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CURRENT SUPPRESSOR

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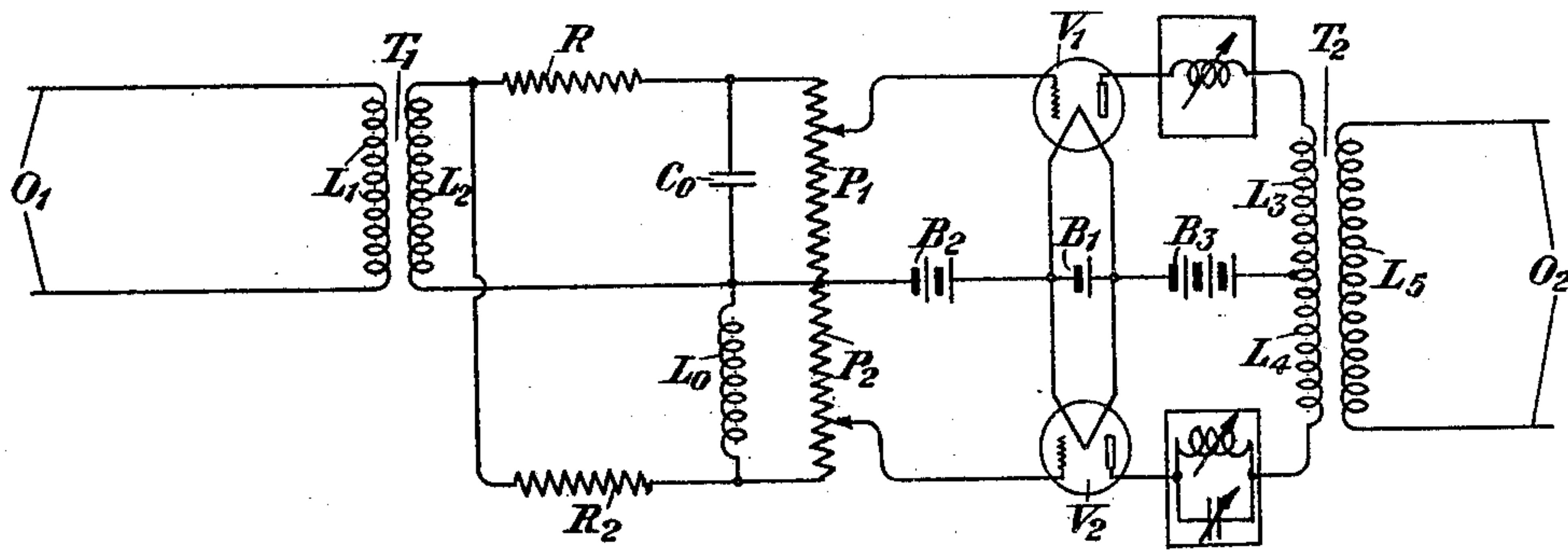


Fig. 1

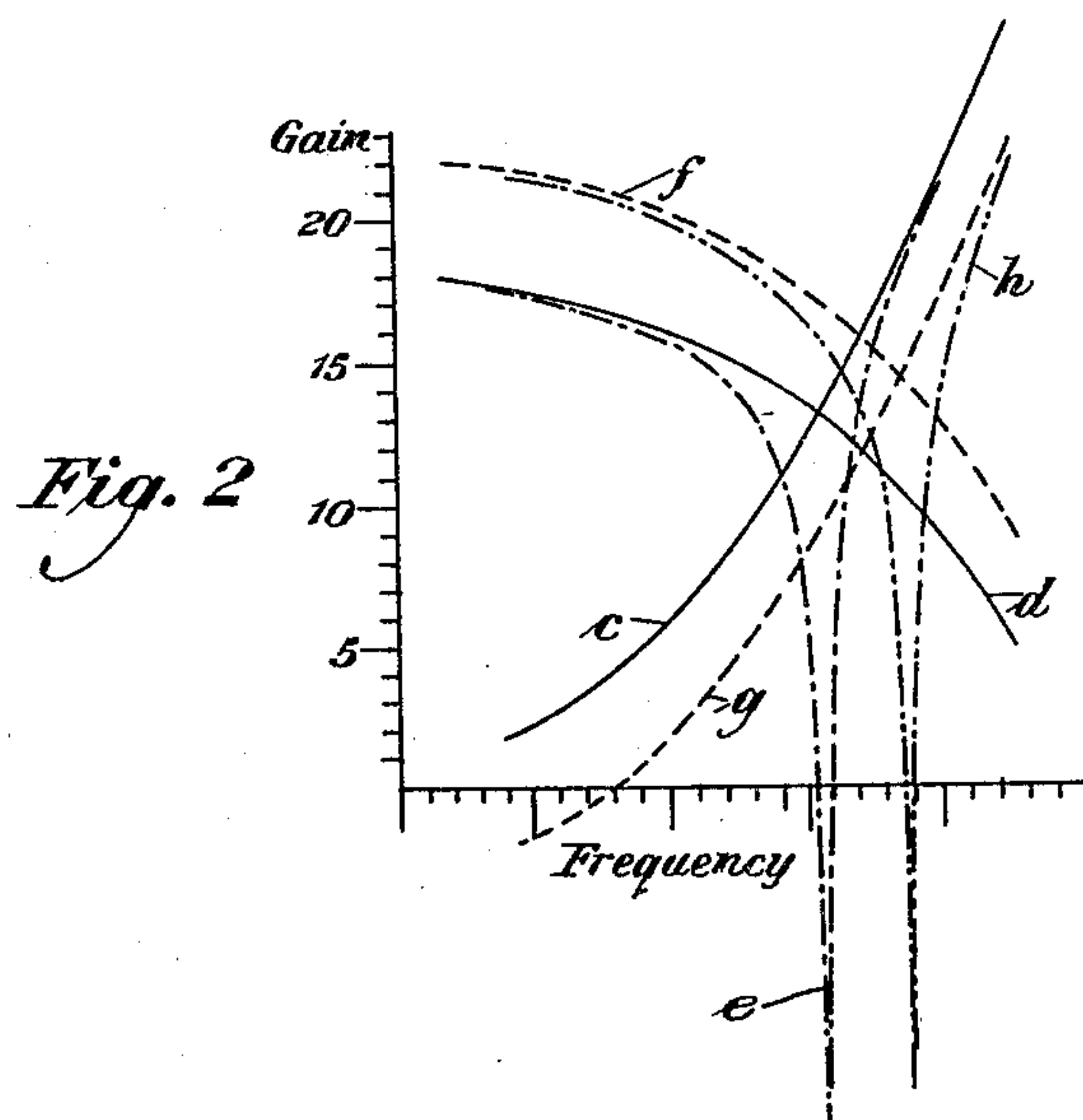


Fig. 2

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CURRENT-SUPPRESSOR

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This invention relates to amplifying systems and to current suppressing systems. More particularly, this invention relates to amplifying systems arranged so as to suppress currents of particular frequencies.

This invention will find application in radio or carrier systems generally, where it is desired to eliminate the effect of current of some particular frequency. This invention will find special application in connection with a balanced modulating system which is arranged to eliminate the carrier current employed in the process of modulation, in which there may be a carrier "leak".

The invention may be broadly considered as comprising two electron tubes which may form an amplifier having two parallel paths to which the same current or currents are transmitted in the same phases and from which these currents are independently obtained, displaced substantially 180 degrees in phase. If these amplifying paths have equal gains, the transmitted current or currents will exhibit equal and opposite effects. If these currents are impressed upon a common circuit, their effects will be neutralized, as is well understood in the art.

This invention will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing in which Figure 1 represents one embodiment of the invention given merely for the purpose of illustration, and Fig. 2 represents a group of curves illustrating certain of the principles involved in the invention.

Referring to Fig. 1 of the drawing, the reference character O_1 represents an input circuit which may be connected to a source supplying currents of a plurality of frequencies, one of which it is desired to suppress. The circuit O_1 is connected to the primary winding L_1 of a transformer T_1 . The secondary winding L_2 of this transformer is connected in a local circuit with a resistance R_1 and a condenser C_0 . The winding L_2 is connected in another local circuit with a resistance R_2 and a winding L_0 . A potentiometer P_1 bridges the condenser C_0 and another potentiometer P_2 bridges the winding L_0 .

The reference characters V_1 and V_2 represent two electron tubes, each of which may be of the three-electrode type. The filaments of these tubes are connected in parallel relationship with respect to a battery B_1 . The grid electrode of the tube V_1 is connected to the movable arm of the potentiometer P_1 and the grid electrode of the tube V_2 is connected to the movable arm of the potentiometer P_2 . A battery B_2 is connected between the junction common to potentiometers P_1 and P_2 and the junction common to the filaments of tubes V_1 and V_2 and this battery is employed for the purpose of biasing the grid electrodes of tubes V_1 and V_2 at suitable negative potentials with respect to their corresponding filaments for good amplifying action.

The reference character T_2 designates a transformer having primary windings L_3 and L_4 and a secondary winding L_5 . Primary winding L_3 is connected between the plate electrode and the filament of the tube V_1 in series with a battery B_3 . The winding L_4 is connected between the plate electrode and the filament of the tube V_2 , also in series with the battery B_3 . This battery is employed for the purpose of maintaining the plate electrodes of tubes V_1 and V_2 at suitable positive potentials with respect to the corresponding filaments. The currents flowing through windings L_3 and L_4 from battery B_3 will be oppositely directed. The secondary winding L_5 is connected to an output circuit O_2 .

The condenser C_0 will receive a current from source O_1 through the transformer T_1 which will lead the impressed voltage 90 degrees. Current will be transmitted through the potentiometer P_1 which will be in phase with the impressed voltage. Inasmuch as the condenser C_0 and the potentiometer P_1 are connected in parallel relationship, the resultant current will lead the impressed voltage and this resultant current will be the vectorial sum of the currents transmitted through condenser C_0 and potentiometer P_1 .

Current through the winding L_0 will lag behind the impressed voltage by a phase angle of 90 degrees while the potentiometer

P_2 will receive current in phase with the impressed voltage. Since winding L_0 and potentiometer P_2 are connected in parallel relationship, the resultant current will lag behind the impressed voltage and the magnitude of the resultant current will be the vectorial sum of the currents through winding L_0 and potentiometer P_2 .

It is to be noted that condenser C_0 and winding L_0 are bridged across two parallel circuits which are supplied with currents of the same phase. These circuits also include tubes V_1 and V_2 , respectively.

The employment of reactive elements in association with the tubes V_1 and V_2 renders their transmission-frequency characteristics non-linear. Thus, currents of all frequencies will not be equally transmitted by these tubes.

If it be desired that the currents transmitted to windings L_3 and L_4 of transformer T_2 be exactly 180 degrees apart in phase, it may be necessary to connect a phase correcting arrangement between the plate electrodes of tubes V_1 and V_2 and the windings L_3 and L_4 . One form of phase correcting network which may be employed in this connection will include a winding of small and variable inductance connected between the plate electrode of tube V_1 and the upper terminal of winding L_3 , a winding of large inductance connected between the plate electrode of tube V_2 and the lower terminal of winding L_4 and a variable condenser in shunt with the winding of large inductance.

The grid electrodes of the tubes V_1 and V_2 are so connected that impressed currents will be exactly in phase with each other if the reactive elements C_0 and L_0 as well as all of the phase correcting elements be omitted from consideration. Moreover, the plate electrodes of the tubes V_1 and V_2 are so connected that the phases of the currents derived from these tubes will be exactly 180 degrees displaced with respect to each other. Therefore, if the potentiometers P_1 and P_2 are adjusted to apply equal amplitudes to the grid electrodes of the tubes V_1 and V_2 , there will be no current in the output circuit O_2 at any frequency. This is due to the interaction in the windings L_3 and L_4 of the transformer T_2 of the equal and opposite currents derived from the tubes V_1 and V_2 .

The addition of the reactive elements C_0 and L_0 has two effects. First, these elements cause the gains of tubes V_1 and V_2 to vary with frequency, as will be shown hereinafter in connection with the description of Figure 2. Second, these reactive elements introduce phase shifts which also vary with the frequency of the current impressed thereon and these phase shifts will vary oppositely. That is to say, the phase shift in the branch $R_1C_0P_1$ will increase with frequency, reaching a maximum of 90 degrees, while the phase in the branch $R_2L_0P_2$ will decrease with frequency,

reaching a value of zero at its limit. Thus, there will be a phase displacement of less than 90 degrees between the two paths so that currents flowing in the plate circuits of the tubes V_1 and V_2 will no longer be in exact phase opposition in the windings L_3 and L_4 . However, the introduction of the phase correcting elements shown in the drawing makes it possible to adjust the phase difference to 180 degrees for any particular frequency. At the same time, the gain may be adjusted by means of potentiometers P_1 and P_2 so that the amplitudes of the currents of the particular frequency for which suppression is desired, will be equal. If the amplitudes of the currents of the particular frequency flowing in windings L_3 and L_4 are equal and their phases 180 degrees apart, no current of the particular frequency will reach the output circuit O_2 .

Fig. 2 shows various curves plotted so that the abscissæ represent frequencies and the ordinates gains. The curve d represents changes in the gain of the tube V_1 for currents of different frequencies while the movable arm of the potentiometer P_1 is maintained stationary. It is to be noted that the gain decreases with frequency and this is due to the employment of an element exhibiting capacitive reactance in shunt across the transmission path which includes the tube V_1 . The curve c represents changes in the gain of tube V_2 for currents of different frequencies while the movable arm of potentiometer P_2 remains stationary. Here the gain increases with frequency and this is due to the employment of an element of inductive reactance in shunt across the transmission path which includes the tube V_2 .

Curves c and d will coincide at a point at which the gains of tubes V_1 and V_2 will be equal. The abscissa corresponding to the point of coincidence will designate the frequency of the current which will be substantially suppressed and will not be found in the output circuit O_2 .

The dot and dash curve e will represent the resultant changes in the gain for currents of different frequencies. The slope of this curve will be 90 degrees at that frequency corresponding to the point at which curves c and d coincide.

The dashed curve f will designate changes in the gain of the tube V_1 for currents of different frequencies when the movable arm of potentiometer P_1 is raised so as to increase the gain of tube V_1 by, for example, 4 decibels. The dashed curve g will represent changes in the gain of tube V_2 for currents of different frequencies when the movable arm of the potentiometer P_2 is lowered so as to reduce the gain of the tube by, for example, 4 decibels. Curves f and g will coincide at a point at which the gains of tubes V_1 and V_2 will be equal and the abscissa determined by this

point will designate the frequency of current at which suppression will occur. The double dot and dash curve h will represent the resultant of curves f and g and it will be noted that curve h has a slope of 90 degrees at a point having the same abscissa as the point of coincidence of curves f and g .

It will be apparent that the two transmission paths including the tubes V_1 and V_2 may be adjusted by potentiometers P_1 and P_2 , respectively, so that the amplitudes of the currents of a particular frequency transmitted by these paths will be equal in order that the effect of these currents may be substantially suppressed. If the movable arm of the potentiometer P_1 is maintained stationary, the frequency at which suppression will occur may be increased by raising the movable arm of potentiometer P_2 and decreased by lowering the movable arm of this potentiometer. Similarly, if the movable arm of potentiometer P_2 is maintained stationary, the frequency at which suppression will occur may be raised by lowering the movable arm of potentiometer P_1 and lowered by raising the movable arm of this potentiometer. So it will be understood that the characteristics of the transmission paths may be changed so as to produce suppression at any desired or predetermined frequency.

While this invention has been shown in one particular embodiment merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to 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. A current suppressing system comprising, in combination, a first potentiometer, a condenser bridging said first potentiometer, a second potentiometer, a winding bridging said second potentiometer, and two amplifiers connected, respectively, to said potentiometers, said amplifiers being connected in opposition, said potentiometers controlling the frequency of the current to be suppressed.

2. The combination of two parallel vacuum tube amplifiers, means for supplying currents to said amplifiers so that these currents may be in phase with each other, means for separately deriving from said amplifiers currents which are displaced about 180 degrees in phase with respect to each other, potentiometric means for rendering equal the amplitudes of the currents of a particular frequency transmitted by said amplifiers, and a circuit coupled to both amplifiers.

3. The combination of an input circuit divided into two branches, a condenser shunting one branch of said input circuit, a winding shunting the other branch of said input circuit, a first potentiometer shunting said condenser, a second potentiometer

shunting said winding, two electron tubes each having grid, filament and plate electrodes, the grid and filament electrodes of one of the tubes being connected to the first potentiometer and the corresponding electrodes of the other tube being connected to the second potentiometer, a transformer having three windings one of which is connected between the plate and filament electrodes of one of the tubes and another to the corresponding electrodes of the other of the tubes, and an output circuit connected to the third winding of said transformer.

In testimony whereof, I have signed my name to this specification this 15th day of April, 1930.

WILLIAM H. T. HOLDEN.

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