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2,263,165

SUPPRESSION OF DISTURBANCES IN RADIO RECEIVING SETS

Filed Aug. 23, 1938

3 Sheets-Sheet 1

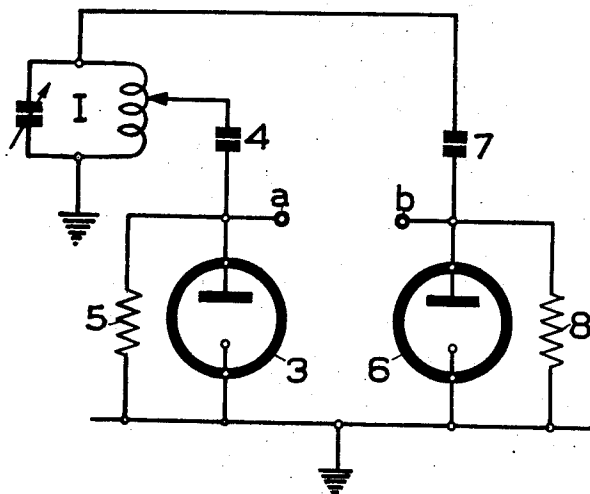


Fig.1.

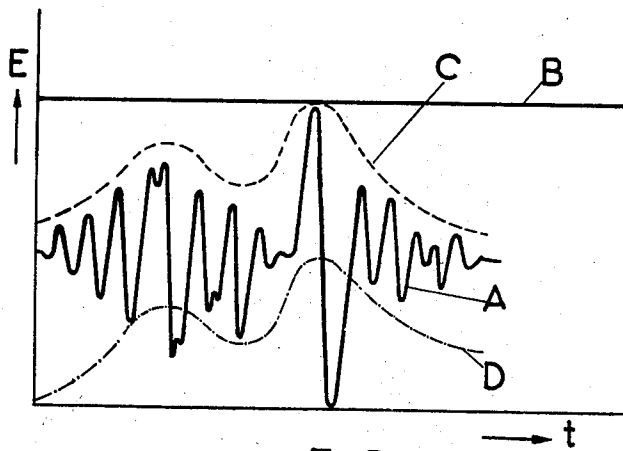


Fig.2.

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3 Sheets-Sheet 2

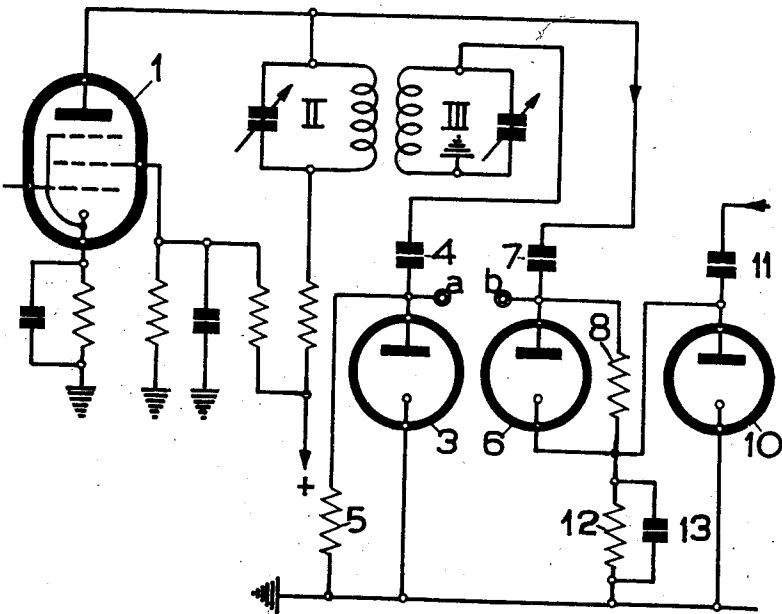


Fig.3.

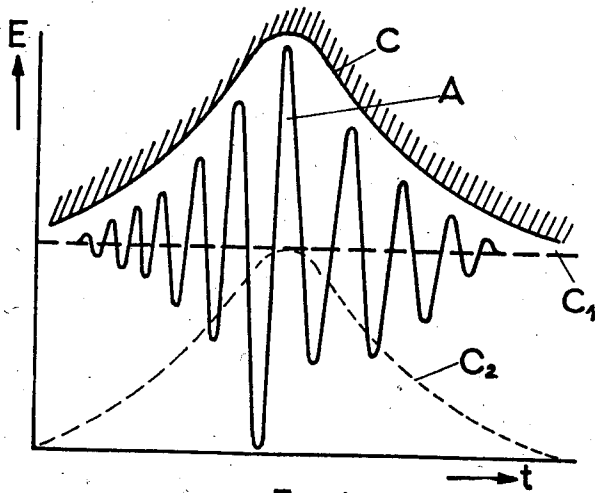


Fig.4

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3 Sheets-Sheet 3

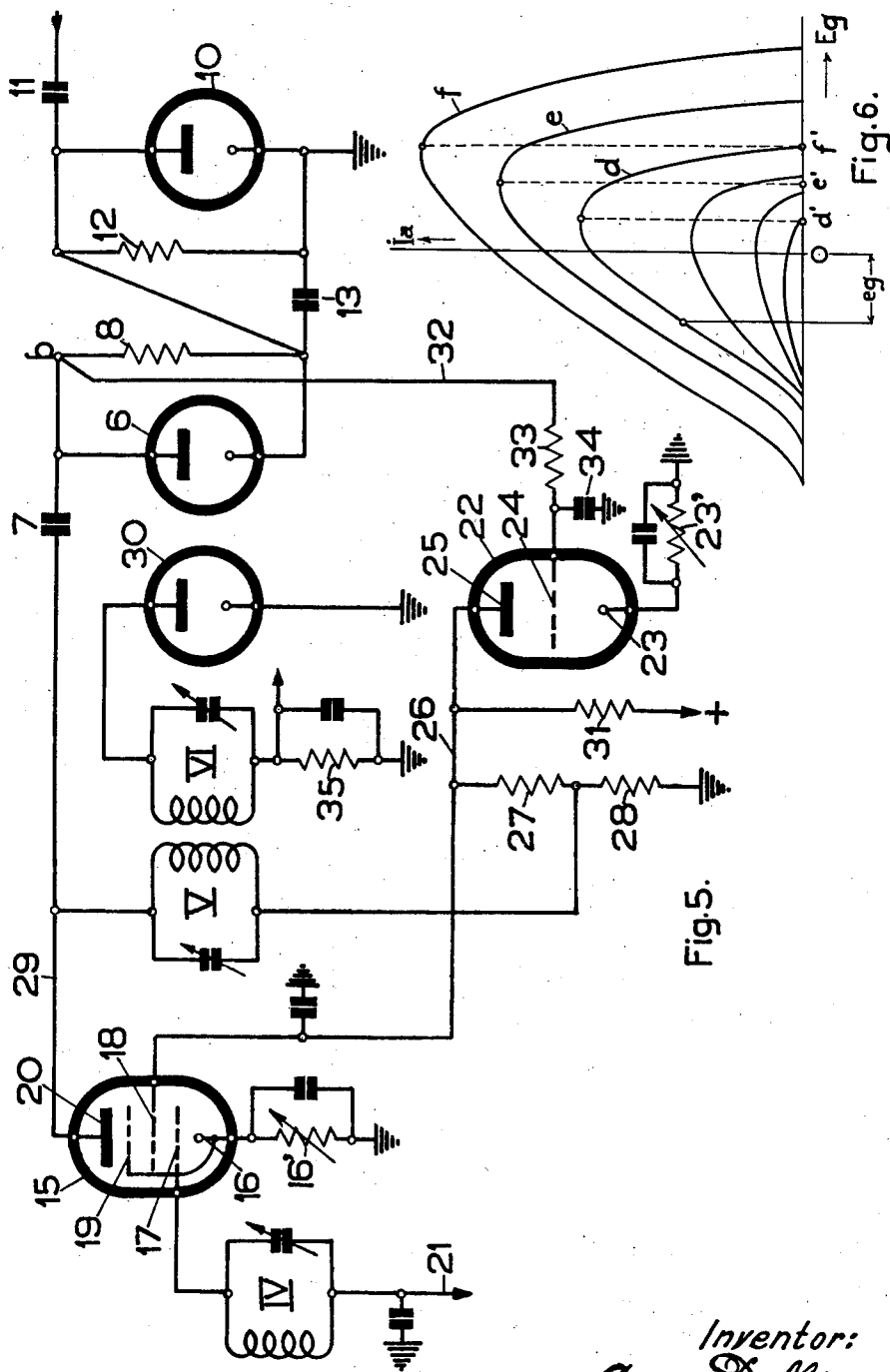


Fig. 5.

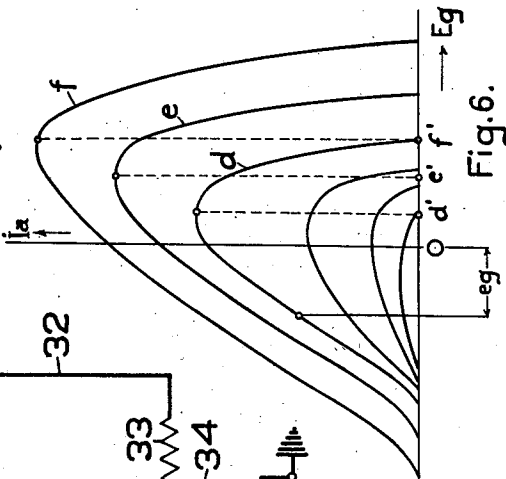


Fig. 6.

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UNITED STATES PATENT OFFICE

2,263,165

SUPPRESSION OF DISTURBANCES IN RADIO RECEIVING SETS

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Application August 23, 1938, Serial No. 226,233
In Hungary May 6, 1938

4 Claims. (Cl. 250—20)

My invention relates to the reception of radio signals and more especially to means for suppressing disturbances in radio receiving sets.

In the known methods for suppressing disturbances, which have for their object to limit the amplitude or to block the receiver for the duration of the disturbance, the limiting potential as a rule is proportional to the field intensity, is of constant level and has a value such that an amplitude exceeding the 100 per cent modulation (the so-called interfering amplitude) cannot arise in the receiver or that the receiver is blocked as soon as the oscillation amplitude rises beyond the 100 per cent modulation. These methods involve the disadvantage that the limiting potential is not capable of following the fluctuations of the amplitude of the alternating potential to be limited, i. e. the modulation percentage.

Other methods which are superior to those referred to above, have been suggested wherein the limiting potential is proportional to the modulation percentage, however, according to these methods the suppression of disturbances can be effected only in the low frequency stage and in such manner that the potential obtained by rectification of the modulated high frequency carrier wave and fluctuating in accordance with the modulation is repeatedly rectified, thereafter filtered and the voltage thus obtained then fed to the limiting member as counter-voltage. However, since for many reasons it is more advantageous to effect the suppression of disturbances in the high frequency stage, it appeared desirable to adapt these methods for utilization in connection with the high frequency stage.

It is an object of this invention to solve this problem. To this end disturbances, which exceed a predetermined peak value (the so-called disturbance suppression level) are suppressed, for the duration of the disturbance, by means of limitation of the amplitude or by blocking the receiver, the biasing potential serving for adjusting the disturbance suppression level being produced, according to this invention, by the combination of two voltages, one of which is proportional to the mean amplitude of the carrier wave, while the other follows the fluctuation of the enveloping characteristic of the modulation.

In this method one voltage component may be generated by rectifying the modulated carrier wave in a circuit capable of following only such fluctuations as are slower than the modulation, while the other voltage component may be produced by repeatedly rectifying the modulating

voltage, obtained by the usual rectification of the carrier wave, in a circuit capable of following the fluctuations of the enveloping characteristic of the modulation. In a preferred embodiment of this method one of the voltage components is produced by rectifying and filtering the modulated carrier wave, while the other voltage component is obtained by repeatedly rectifying and filtering the modulating voltage received in the first mentioned rectification.

My invention also relates to circuit arrangements for carrying out this method.

In the drawings affixed to this specification and forming part thereof the method and arrangements according to this invention are illustrated diagrammatically by way of example. To this end the drawings also contain an illustration of one of the arrangements described and claimed in one of my copending applications filed of even date herewith.

In the drawings:

Fig. 1 is a circuit diagram of the arrangement already disclosed in the copending application and

Fig. 2 a diagram illustrating the mode of action of this arrangement.

Fig. 3 is a circuit diagram of an arrangement adapted for carrying out the method according to this invention,

Fig. 4 being a diagram serving to explain the mode of action of the arrangement of Fig. 3.

Fig. 5 illustrates a modified form of an arrangement for carrying out the method according to this invention and

Fig. 6 is a diagram illustrating a group of characteristics which represent the principle of action of the limiting valve forming part of the arrangement of Fig. 5.

In the several figures identical parts and parts having an identical action are marked with identical reference numerals.

Referring to the drawings and first to Fig. 1, 3 and 6 are two diodes arranged in a circuit and connected to a signal stage I forming the source of current, each diode together with the resistances 5 and 8 and condensers 4 and 7, respectively, forming an arm of the circuit. The time constants of the two arms are so chosen that only the rectified voltage arising across the resistance 5 of the so-called "quick" arm (3, 4, 5) is able to follow the signal modulation, while the rectified voltage arising across the resistance 8 of the other ("slow") arm (6, 7, 8) can follow only slower fluctuations. The arms are so coupled with the signal stage that this latter feeds to the

quick arm only half the alternating potential it supplies to the slow arm.

In Fig. 2 the rectified voltages arising at the output terminals *a*, *b* of the circuit arms are plotted as functions of the time. The curve A illustrates the voltage arising at point *a* and corresponding to the modulation of the carrier wave, while line B indicates the slowly fluctuating voltage (the so-called "level of the disturbance suppression") arising at point *b* and corresponding to the mean amplitude of the carrier wave. During undisturbed reception, i. e. up to a 100 per cent modulation, the point *b* is always more negative than the point *a*, so that the curve A extends below the line B. When a disturbance arises, the voltage at point *a* rises suddenly, since the quick arm follows the fluctuations of the modulation, while the voltage at point *b* remains unchanged, because the slow arm is not able to follow the fluctuations of the modulation. Thus in this case point *a* will be more negative than point *b*, the relative polarity of the two points will be reversed and the curve A will rise above the level B. This variation of polarity can be used for suppressing disturbances.

As explained at the beginning, a more sensitive suppression of disturbances can be obtained if the level of the disturbance suppression indicated by line B is in accordance with the prevailing percentage of modulation, i. e. in accordance with the curve C drawn in dashes, which corresponds to the enveloping characteristic of the modulation.

In order to realise this, it does not suffice to supply the slow arm only with a rectified and filtered low frequency voltage, i. e. with a voltage fluctuating according to the enveloping characteristic of the modulation, as under these conditions the voltage at point *b* would follow the curve D shown in dot and dash lines and this would obviously not satisfy the requirements, since in the case of a disturbance the desired change of polarity would not occur. If the slow arm were supplied the same voltage as the quick arm the desired result would not be obtained either, since in this case the voltage at point *b* would take an outline such as might be indicated by the axis of the curve A, with the result that whenever the high frequency were fully modulated, the point *a* would already become more negative than point *b* and in the case of a disturbance the desired change of polarity would not occur either. If, however, the two effects are combined according to this invention, the desired more sensitive suppression of disturbances will be obtained.

Therefore, according to this invention, to the voltage arising at the point *b* of the slow arm of the circuit, which is proportional to the mean amplitude of the carrier wave, another voltage is added, which is proportional to the variation of the percentage of modulation in each individual case and both arms of the circuit, the quick and the slow one, are supplied with equal voltages.

An arrangement adapted for carrying out this method is shown in Fig. 3, in which the circuits of the quick and the slow arms correspond to those shown in Fig. 1, however with the difference that voltages of equal magnitude are fed to the slow arm from the anode circuit II of the high frequency amplifier I, and to the quick arm from the oscillatory circuit III coupled to this anode circuit II. According to the invention now a further circuit is connected to the slow arm,

this further circuit comprising a diode 10, a condenser 11 and a resistance 12, which latter is shunted by a condenser 13 in order to earth the cathode of the diode 6 with respect to high frequencies. The load resistance 12 is connected in series with the load resistance 8 of the slow arm of the circuit. The diode 10 is supplied, by way of the condenser 11, with audio frequency voltage which is rectified in the diode 10. The condenser 11 and resistance 12 are so chosen, that the time constant of the circuit is about $\frac{1}{40}$ sec., i. e. the time required for producing a recognizable sound. Instead of adjusting the time constant, the same effect may be obtained by corresponding filtration. Across the resistance 12 there thus appears a rectified voltage which is proportional to the variation of the percentage of modulation, thus corresponding to the enveloping characteristic of the latter.

This voltage is added to the slowly fluctuating voltage arising across the resistance 8 which is proportional to the mean amplitude of the carrier, so that the resulting voltage arising at the point *b* relative to the earth potential, i. e. the disturbance suppression level, the outline of which is indicated by the curve C of Fig. 4, consists of the sum of the voltage C_1 arising across the resistance 8 and the voltage C_2 arising across the resistance 12.

In other respects the disturbance suppression is effected in the arrangement according to Fig. 3 in a similar manner as described with reference to Fig. 1. During undisturbed reception the point *b* is more negative than point *a*, but as soon as a peak value of the disturbances exceeding the level of suppression of disturbances arises, the relative polarity of the two points is reversed and this reversal of polarity (difference of potential) is then utilized for the purposes of suppressing the disturbances.

Fig. 5 illustrates another arrangement serving for suppressing disturbances according to this invention. This arrangement includes an amplitude limiting device 15 being a pentode comprising a cathode 16, a control grid 17, a screen grid 18, a suppressor grid 19 connected to the cathode and an anode 20. To the cathode 16 there is connected the variable resistance 16'. The control grid 17 is for instance connected to an oscillatory circuit IV coupled to an intermediate frequency amplifier stage, to which oscillatory circuit a conductor 21 is connected which leads the source of biasing potential. A triode 22 is connected in parallel to the valve 15 with respect to the direct voltage, this triode comprising a cathode 23 with resistance 23', a control grid 24 and an anode 25, to which the anode voltage is fed by way of a resistance 31. Between the conductor 26 leading to the anode and earth there are inserted two resistances 27 and 28 connected in series and forming a potentiometer, the connecting point of which resistances is connected to the oscillatory circuit V which in turn is connected by a conductor 29 to the anode of the tube 15. The conductor 26 is connected with the earthed screen grid 18 of tube 15. The oscillatory circuit V is coupled with an earthed oscillatory circuit VI, which is connected to the signal rectifying diode 30. From the load resistance 35 of this diode the audio frequency can be taken off.

The conductor 29 of the tube 15 is connected by means of the condenser 7 to the slow diode 6 (Fig. 3), which comprises a load resistance 8. The time constant determined by the condenser

7 and load resistance 8 is so chosen that the rectified voltage arising across the resistance 8 cannot follow the signal modulation, with the result that across this resistance a slowly fluctuating voltage corresponding to the mean amplitude of the carrier is formed. Similarly as in Fig. 3 there is connected to the diode 6 a diode 10 which, through condenser 11, is fed with audio frequencies; the load resistance 12, shunted by the condenser 13, of this diode 10 is connected in series with the resistance 8. Here also the time constant determined by the condenser 11 and resistance 12 is so chosen that across the resistance 12 a voltage arises which corresponds to the enveloping characteristic of the audio frequencies. Between the point *b* of the resistance 8 and the earthed end of the resistance 12 there is thus formed the composite voltage mentioned above, which is supplied, through the earthed condenser 34 which is connected through a conductor 32 and filter resistance 33 to the point *b*, as biasing potential to the control grid 24 of the triode 22.

Before explaining the operation of this arrangement, the mode of action of the limiting tube 15 shall be explained. If the anode 20 of this tube is fed in succession with voltages of varying magnitude amounting to e. g. only one half of the voltage applied to the screen grid 18, there will be obtained a series, illustrated in Fig. 6, of almost parallelly displaced anode current-grid voltage-characteristics (I_a-E_g). As shown in Fig. 6, in the case of the curves *d*, *e*, *f*, the anode current reaches its maximum at the grid voltages *d'*, *e'*, *f'*, respectively, while beyond the maximum it falls off in a steep curve. Therefore, if the working point is adjusted by a biasing voltage e_g fed to the control grid 17, the anode current will rise up to a predetermined amplitude of oscillation and beyond this will suddenly drop to zero. In order to attain a sensitive suppression of disturbances, the operation of the tube must be so controlled in each case that, if higher amplitudes shall be limited, the tube will operate according to a more raised characteristic, such as *f*, and if smaller amplitudes shall be limited, according to a less raised characteristic, such as *d*, and that, at the same time, the working point of the tube is adjusted correctly in each case.

In accordance with this invention this control is effected by means of the triode 22. If a more intense current flows through this triode, a greater drop of potential arises across the resistances 27, 28. In consequence thereof a smaller voltage will be fed to the screen grid 18 of the tube 15 through the conductor 26 and to the anode 20 through the oscillatory circuit V and conductor 29 with the result so that the characteristic in Fig. 6 is shifted to the left, in the direction of curve *d*. If, however, the current passing through the triode should drop, then the characteristic of the tube 15 will similarly be shifted to the right in the direction of curve *f*. In each case, the anode 20 will receive a smaller voltage, for instance only half the voltage supplied to the screen grid 18.

The intensity of the current passing through the triode 22 is influenced by the biasing potential of the control grid 24, which depends, as mentioned above, on the composite potential arising across the condenser 34. If this composite potential drops in proportion as the signal amplitudes drop, the negative grid biasing voltage of the triode 22 will drop correspondingly

and so will the current of the triode, with the result that the anode 20 and the screen grid 18 of the tube 15 will receive a smaller voltage. On the other hand, with rising signal amplitudes, a higher voltage will be fed to the anode 20 and screen grid 18 of the tube 15. The characteristic of the tube 15 will thus follow exactly the variation of the modulation, i. e. the tube 15 will operate, in the case of smaller signal amplitudes, for instance according to curve *d*, in the case of higher signal amplitudes, for instance according to curve *f*. The suitable working point of tube 15 is adjusted by the biasing voltage supplied through the conductor 21. Obviously the suppression of disturbances according to this invention can also be carried out with arrangements other than those above described, it being only important to operate in accordance with the fundamental idea underlying the invention, according to which the biasing voltage serving for adjusting the level of suppression of disturbances is produced by combining two voltages, one of which is proportional to the mean amplitude of the carrier while the other follows the enveloping characteristic of the modulation.

Obviously the invention may be used for producing the biasing voltage either with an ordinary limiting device or with a push pull limiting device.

I wish it to be understood that I do not desire to be limited to the exact details of construction shown and described for obvious modifications will occur to a person skilled in the art.

I claim:

1. In the method of suppressing disturbances arising in a radio receiving system and exceeding a certain threshold value determined by the percentage of modulation of the carrier wave received, in combination, the steps of producing a voltage proportional to the mean amplitude of the carrier wave by rectifying the modulated carrier wave and filtering the same, producing another voltage following the fluctuations of the enveloping characteristic of the modulation by rectifying and filtering the modulation voltage obtained by demodulation of the carrier wave, adding said voltages to each other and using the resulting voltage as biasing voltage to adjust said threshold value.

2. A circuit arrangement for suppressing disturbances arising in radio receiving sets and exceeding a peak value determined by the percentage of modulation of the carrier wave received, comprising in combination, a signal stage forming the source of current, two rectifier systems coupled to said source of current, each including a resistance and a condenser, arranged in co-operative connection, one of said systems forming the quick arm, and the other system forming the slow arm of said connection, the quick arm having means causing the rectified voltage appearing across its resistance to follow the signal modulations, the slow arm having means causing the rectified voltage appearing across its resistance to respond only to slower fluctuations, a circuit comprising a rectifier, a condenser and a resistance connected to said slow arm and adapted to follow the fluctuations of the enveloping characteristic of the modulation, said last-named resistance being connected in series to the resistance of the slow arm, whereby to produce between two terminals of said series connection a resulting voltage which is composed of a voltage component proportional to the mean amplitude of the high frequency carrier wave and of an-

other voltage component fluctuating in accordance with the enveloping characteristic of the modulation.

3. The arrangement according to claim 2, wherein the last-named circuit which follows the fluctuations of the enveloping characteristic of the modulation, is adjusted to a corresponding time constant.

4. The arrangement according to claim 2, comprising an amplitude limiting tube and an electric discharge device connected thereto in

parallel with respect to the direct voltage, and means for supplying to said discharge device as biasing voltage that composite voltage which is composed of a voltage component proportional to the mean amplitude of the high frequency carrier wave and another voltage component fluctuating in accordance with the enveloping characteristic of the modulation, said biasing voltage controlling the working voltage of said amplitude limiting tube.

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