

June 1, 1943.

H. BOUCKE

2,320,558

AUDIO BAND WIDTH CONTROL

Filed April 3, 1941

2 Sheets-Sheet 1

Fig. 1

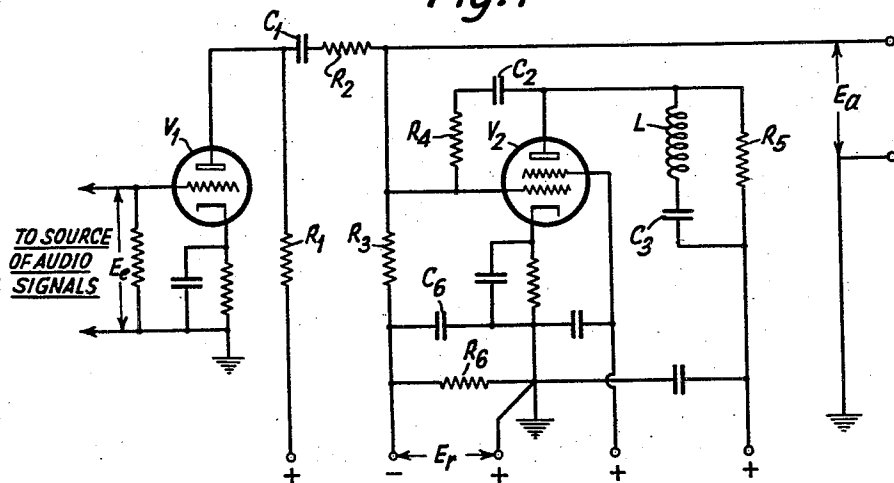


Fig. 2

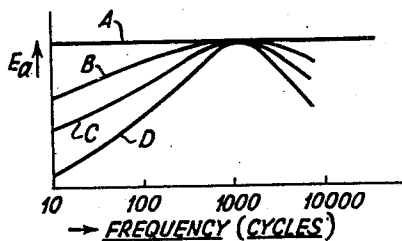
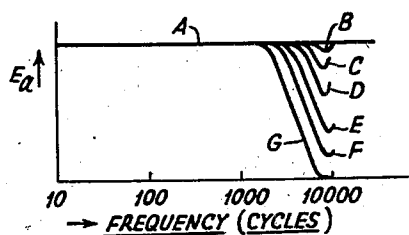


Fig. 4



INVENTOR
HEINZ BOUCKE
BY *H. S. Brown*
ATTORNEY

June 1, 1943.

H. BOUCKE

2,320,558

AUDIO BAND WIDTH CONTROL

Filed April 3, 1941

2 Sheets-Sheet 2

Fig. 3

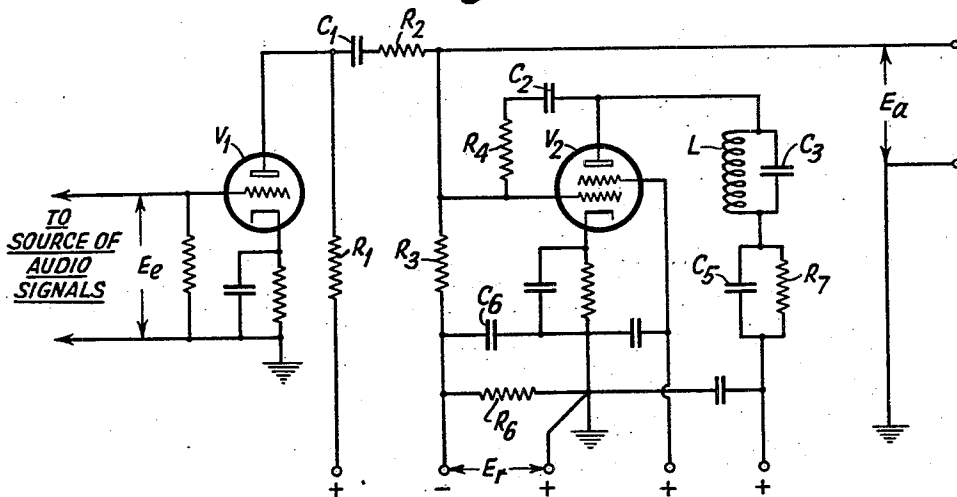
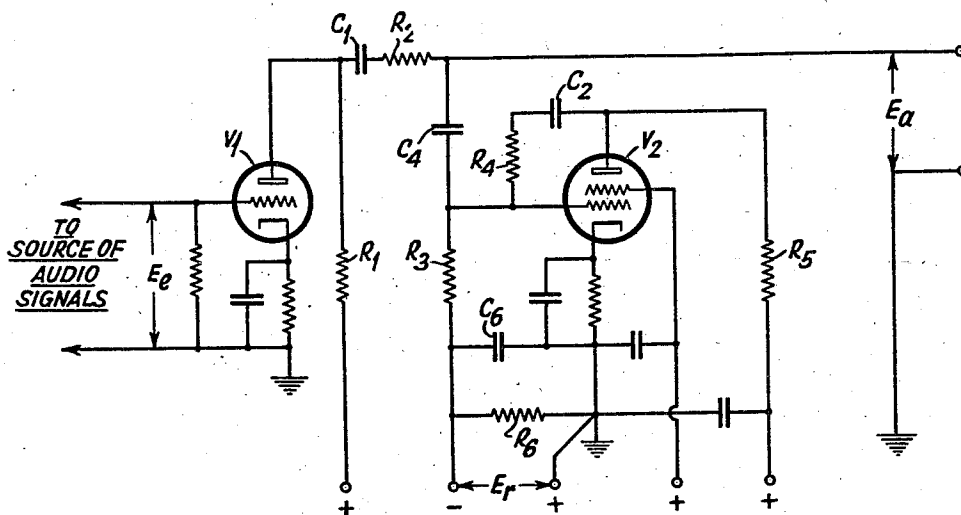


Fig. 5



INVENTOR
HEINZ BOUCKE
BY *H.S. Brover*
ATTORNEY

UNITED STATES PATENT OFFICE

2,320,558

AUDIO BAND WIDTH CONTROL

Heinz Boucke, Berlin-Charlottenburg, Germany;
vested in the Alien Property CustodianApplication April 3, 1941, Serial No. 386,653
In Germany January 16, 1940

6 Claims. (Cl. 179-171)

My present invention relates to an audio frequency band width control with the aid of an additional tube.

It has been proposed in the past to insert as a shunt into the audio frequency section of an audio frequency amplifier, the cathode to anode path of a tube with controlled amplification and with voltage counter-coupling dependent on frequency.

As compared with this arrangement the advantage of the present invention resides in the fact that the direct plate current of the control tube is decoupled from the alternating current circuit in which the tube acts as a shunt. Therefore, a high ohmic design of the alternating voltage divider is possible. Furthermore, this offers the possibility of an easy additional provision of the control element in an already operating amplifier circuit.

In accordance with the present invention the input resistance of a tube provided with a counter-coupling path connected between its anode and grid serves as a frequency-dependent parallel resistance in the audio frequency section, or it represents a part of such a parallel resistance.

The phenomenon known as such is hereby utilized that the input resistance of a tube with voltage counter-coupling from the anode directly to the grid decreases with an increase of the degree of counter-coupling. For the purpose of varying the degree of the counter-coupling the grid biasing potential of the tube having a control characteristic is varied, or a control of the current distribution is carried out.

Examples of construction according to the present invention are shown in the accompanying figures, wherein Fig. 1 shows an embodiment of the invention; Fig. 2 graphically shows the operation thereof; and Fig. 3 is a modification; Fig. 4 shows the operation of Fig. 3, and Fig. 5 shows another modification.

In Fig. 1 the alternating input potential E_e is applied to the grid of the tube V_1 . The input may be audio waves. The alternating potential developed across the plate resistance R_1 is applied to the voltage divider formed by C_1 , R_2 , R_3 and C_6 . The potential E_a tapped at the resistance R_3 serves as the output potential. The condensers C_1 , C_2 and C_6 are chosen with such a high value that they represent a negligibly low resistance for all frequencies. The chosen values may be, for instance, $R_2=300$ kilo-ohms, $R_3=500$ to 1000 kil-ohms, R_4 together with C_2 represent the counter-coupling path, and R_4 is

about 1 to 3 megohm. The series circuit $L-C_3$ may be tuned, for instance, to 1 kilocycle. In that case an alternating plate potential appears at R_5 which is the higher the more it lies above, or below, the short circuit frequency of the circuit $L-C_3$. The degree of the counter-coupling of the circuit, hence, has a minimum for the frequencies at 1 kilocycle. Since a voltage-dependent counter-coupling of the input resistance of the counter-coupling circuit reduces, in the present case, the value of the resistance R_3 in a manner known as such, R_3 has its actual value only for the frequencies in the range of 1 kilocycle approximately. Below this value R_3 appears decreased to an increasing degree.

There corresponds with this frequency-dependent behavior of R_3 the output potential E_a . The frequency curve extends approximately horizontal for a high negative grid biasing potential E_r . Hence, at a small amplification of the tube V_2 , (when disregarding the direct influence of the counter-coupling path), the curve deviates the more towards both sides from 1 kilocycle (see Fig. 2), the higher the control action of the degree of the amplification of V_2 . There corresponds with the curve A in Fig. 2 zero amplification of the tube V_2 , and with the curve D maximum amplification. The curves B and C represent intermediate values.

The circuit of Fig. 3 differs from that of Fig. 1 in that in the former the circuit elements $L-C_3$ are connected as a parallel resonant circuit which is tuned for instance to 9 kilocycles. This denotes that the counter-coupling occurs primarily in the region of this high frequency, i. e. R_3 appears greatly decreased for these frequencies, whereas for the intermediate frequencies and for the low frequencies it retains its actual value. By varying the grid biasing potential E_r , therefore, the effectiveness of the 9 kilocycle blocking means (and therewith, according to Fig. 4, the band width) will be influenced. The curves A to G of Fig. 4 correspond with an increasing amplification of the tube V_2 of Fig. 3.

In Fig. 5 the counter-coupling in the tube V_2 has approximately the same value for all frequencies. The variation of the band width occurs in view of the fact that the frequency-dependent resistance short circuits the high frequencies the more effectively the lower the apparent value of R_3 with increasing amplification of the tube. When dimensioning C_2 in such a manner that the counter-coupling path proper is effective predominantly for the high frequencies, a multiplicative action of the control influence

can be attained and, therewith, a particularly steep descent of the flank of the curve. The same is true for an arrangement according to Fig. 3.

Obviously it is also possible so to design the counter-coupling paths in a manner known as such, that besides the primary change of the frequency curve in the range of the high frequencies, there takes place at the same time a control of the low frequencies, especially in the sense that a slight drop of the low frequencies occurs at a constricting of the band width. This is accomplished in Fig. 3, for instance, by inserting the RC network and designated by R_7-C_5 . This network is so chosen that for the frequencies below 200 cycles a counter-coupling potential develops which increases when frequency decreases.

What is claimed:

1. In an audio amplifier having input and output terminals, an impedance element across the output terminals, an impedance simulation tube having input electrodes connected across said element whereby the input tube resistance between said input electrodes is effectively in shunt with said impedance element, a resonant circuit tuned to a predetermined audio frequency in circuit with the tube output electrodes to cause the input resistance to have a desired frequency response characteristic, and means for varying the tube gain thereby to vary solely the magnitude of the input resistance.

2. In an audio amplifier as defined in claim 1, said resonant circuit being tuned to a frequency of substantially 1,000 cycles whereby the audio voltage of audio frequencies other than 1,000 cycles developed across said impedance element decreases in magnitude in response to increase of said tube gain.

3. In an audio amplifier as defined in claim 1, said tuned audio frequency being substantially 9,000 cycles whereby said response characteristic is a low pass filter response for high tube gain.

4. In an audio amplifier having input and output terminals, an impedance element across the output terminals, an impedance simulation tube having input electrodes connected across said ele-

ment, a resonant circuit tuned to a predetermined audio frequency in circuit with the tube output electrodes to cause the simulated impedance to have a desired frequency response characteristic, means providing degenerative audio feedback from the output electrodes to said input electrodes, means for varying the tube gain thereby to vary solely the magnitude of the simulated impedance, and a condenser-resistor network in circuit with said resonant circuit for reducing the development of voltage of low audio frequencies.

5. In an audio transmission system, a source of audio voltage, an output load element, a resistive element in shunt therewith, a tube for controlling the effective magnitude of said resistive element, said tube having input and output electrodes, said tube input electrodes being connected across said resistive element, a degenerative audio voltage feedback path between the output and input electrodes, means for controlling the gain of said tube whereby the input resistance between the input electrodes, in shunt with said resistive element, is variable, and a tuned circuit in series between said tube output electrodes, said tuned circuit being resonant to a predetermined audio frequency.

6. In an audio transmission system, a source of audio voltage, an output load element, a resistive element in shunt therewith, a tube for controlling the effective magnitude of said resistive element, said tube having input and output electrodes, said tube input electrodes being connected across said resistive element, a degenerative audio voltage feedback path between the output and input electrodes, means for controlling the gain of said tube whereby the input resistance between the input electrodes, in shunt with said resistive element, is variable, and a tuned circuit in series between said tube output electrodes, said tuned circuit being resonant to a predetermined audio frequency, and an aperiodic network in series with the tuned circuit for discriminating against the low audio frequencies.

HEINZ BOUCKE.