May 13, 1941. H. BOUCKE 2,241,581

ELECTRICAL AMPLIFIER

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*Fig. 1.*

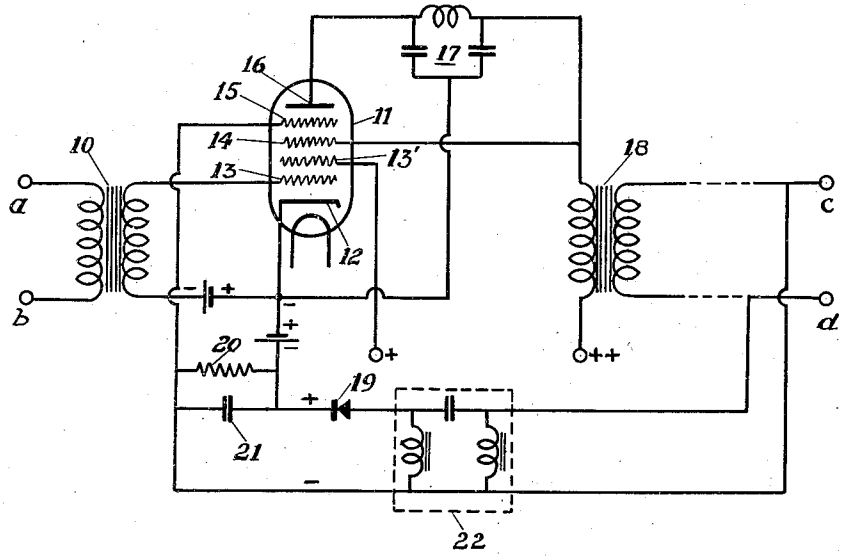
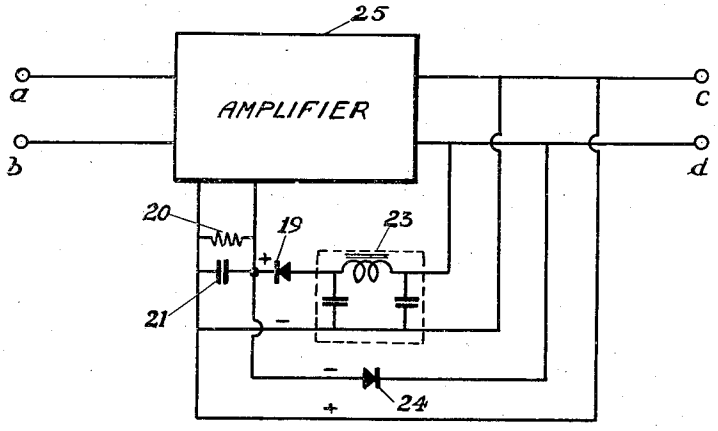



*Fig. 2.*




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## ELECTRICAL AMPLIFIER

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6 Claims. (Cl. 179—171)

The present invention relates to electrical amplifiers, more particularly to audio frequency amplifiers for phonograph or other sound record reproduction, and an object of the invention is to minimize or eliminate the background noise or other similar interference experienced in amplifiers of this type.

More particularly, the invention is concerned with amplifiers of the above character embodying means for controlling the effectiveness of the interference or background noise eliminating device or system in dependence upon the amplitude or intensity of the sound signals being amplified. In this manner the noise is more effectively suppressed as the sound intensity decreases and vice versa, thereby minimizing the effect of the suppression device or system on the reproduction of the useful sound signals and preventing undesirable distortion and other impairment of the quality of the sound reproduction.

Thus, it has become known in the reproduction of phonograph records to provide a needle scratch or noise filter in combination with an amplifier controlled in such a manner that the effectiveness of the filter is decreased in proportion to the increase of the intensity or amplitude of the useful (sound) frequencies to be amplified. As a result thereof, the frequency transmission characteristic of such a system is practically linear for high sound intensity in which case the needle scratch noise is drowned out by the high amplitude of the sound frequencies. In case of low sound intensity, a greater or lesser cutting off of the higher sound frequencies falling within the range of noise frequencies takes place.

Practical experiments when using a filter of the aforementioned type, have shown that if a musical score consists predominantly of low notes, such as in the case of a bass singer, the needle noise is not sufficiently drowned out during the passages of high intensity but appears to be set off in marked contrast to the sound frequencies.

By the present invention the aforementioned drawback is substantially eliminated by the provision of means for controlling the effectiveness of the needle scratch or other background noise filter predominantly in inverse proportion to the intensity of the medium and high sound notes or in other words to reduce or eliminate the effect of the low notes upon the frequency range or band width control. If the frequency range or amplifier band width is controlled by means of a controlling current or potential produced from a portion of the amplified low frequency energy by rectification and subsequent smoothing or filtering, the above reduction of the effect of the lower notes of about 25–250 cycles may be accomplished by eliminating these frequencies from the low frequency energy serving for producing the control potential or by preventing admission of the lower frequencies to the rectifier circuit. This may be accomplished by the provision of a suitable filter or a simple condenser effective in blocking the lower frequencies.

According to another embodiment, the normal control potential derived from a mixture containing the entire sound frequency spectrum is opposed by a further potential derived from a mixture containing the low sound frequencies only, both control potentials being adjusted in such a manner that the portion due to the low frequency range (about 25–250 cycles in practice) of the main control potential is compensated. Alternatively the additional control potential may be applied to a different part of the amplifier to effect a counter acting control for carrying out the invention.

The invention will become more apparent by the following description taken in reference to the accompanying drawing, wherein

Figure 1 shows an audio frequency amplifier circuit embodying an arrangement for automatic background noise control in accordance with the invention, and

Figure 2 illustrates a modification of the arrangement according to Figure 1.

Sound currents or potentials which may be derived from the output of a phonograph pick-up device, from the pick-up system of a talking picture apparatus or the like are impressed upon the primary of an audio transformer **10** through input terminals *a*—*b*. The secondary of the transformer is connected in a known manner to the cathode **12** and grid **13** of a multi-grid amplifying valve **11** further comprising a screen grid **13'** adjacent to the input or control grid **13**, a positive or output grid **14**, a further control or current distribution grid **15** and an anode or plate **16**. The amplified sound currents in the output or plate circuit are transmitted by means of an output transformer **18** to a further amplifier or to a suitable translating device such as a loud speaker to be connected to output terminals *c*—*d*.

There is inserted in the anode or plate circuit a filter known as a scratch or noise filter **17** comprising, in the example shown, a series inductance and a pair of condensers shunted to ground or cathode. This filter is designed to suppress

the higher sound frequencies of the needle scratch or background noise and is substantially composed to prevent their transmission to the output through transformer 18. The screen grid 13', grid 14 and the plate 16 are connected in a known manner to a high potential source indicated by the + signs. The output grid 14 is directly connected to the anode side of the primary of the output transformer 18. In this manner output current will flow through the transformer primary 18 both from grid 14 and plate 16, that is, either directly or by way of the noise or scratch filter 17, whereby the elimination of the higher notes and noise will take place in proportion to the relative distribution of the output currents upon grid 14 and plate 16, respectively. This distribution of the output current is controlled by the aid of the grid 15 placed between the grid 14 and plate 16.

In the example shown for automatic noise control, the control potential for the grid 15 is produced by applying a portion of the output energy to a rectifier 19 in series with a resistance 20 shunted by by-pass condenser 21. Resistance 20 is connected to the cathode and control grid 15 and with the polarities of the biasing batteries in the grid circuit, the cathode lead and of the rectifier 19 being arranged as indicated it is readily seen that as the output energy or sound intensity increases, the grid 15 will become more negative, thereby blocking the electron current to the plate 16 and resulting in increased current flow through the grid 14 directly to the output transformer; that is in turn decreased effectiveness of the noise or scratch filter 17.

On the other hand, as the sound intensity decreases, grid 15 will become more positive, thereby allowing more current to flow through the plate circuit resulting in increased effectiveness of the filter 17.

In order to render the control dependent upon the medium and high sound frequencies only as proposed by the present invention, there is provided a high-pass filter preceding the rectifier circuit 19, 20, 21 designed to be effective in admitting only sound frequencies above about 250 cycles. In this manner, sound frequencies below 250 cycles will be prevented from exerting any effect on the control system in the manner described hereinabove.

Referring to Figure 2, there is shown a modified arrangement, wherein the amplifier which may be of a type similar to or different from Figure 1 is shown schematically by the rectangle 25. According to this embodiment, a pair of control potentials are produced by deriving output energies applied to separate rectifiers 19 and 24 having their outputs impressed upon the same circuit 20, 21. The rectifiers 19 and 24 are arranged with their polarities reversed, whereby the output potentials are opposed to each other. In order to suppress the effect of the low sound notes there is provided a low-pass filter 23 in one of the rectifier circuits, whereby only the lower notes will be suppressed by compensation and only the medium and high sound notes are effective in producing a potential for the automatic noise control. Suitable volume control or potentiometer arrangements may be provided to adjust the relative amplitudes of the controlling potentials to effect the desired compensation, as will be obvious to those skilled in the art.

Arrangements of the above described type have the advantage of substantially improving the suppression of the needle scratch or other background noise in sound producing systems. Moreover, the invention does not suffer from the disadvantage of increased suppression of the useful frequencies due to the continued effectiveness of the noise filter for both low and high intensity of the sound consisting predominantly of lower frequencies. This is due to the fact that in practise sounds such as music consisting predominantly of low frequencies (voice of a bass singer) are extremely poor in higher harmonics, whereby the filter is substantially more effective in suppressing needle scratch and other background noise than affecting the useful sound frequencies and impairing the fidelity of reproduction.

As will be understood, the invention has many other uses in addition to the suppression of the needle scratch noise in phonograph reproduction and in its broad aspect applies to all cases where it is desired to suppress interference or background noise comprising substantially components falling within the higher useful (sound) frequency range, such as in public address systems, talking picture apparatus (background noise due to film graininess), magnetic recording apparatus, and many other applications. The specification and drawing are accordingly to be regarded in an illustrative rather than in a limiting sense.

I claim:

1. In an audio frequency amplifier for reproducing sound records, an electron valve comprising a cathode, an input electrode and a pair of output electrodes, an output circuit, circuit connections from each of said output electrodes to said output circuit, a filter in one of said circuit connections effective in suppressing frequencies in the higher audible range, means for controlling the relative amount of electron current to said output electrodes, further means for producing a potential varying in proportion to the average amplitude of the sound currents being amplified, said potential controlling said last mentioned means, whereby with increased sound intensity the relative current to the output electrode connected to said output circuit through said filter is decreased and vice versa, and further means whereby said control potential varies only in proportion to the average intensity of sound signal components beyond a predetermined lower limit frequency.

2. In an audio frequency amplifier for reproducing sound records, an electron valve comprising a cathode, an input electrode and a pair of output electrodes, an output circuit, circuit connections from each of said output electrodes to said output circuit, a filter in one of said circuit connections effective in suppressing frequencies in the higher audible range, means for controlling the relative amount of electron current to said output electrodes, further means for producing a potential varying in proportion to the average amplitude of the sound currents being amplified, said potential controlling said last mentioned means, whereby with increased sound intensity the relative current to the output electrode connected to said output circuit through said filter is decreased and vice versa, and further means whereby said control potential varies only in proportion to the average intensity of sound signal components higher than 250 cycles per second.

3. In an audio frequency amplifier for reproducing sound records, an electron valve comprising a cathode, an input grid, a positive grid and

an anode, an output circuit connected to both said positive grid and anode, a filter inserted between said anode and output circuit, said filter being effective in suppressing frequencies in the upper audible range, a further control grid positioned between said positive grid and anode adapted to control the relative electron current flow to said positive grid and to said anode in dependence upon a biasing potential applied thereto, means for averaging a portion of the output energy for deriving a potential proportional to the averaged energy to be impressed upon said further grid, whereby with increased output the relative current to said anode is decreased and vice versa, and further means whereby said control potential varies only in proportion to the average strength of output current components above a predetermined lower limit frequency.

4. In an audio frequency amplifier for reproducing sound records, an electron valve comprising a cathode, an input grid, a positive grid and an anode, an output circuit connected to both said positive grid and anode, a filter inserted between said anode and output circuit, said filter being effective in suppressing frequencies in the upper audible range, a further control grid positioned between said positive grid and anode adapted to control the relative electron current flow to said positive grid and to said anode in dependence upon a biasing potential applied thereto, means for averaging a portion of the output energy for deriving a potential proportional to the average energy to be impressed upon said further grid, whereby with increased output the relative current to said anode is decreased and vice versa, and further means whereby said control potential varies only in proportion to the average strength of output current components above a lower limit frequency of about 250 cycles per second.

5. In an amplifier for signal energy comprising a band of component frequencies, an electron valve comprising a cathode, an input control electrode and a pair of anodes, means for impressing signal potential upon said input electrode, an output circuit, coupling circuit connections from each of said anodes to said output circuit, filter means in one of said circuit connections effective in suppressing frequencies in the higher frequency range of said band, a further control electrode for varying the relative amount of electron current to said anodes, a rectifying circuit, means including a filter effective in suppressing frequencies in the lower frequency range of said band for impressing signal energy upon said rectifying circuit, further means including a smoothing filter to derive a control potential from said rectifying circuit varying in proportion to the average amplitude of the signal energy being amplified, and means for impressing said control potential upon said further control electrode.

6. In an amplifier for signal energy comprising a band of component frequencies, an electron valve comprising a cathode, an input control electrode and a pair of anodes, means for impressing signal potential upon said input electrodes, an output circuit, coupling circuit connections from each of said anodes to said output circuit, filter means in one of said circuit connections effective in suppressing frequencies in the higher frequency range in said band, a further control electrode for varying the relative amount of electron current to said anodes, a first rectifying circuit, means including a filter effective in suppressing frequencies in the higher frequency range of said band for impressing signal energy upon said rectifying circuit, a further rectifying circuit, means for impressing signal energy of substantially the entire frequency range of said band upon said further rectifying circuit, further means including smoothing filter means to derive and differentially combine potentials from each of said rectifying circuits varying in proportion to the average amplitude of the respective impressed signal energies, and means for applying the derived differential potential to said further control electrode.

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