1 and that flowing in the vacuum tube V_1 , by virtue of the capacity between the plate and the grid, are both equal in magnitude and opposite in phase, they will balance and neutralize each other, and consequently they will have no effect upon the faithful amplification of signals by said vacuum tube.

It will be understood that each of the auto-transformers, such as L_1 , may be of the air-core type or of the iron-core type and that this transformer is employed primarily to obtain the reversal in phase of the current to be fed back through condenser C_1 . Of course, windings a_1 and b_1 of transformer L_1 may or may not have the same number of turns; yet if condenser C_1 , which is associated with transformer L_1 , has a capacity equal to the inherent capacity between the plate and grid of vacuum tube V_1 , then it becomes desirable to have a turn ratio of unity. Obviously, the windings of transformers L_2 and L_3 may also be proportioned in accordance with the ratio between the capacities of condensers C_2 and C_3 and the inherent capacities between the plate and grid electrodes of vacuum tubes V_2 and V_3 , respectively.

Thus, neutralization is accomplished in this invention as follows: Current flowing through the circuit including K_1 , resistance R_1 and battery B_2 , causes the application of an alternating current voltage between the grid and filament of vacuum tube V_2 . Some alternating current will, nevertheless, flow

through winding a_1 , battery B_1 , ground and back to the filament of vacuum tube V_1 . Accordingly, there will be a voltage induced in winding b_1 which is substantially equal to the voltage across winding a_1 , though opposite in phase. This voltage is transmitted through condenser C_1 and will neutralize and render ineffective the feed-back arising from the inherent capacity between the plate and grid (of vacuum tube V_1). Obviously, the same principles apply in the consideration of the circuits associated with vacuum tubes V_2 and V_3 .

Untuned or aperiodic amplifiers are suitable in many systems where tuned and periodic amplifiers are especially unsuitable. It is to be understood that it is one of the features of this invention to provide an untuned or aperiodic amplifier which has neutralizing means associated therewith, so that the effect of inter-electrode capacity is completely eliminated.

While the invention has been disclosed in one particular embodiment, which is deemed desirable, it is to be understood that it is capable of embodiment in other and widely varied organizations, without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. In an untuned, multi-stage amplifier for amplifying currents of all frequencies within a wide range of the frequency spectrum, a plurality of vacuum tubes each having a plate, a filament and a grid, impedance means including a condenser for coupling each pair of said vacuum tubes, a plurality of inductive reactances each of fixed magnitude, a plurality of capacitive reactances each of fixed magnitude, each inductive reactance being in series relationship with the corresponding capacitive reactance in a circuit between the plate and grid of the corresponding vacuum tube, a source of potential connected to the plate of each vacuum tube through the inductive reactance associated therewith, the current flowing through the inductive and capacitive reactances associated with each vacuum tube and the current flowing in each vacuum tube by virtue of the capacity existing between the plate and grid thereof being equal in magnitude and opposite in phase.

2. In a multi-stage, impedance coupled amplifier of the untuned or aperiodic type for amplifying currents of all frequencies within a broad band of the frequency spectrum, the combination of a plurality of vacuum tubes each having a plate, a filament and a grid, a plurality of condensers, a plurality of untuned auto-transformers, one condenser and one auto-transformer being in series relationship with the plate and grid of the corresponding vacuum tube, impedance means including a condenser for coupling each pair of said vacuum tubes, and means for transmit-

ting a current through the condenser and the corresponding auto-transformer associated with each vacuum tube which will be equal in magnitude and opposite in phase to the current flowing within the tube by virtue of the inherent capacity existing between the plate and grid of said tube.

3. In a multi-stage, impedance coupled amplifier of the untuned or aperiodic type for amplifying currents of a broad band of frequencies, the combination of a plurality of vacuum tubes each having a plate, a filament and a grid, a plurality of condensers, a plurality of untuned auto-transformers, one condenser and one auto-transformer corresponding to each vacuum tube and being connected in series relationship with each other between the plate and grid of the associated vacuum tube, impedance means including a condenser for coupling each pair of said vacuum tubes, and means for establishing a neutralizing current through each series condenser and auto-transformer which shall be equal in magnitude and opposite in phase to the current flowing within the tube by virtue of the inherent capacity between the plate and grid thereof.

In testimony whereof, I have signed my name to this specification this 25th day of May 1926.

WILLIAM H. T. HOLDEN.

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