Jan. 1, 1935. K. H. KRAMBEER 1,985,999

AUDIO FREQUENCY AMPLIFIER

Filed July 16, 1930

Fig. 1

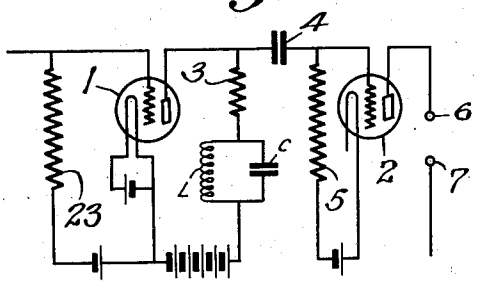



Fig. 2

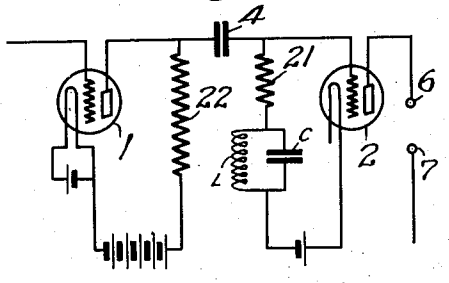



Fig. 3

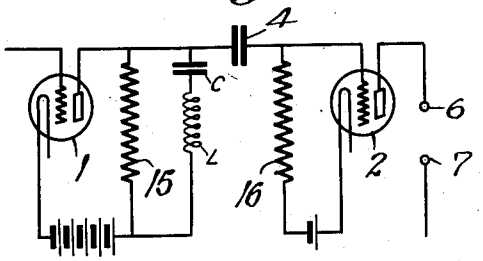



Fig. 4

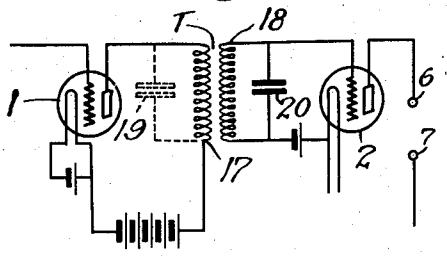
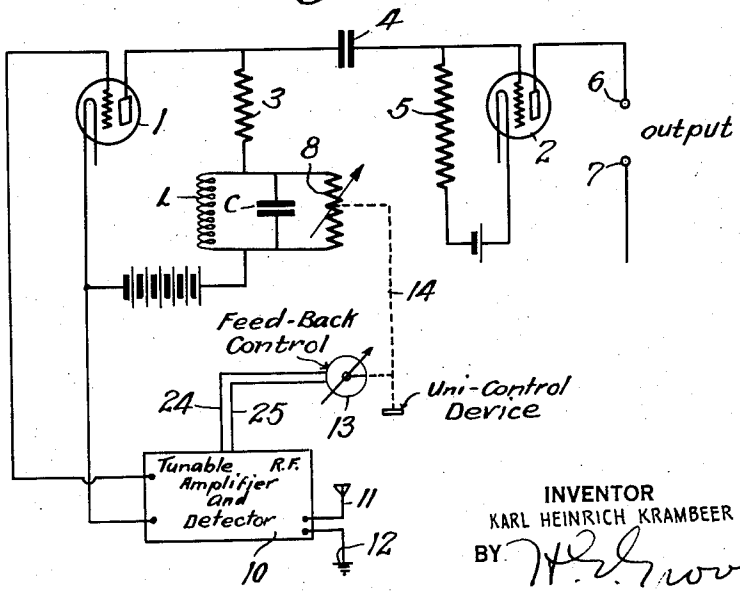



Fig. 5




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## AUDIO FREQUENCY AMPLIFIER

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8 Claims. (Cl. 250—20)

This invention relates to an audio frequency amplifier adapted to amplify signal currents transmitted by radio, and the same serves the purpose to compensate such distortion as has been occasioned in the radio frequency amplifier and the rectifier by selectance driven unduly far i. e., by undue selectance.

Owing to the slight difference in the frequencies of the carrier waves of the various adjacent broadcast stations more or less perfect reception is feasible only by the aid of means adapted to insure greater tuning sharpness or so-called selectance. In order that two transmitter stations may be separated, it is frequently necessary to push the selectance beyond the limit where undistorted reception is still feasible. The selectance of the receiver apparatus becomes particularly favorable if in long-distance reception regenerative coupling is made very close for the purpose of insuring large volume. But distortion of both voice and music is then inevitable. However, it is chiefly the high frequencies that are hurt, and the result is that both voice and music are dull in reproduction.

In most instances it is impossible to dispense with high selectance in the tuning means. But if reception shall be made acceptable in spite of that there remains no other remedy than to make an attempt to compensate such distortion as has been caused by undue selectance.

Now, according to the present invention this compensation is insured in the audio frequency part of the receiver in that by additional circuit means, or by suitable dimensioning of the normal transfer resistances, the distortions occasioned by undue selectance are compensated. It is then possible to work with maximum selectance in the radio frequency amplifier and this is especially important for long-distance reception. Such supplementary circuit elements as are provided may be connected in parallel or in series with the plate or grid resistances or else to the loudspeaker.

It should here be noted that so far as the essential features of the basic idea of the invention are concerned it is immaterial whether the distortion is caused in each stage or only in one stage. When the selectance changes and thus also the distortion, say, owing to a change in regeneration, then, according to the invention, also the distortion-compensating means are altered, this alteration being brought about in a positive manner.

In the drawing which shows embodiments by way of example of the idea underlying this invention:

Figure 1 illustrates diagrammatically one preferred embodiment of my invention in which a resonant circuit is placed in the output of an amplifier tube;

Figure 2 shows the invention diagrammatically with the resonant circuit placed in the input of an amplifier tube;

Figure 3 illustrates another embodiment of the invention in which the resonant circuit is placed in parallel relation to the plate and grid resistance;

Figure 4 illustrates diagrammatically my invention as applied to a transformer coupled amplifier; and,

Figure 5 illustrates diagrammatically a way of obtaining variable distortion compensation as applied to the circuit shown in Figure 1.

According to Fig. 1 in series with the plate resistance, there is connected a stopper circuit comprising condenser C and coil L in parallel, in a resistance-coupled audio frequency amplifier. If the circuit elements are suitably proportioned, amplification for the frequency range in the neighborhood of resonance of the stopper circuit may be promoted. Choosing a resonance frequency of around $f=8000$, this makes it feasible to insure compensation of the distortion caused by undue radio frequency selectance. In said Figure 1 a first tube 1 preferably coupled to a source of energy to be amplified by means of impedance 23 is provided with an output circuit comprising an impedance element 3, an inductance L shunted by a condenser C and the usual source of anode current. The anode of the tube 1 is connected to the grid element of a second tube 2 through coupling capacity 4. An impedance element 5 is connected between the grid and cathode of the tube 2. Terminals 6 and 7 represent the output terminals of the device to which may be connected any suitable type of translating device. From what has preceded it is obvious that the output of the tube 1 is impressed upon the input of tube 2.

The same result is realized if a stopper circuit is connected in series with the grid leak as shown in Fig. 2. In Figure 2 the output circuit of tube 1 is provided with an impedance 22. As shown, the anode of tube 1 is connected to the grid of tube 2 through a coupling capacity 4 and tube 2 is provided with a grid leak 21 in series with the stopper circuit LC. As in the case of Figure 1 terminals 6 and 7 of Figure 2 are the output terminals of the circuit.

Distortion-compensation may be secured also by that in parallel relation to the plate and grid resistance a resonant circuit (condenser and coil

in series) is disposed which is tuned to a low frequency (Fig. 3). In Figure 3 two tubes 1 and 2 are shown cascaded through a coupling condenser 4. Tube 1 has connected between the anode and cathode thereof an impedance 15 which is shunted by a condenser C and a coil L in series. A grid leak 16 is connected between the grid and cathode of tube 2. Here again terminals 6 and 7 represent the output terminals of the amplifier to which any suitable translating device may be connected.

The invention is useful also in combination with transformer-coupled audio frequency amplifiers. As shown in Fig. 4 the desired compensation of distortion may here be accomplished by shunting the primary or the secondary winding of the transformer by a condenser 20. In Figure 4 the tubes 1 and 2 are transformer coupled. For this purpose transformer T is provided with a primary 17 which is associated with the output of tube 1 and a secondary 18 shunted by a condenser 20, connected between the grid and cathode of tube 2.

In the presence of suitable dimensions the self-capacity of the transformer represented by condenser 19 shown in dotted lines may be utilized for this purpose so that additional circuit elements for that purpose are dispensable.

As already pointed out radio frequency selectance and the distortion caused thereby depends markedly upon the feed-back setting of the audion tube. The reception of long-distance stations, when the regenerative coupling is very close, is attended by far more distortion than is true of local broadcasters. But if perfect reception shall be insured in all cases, then the anti-distortion means hereinbefore disclosed must be adjustable or regulable in such a way that the degree of distortion compensation must always be closely adapted to the feed-back. These simultaneous settings may also be joined or made interdependent in a positively acting manner.

Variable distortion compensation may be insured, for instance, in a circuit scheme of the kind illustrated in Fig. 1 by that a variable high-ohm resistance is connected in parallel relationship, to the stopper circuit (Fig. 5).

In Figure 5 tubes 1 and 2 are coupled through the same type of circuit as shown in Figure 1. However, in this case there is provided a variable tone control device 8. The input of the tube 1 is connected to the output of a tunable radio frequency amplifier and detector circuit 10 as shown. The device 10 is provided with a feedback control 13 connected to 10 through conductors 24 and 25. Device 13 is shown variable and is adapted to be uni-controlled through a common shaft or other suitable interconnecting means 14 with the tone control 8. Numerals 11 and 12 represent generally the antenna and ground of the usual radio receiver.

Where audio frequency amplifiers having a plurality of stages are employed the means hereinbefore disclosed may be inserted either above or below each stage as well as in the loudspeaker circuit.

I clam:

1. In a signal receiving system of the type including a tunable radio frequency selector circuit, a selectivity control device adapted to adjust the selector circuit for different degrees of selectivity resulting in giving the selector circuit such sharp selectance characteristics that signal energy passed therethrough is distorted in various degrees depending upon the adjustment of the selectivity control, a detector and an audio frequency amplifier, said audio frequency amplifier being provided with a resonant circuit the resonance characteristics of which tend to compensate for the radio frequency circuit signal distortion and means for varying the compensating characteristics of said resonance circuit simultaneously with the variations in adjustment of the selector circuit for the different degrees of selectivity whereby the signal distortion compensating means varies simultaneously with the variations in the selectance characteristics of the selector circuit to thereby compensate for the various degrees of distortion.

2. In a radio signalling system, a radio frequency circuit, adjustable means associated with said circuit the operation of which affects the selectivity characteristics of said circuit, an audio frequency amplifier, means for controlling the tone of said amplifier and additional means for rendering said tone control means simultaneously operative with said adjustable means whereby the tone control means compensates for any signal distortion caused by adjustments in the said adjustable means.

3. In a signalling system including a tunable selector circuit and a signal amplifier, an adjustable selectivity control means associated with the selector circuit, an adjustable distortion compensating means associated with the signal amplifier and a single means for adjusting both said last named means simultaneously.

4. In a radio receiver, a tunable radio frequency circuit, adjustable means associated with said circuit, operation of said adjustable means acting to affect the selectivity characteristic of said circuit, a detector, an audio frequency amplifier, means for controlling the tone of said amplifier and additional means for rendering said tone control means simultaneously operative with said adjustable means.

5. The method of maintaining substantially uniform tone fidelity in radio receivers and the like provided with radio frequency and audio frequency amplifiers of the type wherein a characteristic of the radio frequency amplifier is controllable between two extreme conditions and wherein variations in said characteristic causes inherent variations in the selectivity characteristic of the amplifier which comprises simultaneously varying the ratio of high-to-low frequency response of the audio frequency amplifier with variations of the selectivity characteristic of the radio frequency amplifier.

6. In radio signalling apparatus, a radio frequency selector circuit provided with adjustable means operation of which varies at least two characteristics of said circuit one of which is the selectivity of the circuit, an audio frequency circuit, adjustable means for controlling the tonal characteristics of said audio frequency circuit and single means for rendering the tone control simultaneously operative with said first named adjustable means said tone control means acting to compensate for any signal distortion caused by adjustments in the first named means.

7. In a radio receiver, a radio frequency circuit, adjustable means associated with said circuit operation thereof acting to vary a characteristic of said circuit, variations of said characteristic of said circuit also acting to vary the selectivity characteristic of said radio frequency circuit, an audio frequency amplifier, means for controlling the tonal characteristics of said amplifier and means for rendering the tone control

means simultaneously operative with said adjustable means whereby the tone control means compensates for any signal distortion caused by changes in the selectivity characteristics of said radio frequency circuit.

8. A radio signalling system comprising in combination a radio frequency amplifier, an audio frequency amplifier, adjustable means associated with said radio frequency amplifier and operable by a control member acting upon operation to vary at least two different characteristics of the radio frequency amplifier, one of said characteristics being the selectivity thereof, and means operable by said control member for varying the ratio of high-to-low frequency response of said audio frequency amplifier simultaneously with variations in the selectivity of the radio frequency amplifier to thereby compensate for any signal distortion caused by variations in the selectivity of the radio frequency amplifier.

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