Aug. 6, 1935. H. F. ELLIOTT 2,010,014

AMPLIFIER AND DETECTOR SYSTEM

Filed May 3, 1932

Fig. 1.

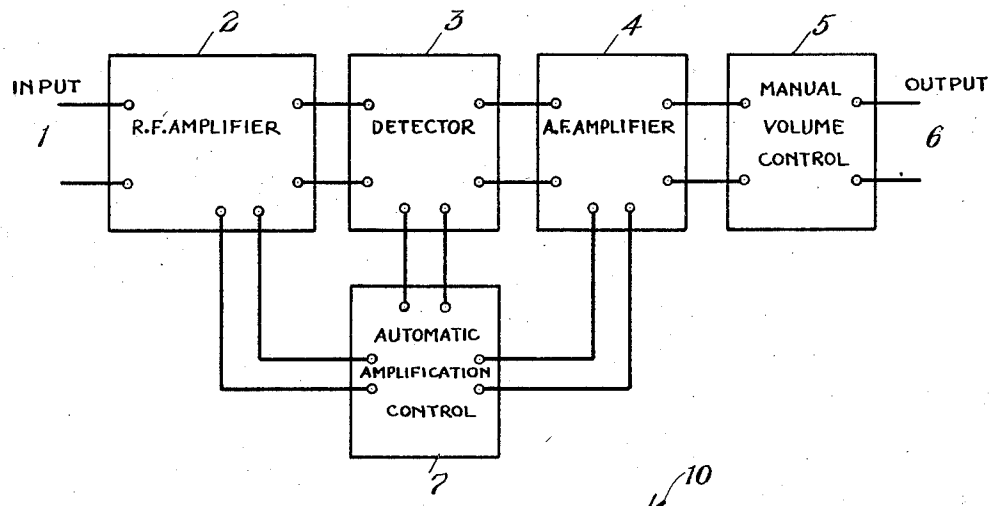
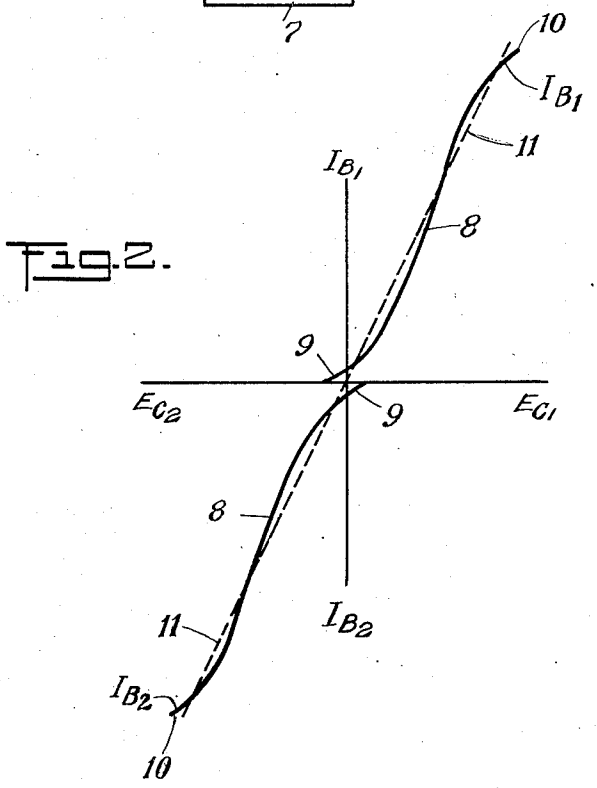


Fig. 2.



INVENTOR

Harold F. Elliott

BY HIS ATTORNEY

Howard P. King

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AMPLIFIER AND DETECTOR SYSTEM

Harold F. Elliott, Palo Alto, Calif.

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14 Claims. (Cl. 250—20)

My invention relates to amplifier and detector systems such as are widely used in electrical communication, radio reception, talking pictures and other fields. An object of my invention is to provide means whereby the quality of reproduction of such systems may be improved. Another object is to provide means whereby the output of such systems may be controlled without impairing the quality of reproduction. Another object is to provide means whereby amplifiers and detectors may always be operated under conditions which give optimum quality of reproduction even though the input and output conditions are required to cover a relatively wide range. These and other objects and features of my invention, as defined in the appended claims, will be made clear in the following description.

Referring to the drawing:

Figure 1 shows schematically an arrangement of apparatus whereby the objects of my invention may be carried out.

Figure 2 shows curves pertaining to the operation of electron amplifiers and serves to illustrate causes of distortion in such apparatus, as well as the means which I adopt in minimizing distortion in accordance with the principles of my invention.

It is well known, to those skilled in the communication art, that electron tubes such as are widely employed as amplifiers and detectors introduce distortion by reason of the fact that such electron tubes do not have a strictly linear relation between input and output. Thus in Fig. 2 if the abscissas represent input potentials and the ordinates represent output currents, a typical electron tube will depart from the theoretically ideal linear relation as represented by dotted line 11, and will assume more or less the form shown by the curved lines 9—8—10. An amplifier or detector stage employing a single electron tube will be fairly free from distortion if operated within the range of input and output conditions where the characteristic curve is reasonably straight, as at 8. Likewise a stage employing two tubes, either in "push-pull" relation or "push-push" relation, will be comparatively free from distortion if operated in the range of input and output conditions where the relation between these two is substantially linear. However any stage is likely to produce distortion if the input is less than a certain minimum or greater than a certain maximum lying outside the linear range. In order to obtain amplification or detection reasonably free from distortion, it is therefore desirable that the input be held above a certain minimum and below a certain maximum. Thus for the case shown in Fig. 2, which represents a "push-push" or class "B" amplifier, objectionable distortion is likely to occur if the input is so low as to fall within the lower curved range, designated by numerals 9—9, or so high as to come within the upper curved range, designated by numerals 10—10. On the other hand, reasonably satisfactory amplification may usually be obtained if the input falls between these two extremes so that the net result of the operation of the amplifier reasonably approaches the ideal straight line 11—11. The point is that the input must be held within the limits where the percentage of non-linear operation is low.

In my invention, I keep the input to the amplifier or detector always within the range which gives performance reasonably free from distortion by providing an automatic system of control in the equipment which precedes the stage whose operation is to be held free from distortion. Thus in Fig. 1 which may represent a radio receiver or other typical apparatus, I show a radio frequency amplifier 2 having input terminal 1. The RF amplifier is followed by a detector 3 and an AF amplifier 4. The RF amplifier, detector and AF amplifier are inter-related through an automatic amplification control 7. The relations between these units should be such that the input to the detector 3 and AF amplifier 4 is held substantially constant, and at the value which gives minimum distortion, over the entire range of input conditions which the apparatus, as a whole, is designed to handle. Details of circuits for accomplishing this are given in my co-pending application Serial No. 605,185, filed April 14, 1932.

In order that the output from the system may be regulated to any desired level a manual volume control 5 is placed between AF amplifier 4 and the output terminals 6. This control may take any of the forms known to the art which are suitable for introducing attenuation between the AF amplifier 4 and output terminals 6. The attenuator may, if desired, be made strictly linear, so that the output at 6 is always a true replica of the output of AF amplifier 4. Alternatively, the attenuator 5 may be designed so that translating apparatus, such as a loud speaker, attached to terminals 6, gives a result which is pleasing to the ear under all operating conditions. For example, it is sometimes desirable to increase the ponderance of the lower frequency components of music or speech, when the output is reduced to a relatively low level. The desirability of doing this in some conditions is well understood and arises

from the phenomenon that the human ear is less responsive to sounds of low pitch than it is to sounds of an intermediate range, which phenomenon is accentuated in sounds of low intensity.

What I claim is:

1. Electronic apparatus comprising an audio-frequency amplifier having an operating range of low distortion between upper and lower limits of input level, an input and output, automatic control means for maintaining said input thereto within the low distortion range of operating conditions, and attenuating means in said output of the audio frequency amplifier.

2. In combination, an amplifier having an operating range of low distortion between upper and lower limits of input level, an input, an automatic control amplifier for maintaining said input within said range of operating conditions, an output, and a volume control in said output.

3. In combination, a detector having an input, an automatic control amplifier for maintaining said input within a range of operating conditions, a second amplifier succeeding the detector, said second amplifier having low distortion within the upper and lower limits of said input range, an output, and a volume control in said output.

4. In combination, an amplifier and detector having an output, means for maintaining the output within a range of operating conditions, a second amplifier connected to receive said output, said second amplifier being of the class B type and having low distortion within the limits of the aforesaid range, an output, and a volume control in said output of the second amplifier.

5. The method of minimizing distortion and controlling volume in a class B amplifier having low distortion between the upper and lower limits of a range of input operating conditions which comprises maintaining the input to the amplifier automatically within said range of operating conditions and attenuating the output of the amplifier to control volume.

6. The method of minimizing distortion and controlling output in an amplifier and a detector followed by a second amplifier having low distortion within a limited range but distorting both above and below this range of operating conditions which comprises maintaining the input to the detector within said low distortion range of operating conditions and attenuating the output of the second amplifier to control output.

7. The method of minimizing distortion and controlling output in a power amplifier embodied in amplifying apparatus having a variable input and a variable output and subject to distortion both above and below an operating range which comprises automatically controlling the gain preceding the input to the power amplifier so as to maintain said input above the low level distortion range and below the high level distortion range and attenuating the output of said power amplifier to obtain a desired output level.

8. The method of minimizing distortion and controlling output in a detector and amplifier embodied in carrier wave amplifying and detecting apparatus having a variable input and a variable output and subject to distortion both above and below a limited operating range which comprises automatically controlling the input to the detector so as to maintain said input within the low distortion range and attenuating the output of the amplifier to obtain a desired output level.

9. The method of minimizing distortion and controlling output in an amplifier and detector followed by a class B power amplifier embodied in apparatus having a variable input and a variable output which comprises automatically controlling the input to the detector and power amplifier so as to maintain said input within the limits outside which distortion occurs and attenuating the output of said power amplifier to obtain a desired output level.

10. In combination, an audio-frequency amplifier having an operating range of low distortion between upper and lower limits preceded by an amplifier with automatic gain control means for maintaining the input to the audio-frequency amplifier within said low distortion range of operating conditions, and means for attenuating the output of the audio-frequency amplifier.

11. A radio receiver comprising a radio frequency amplifier, a detector, an audio-frequency amplifier having low distortion between upper and lower limits of input level, an input and an output, automatic control means whereby the said input is maintained within said limits, and manual volume control means in the said output of the audio-frequency amplifier.

12. A radio receiver comprising a radio frequency amplifier, a detector, an audio-frequency amplifier of the class "B" type having low distortion within a range of operating conditions having upper and lower limits of input level, an input and an output, automatic control means whereby the said input is maintained within said low distortion range of operating conditions, and manual volume control means in the said output of the audio-frequency amplifier.

13. A radio receiver comprising a radio frequency amplifier, a detector, an audio-frequency amplifier having low distortion between the upper and lower limits of a limited range of input level, an input and an output, automatic control means whereby the said input is maintained within said low distortion range of operating conditions, manual volume control means in the said output of the audio-frequency amplifier and a loud speaker following the manual volume control.

14. The method of controlling volume and minimizing distortion in a class B amplifier which comprises automatically maintaining the input above a lower level where distortion is encountered due to non-linearity in the input-output characteristic and below the level where overloading occurs, and attenuating the output to control volume.

HAROLD F. ELLIOTT.