Dec. 2, 1941. W. RÖHR ET AL 2,264,715

TONE CONTROL CIRCUITS

Filed Feb. 21, 1939

Fig. 1

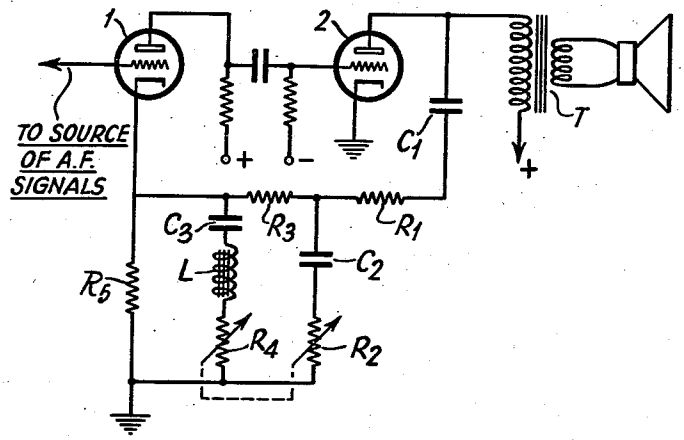


Fig. 2

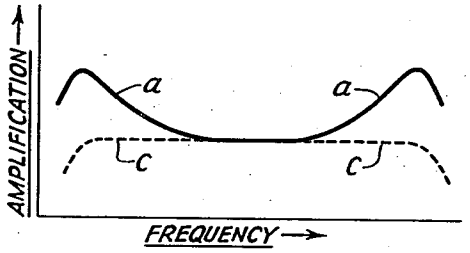


Fig. 3

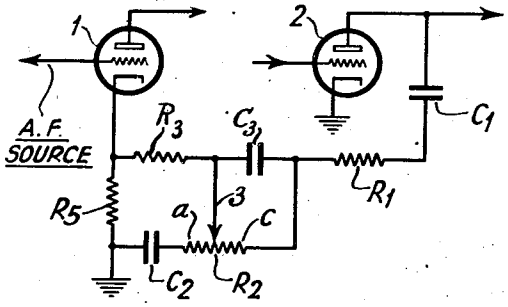
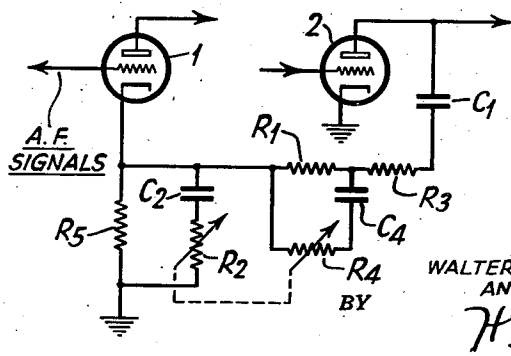


Fig. 4



INVENTORS
WALTER ROHR, WALTER DIFFRING
AND HELMUT PITSCH
BY
H. S. Brower
ATTORNEY.

Patented Dec. 2, 1941

2,264,715

UNITED STATES PATENT OFFICE

2,264,715

TONE CONTROL CIRCUITS

Walter Röhr, Berlin, Walter Diffring, Kiel, and Helmut Pitsch, Berlin, Germany, assignors to Telefunken Gesellschaft für Drahtlose Telegraphie m. b. H., Berlin, Germany, a corporation of Germany

Application February 21, 1939, Serial No. 257,696
In Germany March 23, 1938

4 Claims. (Cl. 179—171)

There has been previously described a tone control operating with counter-coupling, and in which the low audio frequencies and at the same time the high audio frequencies can be such that they are favored as against the intermediate audio frequencies. This is accomplished in that the counter-coupling of the high notes and low notes is always eliminated, while the counter-coupling of the intermediate audio notes is varied by means of a control device. At one end position of the control device, the intermediate audio notes are highly counter-coupled thus weakened relative to the low notes and high notes. The amplification of the low notes and high notes is in this case greater than that of the intermediate audio notes. In the other end position of the control device no counter-coupling takes place for any note, so that the frequency-response curve is not affected by the tone control.

According to the invention it is proposed to take the opposite step. This step resides in keeping the counter-coupling of the intermediate audio frequencies the same at all positions of the tone control arrangement placed in the counter-coupling channel; while this control sets, at the same time, the counter-coupling of the high audio frequencies and low frequencies, and, hence, the increase of the amplification of these frequencies relative to the intermediate audio frequencies.

The advantage of the invention resides in that in each position of the control device the distortion reduction of the intermediate audio frequencies comprising the principal audio frequency range is the same owing to the constant counter-coupling. In contrast therewith, in the prior known circuit counter-coupling is not had at one end position of the control device.

Various modes of construction, according to the invention, are shown in the drawing, in Figs. 1, 3 and 4; while Fig. 2 shows the types of frequency-response curves that can be secured.

In Fig. 1 the two tubes 1 and 2 are coupled, for instance, by means of a resistance coupling. The alternating plate potential of the second tube is applied to the output transformer T, and also to a voltage divider network R_1, R_3, R_5. The condenser C_1 serves only to prevent the direct current plate potential from reaching the voltage divider. The resistor R_5 of the voltage divider is placed in the cathode lead of the tube 1; the grid of the tube 1 is subjected to counter-coupling or negative feedback, by means of the partial potential of the alternating plate potential which appears at the said resistor. The series connection of the choke L and variable resistor R_4, placed in parallel to the cathode resistor R_5, serves for diminishing at will the counter-coupling for the low audio notes. This reduction of the counter-coupling is the highest when the resistor R_4 is set to its minimum value. In this case, the amplification of the low notes below the limit frequency established by L and R_5 is greater than that of the intermediate audio notes, as shown by the lefthand part of the full line curve *a* in Fig. 2.

The cathode resistor R_5, furthermore, has placed in parallel thereto, across the resistor R_3, the series connection consisting of the condenser C_2 and variable resistor R_2. When this resistor is set to its minimum value, the counter-coupling of the high audio notes will be suppressed in view of the condenser C_2 of, for instance, 3000 micro-microfarads (m. m. f.). Therefore, the amplification of the high audio notes will be increased against that of the intermediate audio notes, as indicated by the righthand part of the curve *a* in Fig. 2.

The resistor R_3 could be omitted; however, it is advisable to use it whereby the required capacity of the condenser C_2 will be within reasonable limits (to save cost). The limit frequency at which the rise of the curve *a*, shown at the right in Fig. 2, takes place is in the absence of the resistor R_3 determined in fact by the resistor R_4 and by the capacitance C_2. Since the resistance of R_4 is relatively low (for instance 500 ohms), the condenser C_2 would have to be very large in order that at the said limit frequency its capacitive resistance would have the same value. When inserting the resistor R_3, having a value of from 5000 to 10,000 ohms, the said limit frequency is determined however substantially by this resistor, because R_5 can be neglected against R_3. On the other hand, the influence of R_1 upon the limit frequency can be neglected, since the resistance of R_1 is high as compared with that of R_3 (for instance, 50,000 to 100,000 ohms).

As shown, the two variable resistors R_2 and R_4 are coupled in the same sense so that in one end position (lowest resistance value) there will be obtained the curve *a* in Fig. 2, while in the other end position (highest resistance value) the dotted line curve *c* in Fig. 2 will be obtained. In the latter end position the circuit elements L and R_4, as well as C_2 and R_2, can be considered as practically non-existent, so that the counter-coupling for all frequencies is given essentially by the voltage divider R_1, R_3, R_5. The condenser C_3 is suitably provided for the purpose of avoiding at the setting of the resistor R_4 a variation of the direct current potential drop existing through R_5 and

serving as grid biasing potential. The capacity of said condenser C_3 is so chosen that its resistance is low, also, for the low notes as against the other resistances of the circuit branch. Obviously it is possible to employ circuit elements known as such for the purpose of rendering the grid bias potential of the tube I higher or lower than the direct current potential existing at the resistor R_5.

Fig. 3 shows another example of construction in which a small choke is required, and only one variable resistor R_2. When the contact arm 3 is in the righthand position, the condenser C_3 which prevents a counter-coupling of the low notes is short-circuited. At the same time the condenser C_2, chosen to suppress the counter-coupling of the high notes, is practically ineffective owing to the resistor R_2 connected in series thereto. When the control arm is in the righthand position the circuit acts substantially as if only the resistors R_1 and R_5 were present. Then the frequency curve c in Fig. 2 will be obtained. In the end position of the contact arm at the left side, the condenser C_2 is fully effective, since it short-circuits the counter-coupling resistor R_5 for the high notes. The limit frequency at which the righthand slope of the curve *a* begins, is determined by the equality between the resistance R_5 and the capacitive resistance of C_2. As in the case of Fig. 1, by means of a proper insertion of a resistor R_3 between the cathode and the sliding arm it can be acomplished that the capacity of the condenser C_2 need not assume excessively large values. At the lefthand position of the control arm there is eliminated at the same time the short-circuit of the condenser C_3 in view of the high resistance of R_2 placed in parallel. Consequently, the low audio notes will be counter-coupled to a lesser extent. The limit frequency at which there takes places the rise of the left part of the curve *a* is determined substantially by R_1 and C_3.

In the example of Fig. 4, two separate series resistors are required which are coupled in the same sense. The condenser C_2 serves for suppressing the counter-coupling of the high notes, and C_4 for the suppression of the counter-coupling of the low notes.

What is claimed is:

1. In an audio amplifier circuit of the type comprising at least two cascaded tubes, means impressing audio signal voltage between the first tube input electrodes, an audio signal voltage feedback path connected between the second tube output electrodes and said input electrodes, and said path including a resistive impedance in the first tube space current path which is connected between said input electrodes; the improvement which comprises a first adjustable reactive impedance path shunted across said resistive impedance, and a second adjustable reactive impedance path shunted across said resistive impedance, one of said paths comprising an inductive element in series with a variable resistor and being adapted to adjust the amplitude solely of the low audio frequency feedback voltage, and the second path comprising a capacity element in series with a variable resistor and being adapted to adjust the amplitude solely of the high audio frequency feedback voltage.

2. In an audio amplifier circuit of the type comprising at least two cascaded tubes, means impressing audio signal voltage between the first tube input electrodes, an audio signal voltage feedback path connected between the second tube output electrodes and said input electrodes, and said path including a resistive impedance in the first tube space current path which is connected between said input electrodes; the improvement which comprises a first adjustable reactive impedance path shunted across said resistive impedance, and a second adjustable reactive impedance path shunted across said resistive impedance, one of said paths comprising an inductive element in series with a variable resistor and being adapted to adjust the amplitude solely of the low audio frequency feedback voltage, and the second path comprising a capacity element in series with a variable resistor and being adapted to adjust the amplitude solely of the high audio frequency feedback voltage, and means for simultaneously adjusting the impedance magnitudes of both said paths in the same sense.

3. In an audio amplifier circuit of the type comprising at least two cascaded tubes, means impressing audio signal voltage between the first tube input electrodes, an audio signal voltage feedback path connected between the second tube output electrodes and said input electrodes, and said path including a resistive impedance in the first tube space current path which is connected between said input electrodes; the improvement which comprises a first adjustable reactive impedance path shunted across said resistive impedance, and a second adjustable reactive impedance path shunted across said resistive impedance, said paths consisting of passive reactances of opposite signs, each reactance being in series with its individual variable resistor, one of said paths being adapted to adjust the amplitude solely of the low audio frequency feedback voltage, and the second path being adapted to adjust the amplitude solely of the high audio frequency feedback voltage.

4. In an audio amplifier of the type comprising at least two tubes arranged in cascade, a degenerative feedback path between the second tube output electrodes and the first tube input electrodes, the feedback path including a resistor arranged between said input electrodes; the improvement which comprises an inductive element in series with a variable resistor both shunted across said resistor, and a capacity element in series with a variable resistor both shunted across said first resistor, and means for adjusting the magnitudes of both variable resistors in the same sense.

WALTER RÖHR.
WALTER DIFFRING.
HELMUT PITSCH.