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R. AUBERT

1,978,184

AUTOMATIC VOLUME CONTROL

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Fig. 1

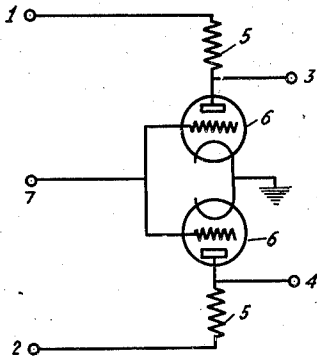


Fig. 2

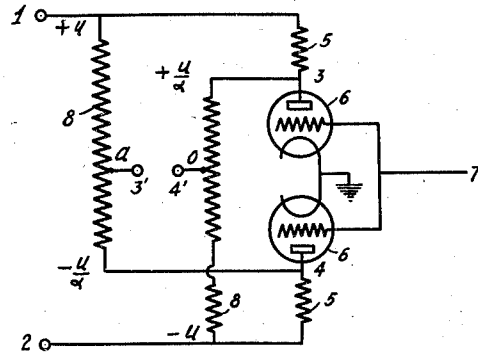


Fig. 2a

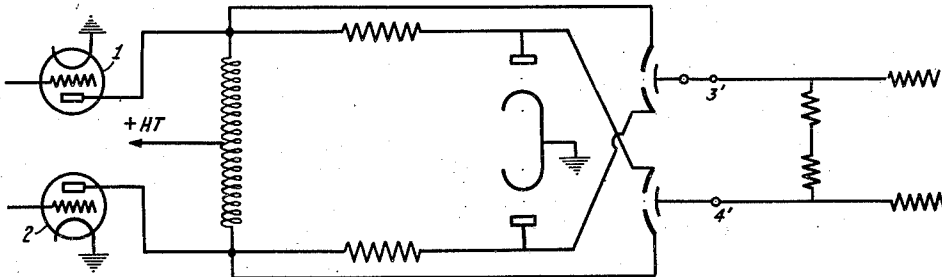


Fig. 4

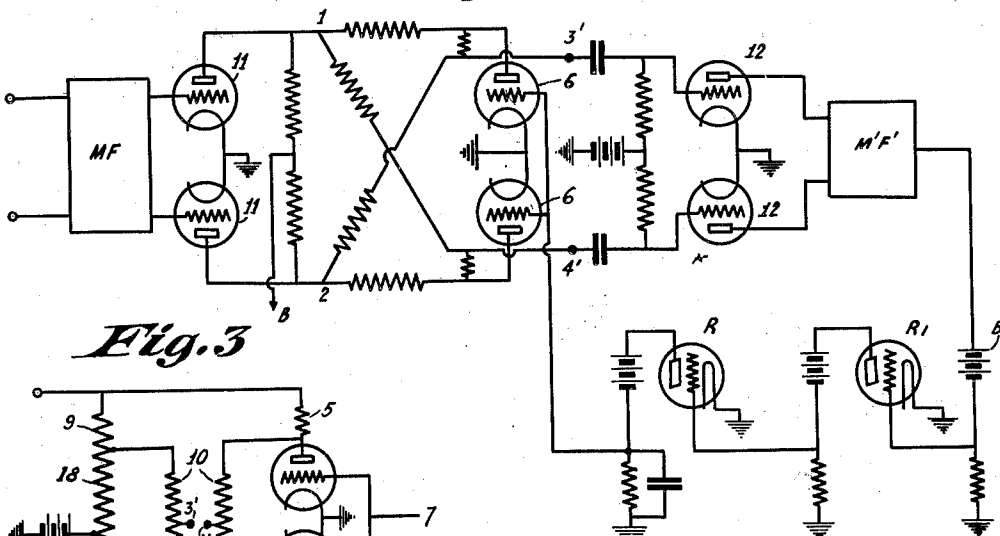
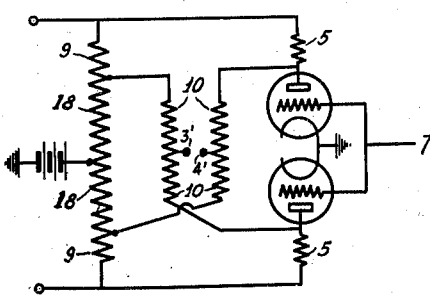


Fig. 3



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AUTOMATIC VOLUME CONTROL

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Application May 4, 1931, Serial No. 534,869
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5 Claims. (Cl. 250—20)

The present invention relates to improvements in circuit arrangements adapted to regulate the sensitivity of amplifiers.

Systems generally used for insuring an automatic variation of the sensitivity of an amplifier are well known in the prior art. These systems can be divided into two chief classes. In the first class the polarizing, or biasing, potential of the grid of the amplifier tubes is directly acted upon so as to regulate the amplification of the system by the convenient choice of the working points of the tubes. In the second class the plate impedance of triodes is shunted by the filament-plate circuit of a supplemental triode whose internal resistance is varied by regulation of its grid potential, for instance. The effective amplification of the stage is thus set to the desired value.

Now, both of these two systems involve certain inconveniences. In the former, with the signal and the control system both acting upon one and the same electrode, there occurs always detection and distortion of the signal, the latter being so much more marked the stronger the signal. In the second class, the signal and the control system act upon two different electrodes, and the distortion of the signal may be reduced to zero by the judicious choice of the shunt tube. However, the variation in amplification permitted by the system is diminished owing to the low internal resistance of the shunt tube which is never of zero value.

The system which forms the object of the present invention, and which represents an improvement upon that disclosed in a prior co-pending application, permits a very great variation in amplification, while at the same time avoiding the distortion of the signal. Briefly, it comprises a potentiometer coupling associated with a complete compensation of the residual effect.

In the drawing,

Fig. 1 shows an amplifier arrangement without the present invention,

Fig. 2 shows the arrangement of Fig. 1 embodying the present invention,

Fig. 2a is a modified form of the invention.

Fig. 3 shows still another modification,

Fig. 4 schematically shows a receiving system embodying a preferred form of the invention.

In order to facilitate the understanding of the operation of the system, Fig. 1 shows the provision of a potentiometer coupling device without compensation of the residual effect. The coupling between the input terminals 1, 2 and the output terminals 3, 4 of an amplifier is insured across an assembly of fixed resistances 5 and triode tubes 6. The system controlling the amplifier acts at 7 upon the grid potential of tubes 6 so as to modify their internal resistance. When the internal resistance of the tubes 6 is high com-

pared with resistance 5, the ratio between the potentials prevailing across 3, 4 and 1, 2 is close to unity, and may be expressed as follows:

$$\frac{U_{3,4}}{U_{1,2}} \approx 1 \quad 65$$

where $U_{3,4}$ is the potential difference between points 3 and 4, and $U_{1,2}$ is the potential difference between points 1, 2.

When the internal resistance of tubes 6 is equal to ρ the relationship between the potentials across 3, 4 and 1, 2 is:

$$\frac{U_{3,4}}{U_{1,2}} = \frac{\rho}{R + \rho} \quad 75$$

where R is the magnitude of the resistor 5.

The maximum amplification variation is thus equal to:

$$\alpha = \frac{R + \rho_{min.}}{\rho_{min.}} \quad 80$$

The resistance $\rho_{min.}$ being given, and since the resistance R should not be too high (for this would cause tube 6 to operate under an unduly low plate potential), the maximum amplification variation is limited. The scheme shown in Fig. 2 is adapted to neutralize the residual effect of resistance ρ .

The system is particularly adapted to amplifiers with a symmetric circuit arrangement. An embodiment thereof as applied to an amplifier as stated is shown schematically in Fig. 2.

With this end in view two high resistances 8 are disposed between points 1, 4 and 2, 3 of the system, connection with the next stage being then established at 3', 4'. The rough outline to be given hereinafter will facilitate the understanding of the operation of the system. When tube 6 has its lowest internal resistance $\rho_{min.}$, points 1 and 2 respectively are at potentials $+U$ and $-U$, and the points 3 and 4 at potentials

$$\frac{+U}{\alpha} \text{ and } \frac{-U}{\alpha}.$$

The resistances 8 being always arranged between two points having potentials

$$\left(+U \text{ and } \frac{-U}{\alpha} \right)$$

for the first, and

$$\left(-U \text{ and } \frac{+U}{\alpha} \right)$$

for the second one, two symmetric points 3' and 4' will be found upon these resistances which will be at zero potential and for which the residual amplification will be of zero value. If the resistances 8 are high compared with resistances 5, the maximum amplification will be but slightly affected. At all events, however, the variation of amplification will be as high as may be desired.

Fig. 3 shows another embodiment of the system. The sum total of the resistances 9 and 10 of Fig. 3 corresponds to resistances 8, Fig. 2, resistances 9 being equal to resistances 5 and resistance 10 being high compared with resistances 5, so as to preserve a high maximum amplification. The two resistances 18 connected between (across) the terminals of resistances 9 and the midpoint of the system are equal to the minimum internal resistance of the triodes. In order that these systems may be stable it is evidently necessary that the internal resistance of the triodes should grow when the strength of the signal falls off, and vice versa. In other words, the negative potential applied to the grids must increase when the volume of the signal falls off.

This purpose may be obtained by detecting (rectifying) the signal, and by amplifying it in a suitable manner (for instance, by a direct current amplifier) until the desired value and sense of variation is insured. The flow of the current through the plate resistance of a direct current amplifier tube will be used to polarize the grids.

Fig. 4 shows by way of example a mode of application of the invention to the regulation of an amplifier MF. The regulator system like the one shown in Fig. 2 of which the input terminals 1, 2 and the output terminals 3', 4' are indicated is inserted between the stages of medium frequency amplification schematically indicated by the boxes MF and M'F', the output tubes of the former 11, 11 and the input tubes of the second 12, 12 being diagrammatically indicated by their grid and plate electrodes. B represents the plate supply of the tubes, and C the grid biasing source. The potential actuating the regulator tubes is furnished from the direct current amplifier represented by the relay tubes R, R' coupled by resistance with plate counter batteries, and excited by the detected current at the output end of the amplifier M'F' in line with a well-known scheme which is but partly shown in Fig. 4.

The modus operandi of the device is as follows: The incoming signal is amplified by amplifier MF, and then detected. Part of the detected current is supplied to the direct current amplifier which constitutes means adapted to make the potential dependent only upon the carrier wave with preclusion of modulation, and which at the output end results in an amplified potential adapted to strongly polarize the tubes 6. These tubes shunt one stage of amplification 11. When the incoming carrier wave varies in one sense or the other the resistance of the tubes 6 varies in suitable sense to produce a variation in the amplification inverse to that of the incoming signal. In virtue of the arrangement of the invention it is feasible to secure a wide range of variations of the amplification without an incidental distortion of the incoming signal.

Such a regulation system wherein all impedances are pure resistances is particularly advantageous for controlling a radio frequency or audio amplifier without introducing non-linear distortion, or distortion of supplemental frequency. It will be understood that the triodes 6 may be replaced by a tetrode or pentode whose characteristics occasionally are of greater advantage.

It is evident that the circuit arrangements hereinbefore disclosed are capable of a number of modifications without departing from the basic spirit of the invention. For instance, the plates of tubes 6 may be furnished with potential by 1 and 2, 3, 4 or 3', 4' by the aid of blocking impedance, or directly by the system itself as

shown in Fig. 4. While the system has here been shown as comprising resistances, the latter could be replaced by reactance, either inductive or capacitive, at least for the impedances 8 of Fig. 2, and 18, 9, 10 of Fig. 3 as shown in Fig. 2a.

What I claim is:

1. In a receiver, cascaded amplifiers of super-audible frequency, each thereof comprising a pair of tubes in push-pull, means for detection connected with the output of the amplifiers, a coupling means inserted in the cascade and comprising a pair of tubes in parallel whose plates are associated with the plates of the amplifier below, an assembly of symmetric impedances interconnecting each plate of the preceding amplifier stage with the plate of an opposite coupling tube, connections between points of each of these impedances which are at alternating zero potential when the internal impedances of the said coupling tubes are at a minimum and the input of the next amplifying stage and means for applying the output currents of the detection means to the grids of the said coupling tubes.

2. In a receiver, a cascade of amplifiers of high frequency, each comprising a pair of tubes in push-pull, means for detection connected with the output of the amplifiers, a coupling element inserted in the cascade and comprising a pair of tubes in parallel whose plates are associated with the plates of the preceding amplifier stage, an assembly of symmetric impedances interconnecting each plate of the preceding amplifier stage with the plate of an opposite coupling tube, other impedances interconnecting the plates of the preceding amplifier stage, connections between points of each of the said first-mentioned impedances which are at alternating zero potential when the internal impedances of the said coupling tubes are at a minimum and the input of the next amplifier stage, and means for feeding the output current of the detection means to the grids of the said coupling tubes.

3. In a receiver, a cascade of amplifiers of high frequency, comprising each a pair of push-pull tubes, means for detection connected with the output of the amplifiers, a coupling element inserted in the cascade and comprising a pair of tubes in parallel whose plates are associated with the plates of the preceding amplifier stage, an assembly of symmetric impedances interconnecting each plate of the preceding amplifier stage with the plate of an opposite coupling tube, connections between points of each of these impedances which are at alternating zero potential when the internal impedances of the said coupling tubes are at a minimum, and the input of the next amplifier stage, means for amplification of the current at the output end of the detection means, and means for feeding the amplified current to the grids of the said coupling tubes.

4. In a receiver, a cascade of amplifiers of high frequency, each comprising a pair of push-pull tubes, means for detection connected with the output of the amplifiers, a coupling element inserted in the cascade and comprising a pair of tubes excited in parallel whose plates are associated with the plates of the preceding amplifier stage, an assembly of symmetric impedances interconnecting each plate of the preceding amplifier stage with the plate of an opposite coupling tube, other impedances interconnecting the plates of the preceding amplifier stage, third impedances inserted between each plate of the preceding amplifier stage and the plate of the coupling tube

on the same side, connections between points of each of the said first-mentioned impedances which are at alternating zero potential when the internal impedances of the said coupling tubes are at a minimum and the input of the next amplifier stage, and means for feeding the output current of the detection means to the grids of the said coupling tubes.

5 In an anti-fading receiver, amplifiers of high frequency each comprising a pair of push-pull tubes, means for detection connected with the output of the amplifiers, a coupling element inserted in the cascade and comprising a pair of tubes excited in parallel whose plates are associated with the plates of the preceding amplifier stage, an assembly of symmetric impedances interconnecting each plate of the preceding ampli-

fier stage with the plate of an opposite coupling tube, other impedances interconnecting the plates of the preceding amplifier stage, third impedances inserted between each plate of the preceding amplifier stage and the plate of the coupling tube being on the same side, each of the said first mentioned impedances being equal to the sum total of one of the said third impedances and the internal resistance of a coupling tube, connections between the points of the said first-mentioned impedances separated from the plate by the impedance equal to the said third impedance and the input of the following amplifier stage, and means for feeding the output current of the detection means to the grids of the said coupling tubes.

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20	95
25	100
30	105
35	110
40	115
45	120
50	125
55	130
60	135
65	140
70	145
75	150