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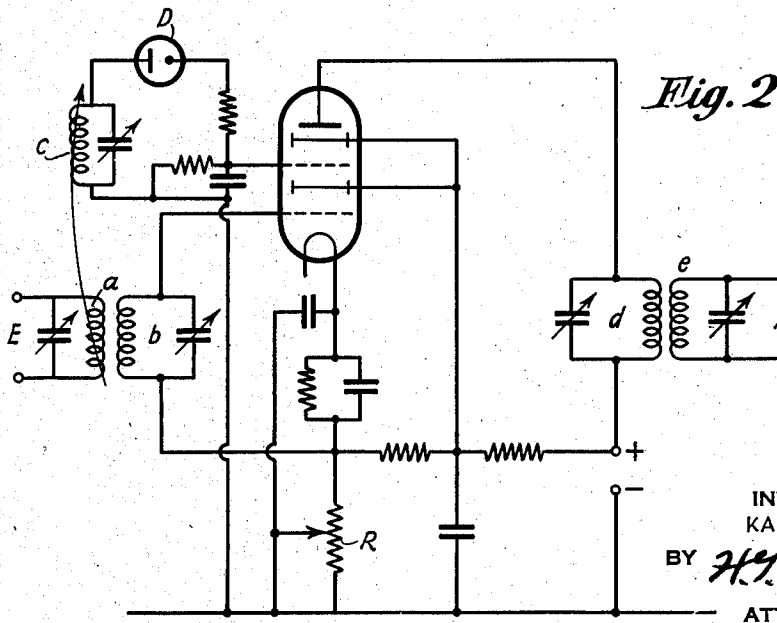
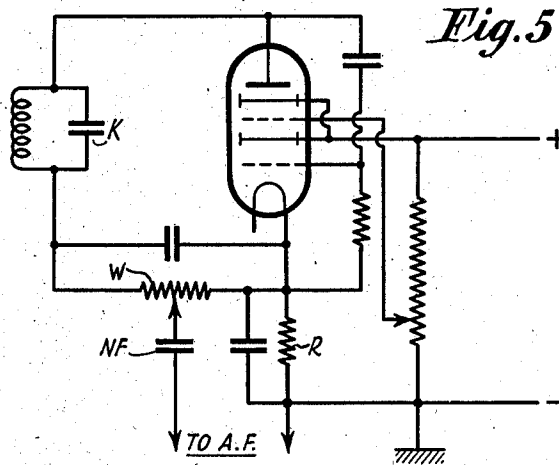
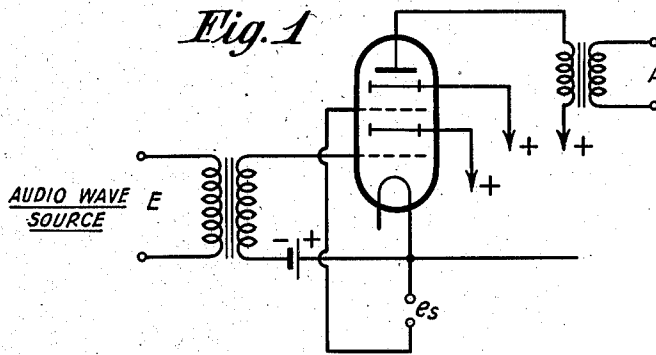
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RECEIVER NOISE QUIETING CIRCUITS

Filed May 9, 1936

2 Sheets-Sheet 1



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*Fig. 3*

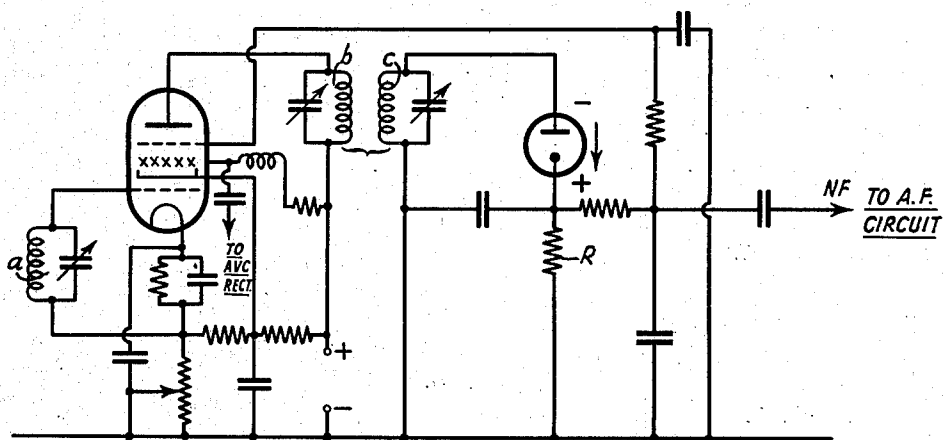
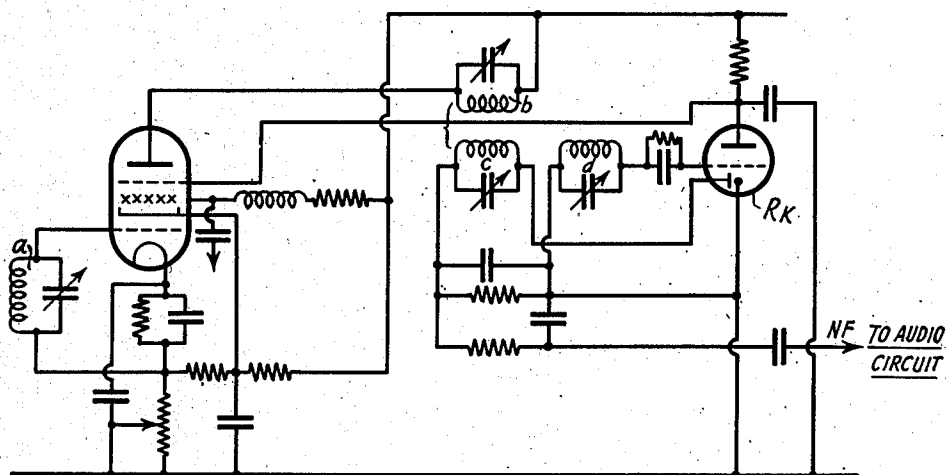


*Fig. 4*



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## UNITED STATES PATENT OFFICE

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## RECEIVER NOISE QUIETING CIRCUITS

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2 Claims. (Cl. 250—20)

This invention is concerned with receiver apparatus equipped with means adapted to insure automatic compensation of fading, or automatic volume control. Circuit organizations of this kind, as is well known from the prior art, operate in this manner that, in accordance with the incoming field intensity, an oppositely directed change in the amplification factor, or gain, is effected so that in the output of the receiver is obtained a signal strength roughly uninfluenced by fading, or signal strength fluctuations, in the input of the receiver. The result of this mode of operation is that in tuning the receiver between the positions where stations are coming in, the gain owing to the absence of a carrier wave rises to its maximum value. The consequence of this condition is that the stray noise level (atmospherics, roar, motor interference, and the like) is reproduced very markedly. Inasmuch as operation may be pushed to the very maximum power of the last, or power, stage, if the stray level is sufficiently high, it follows that the noise resulting from this situation becomes extremely annoying to the listener.

Now, in order to overcome this trouble it has been suggested in the prior art to provide blocking means in any of the stages of the receiver set whereby the gain of the entire apparatus is diminished to a very low value as long as the set has not been actually tuned to a carrier wave. The operation of the set would then be altered in such a way that, when tuning is proceeding, the same would become automatically blocked between the various stations, with the apparatus being actually turned on only upon a certain and pre-arranged minimum amplitude of incoming oscillations having been reached. Receiver sets of the said sort have come to be called "silent-tuning" sets.

With a view to solving the above problem, it has been suggested in the earlier art to impress upon the control grid of an amplifier tube contained in the receiver cascade a blocking potential, which may be eliminated or removed by a "control potential" being a function of the amplitude of the incoming oscillations. The said control, or unblocking, potential is obtained by the rectification of the incoming oscillations above any one of the stages of the receiver cascade where an adequate radio-frequency voltage is already available.

Now, these known circuit schemes have a number of drawbacks which are obviated by the invention hereinafter to be disclosed. These drawbacks consist particularly in the undesir-

able and unfavorable mingling of the two control actions inside the very tube as a result of the fact that the two voltages are impressed upon one and the same grid. For instance, if the unblocking potential is fed to the grid of a radio-frequency or intermediate-frequency amplifier, if the signal amplitudes are high, there is likelihood of the voltage peaks reaching as far as the positive voltage regions. In this case, the radio-frequency oscillation circuit associated with the grid is subject to marked damping by the incipient grid current, and this means a reduction of the sensitiveness of the receiver. Among other drawbacks may be mentioned the fact that in the above-mentioned circuit schemes, as a function of the unblocking potential, the operating point of the control grid is shifted over regions presenting greater curvature in the characteristic so that undesirable distortions and cross-modulation are inevitable.

Now, with a view to insuring quiet tuning, the scheme disclosed in the present invention comprises the use of a multi-grid type of amplifier tube for the tube which is acted upon, and in which the electrode potentials are to be chosen in such a way that the characteristic slope of a control grid is capable of being varied by the voltage prevailing at another grid, in other words "tilting" of the grid-plate transconductance (mutual conductance) about its base as a function of the said other grid voltage. Inasmuch as the various characteristics inside this circuit change should in themselves be linear, it will be noted that distortions and cross-modulation will be avoided. There, moreover, results this appreciable advantage that, without impairing the operation, the voltage at the unblocking grid may assume positive values. Inadmissible damping of the control-grid oscillation circuit is not occasioned thereby. On the contrary, there is a chance for insuring automatic limitation of the amplitude of the unblocking potential by the incipient grid current. If the resistances have been chosen suitable in the circuit of the unblocking voltage, as will be seen, the said potential will not go beyond the point of initiation of grid current flow. By suitable choice of the electrode potentials of the multi-grid tube, it is an easy matter to make conditions so that this point will coincide with the adjustment to maximum gain.

Fundamentally speaking, even a standard double-grid tube affords a chance to produce "tilting or reversing" of the characteristics, if the grid farther away from the filament is im-

pressed with the input potentials, and upon the space-charge grid are impressed the unblocking potentials; and if, furthermore, care is taken so that the latter keeps inside the region and range of the space-charge-grid potential in that an increase in the control-grid-plate current characteristic is brought about with increase of the voltage. Another improvement in the operation of the tube is assured, if between the unblocking grid and the control grid, a further screen grid, maintained at a positive potential, is provided.

This grid, on the one hand, insures a better decoupling between the input grid and the unblocking grid; while on the other hand, there is a chance of operating the unblocking-voltage grid at a negative potential over a major portion of its voltage operation range. This is desirable from the viewpoint of power supply output, for the potential source provided for said unblocking grid. It will be understood, of course, that the "sticking" or "tacking" of the unblocking voltage at the point of incipient grid-current flow will be found useful also in the connection with this arrangement. In order that variation of the internal resistance of the tube as a function of the unblocking potential, in a three-grid tube (pentode) may be avoided, another object of this invention is to dispose between the outer unblocking or control grids and the plate a further, that is to say, a fourth grid which is to act as a screen grid. By the operation and action of this latter grid, all harmful changes in internal resistances will be precluded.

In the drawings:

Fig. 1 shows a circuit arrangement of one form of the invention,

Fig. 2 illustrates an alternative circuit,

Fig. 3 is a circuit diagram of another alternative arrangement,

Fig. 4 shows a modification of the arrangement in Fig. 3, and

Fig. 5 is still another modification.

In Fig. 1 an exemplified embodiment of the invention is illustrated, this form of construction applying to the case where the unblocking potential is fed to and impressed upon an audio-frequency amplifier tube. In this scheme, the first grid (figured from the filament) acts as the control grid for the transmitted (or signal) oscillations; the second grid acts as a screen grid, and the same is kept at a constant positive potential; the third grid is impressed with the unblocking voltages; the fourth grid acts as a screen grid, while at the plate are made available the amplified oscillations. Owing to the equivalency of the first and the third hexode grid, the circuit scheme could in this instance also be modified in this way that the unblocking potential is fed to the grid adjacent the cathode, and the incoming, or input, potentials to the third grid. As can be seen from the above considerations, the unblocking grid, in quiescent or non-operative (unexcited) state must be negatively biased to such an extent that the gain will be entirely eliminated or at least be reduced a few decimals. The said biasing voltage is suitably obtained across a resistance inserted in the filament circuit of the tube, and this resistance is preferably made variable so as to make the threshold value of action changeable.

Fig. 2 shows an embodiment of the invention in schematic form which indicates also the mode of furnishing the unblocking voltage. Referring to this figure, suppose that  $a$  is the plate oscilla-

tion circuit, carrying intermediate-frequency current, of a tube preceding the stage in which the unblocking action is to be produced. Coupled with the said circuit  $a$  are the circuits  $b$  and  $c$ ,  $b$  pertaining to the control grid and  $c$  to the circuit of rectifier  $D$  by the action of which the unblocking potential is obtained from the intermediate-frequency oscillations. The circuits  $d$  and  $e$  serve to transfer the amplified oscillations to the next receiver stage.

For the proper operation of all circuits and actions for quiet tuning, it is important that the unblocking action (contra-distinct to the mode of operation of automatic volume control) should be caused to become operative quite suddenly upon the presence of a certain pre-arranged minimum amplitude of the incoming oscillations, while being discontinued just as suddenly when the incoming amplitudes fall below the said minimum. In an extreme instance, it may be even desirable in this connection to accomplish this action only when and as the receiver has been correctly set, i. e. has been actually tuned to the carrier wave.

Fig. 3 shows an exemplified embodiment in which the first one of the two problems above referred to, namely, the abrupt initiation and discontinuance of the unblocking potential is solved. The process is produced by the aid of a four-grid tube which may be included in the radio-frequency, or the intermediate-frequency, amplifier. The first grid serves as the control grid, the second acts as a screen grid and is maintained at a positive potential. From the third grid operating as an auxiliary plate are taken off the amplified radio-frequency, or intermediate-frequency, oscillations, and fed to the rectifier which is to furnish the gain regulating voltage. The fourth grid (figured and counted from the cathode) is the unblocking-voltage grid properly so-called. What is essential in the circuit organization here shown is that the signal voltages fed to the rectifier intended for handling the unblocking voltage are taken from the plate circuit of a tube which itself is influenced by the unblocking voltage as regard the amplifier process. What results therefrom is a spontaneously growing inter-action between a growth of input amplitude and the resultant growth of unblocking voltage and gain variation.

Fig. 4 shows a further evolution of the circuit arrangement shown in Fig. 3, in which also the second one of the problems above mentioned, namely, actuation only in the presence of proper tuning, has been solved. The operation of the multi-grid tube in this scheme, however, is unchanged in comparison with Fig. 3. From the plate circuit  $b$  the amplified oscillations are fed to the circuits  $c$  and  $d$  which belong to the combination tube  $R_k$ . The latter contains a diode and a triode system, and the same is connected in such a way that the diode system demodulates the oscillations coming from  $c$ , while the triode system, in audio connection, rectifies (by grid detection) the oscillations coming from  $d$  for the production of the unblocking voltage. Now, there is a chance to make the coupling of circuit  $d$  pertaining to the rectifier, providing the unblocking potential looser than  $c$ , and to make the damping thereof lower. If desired, this circuit may be regenerated also artificially. The practical result thereof is that the actuating process will really be caused to become operative only in the presence of proper tuning.

The exemplified embodiment in Fig. 4, with-

out any special expenditure and provision of circuit means, fulfills the above-mentioned requirements, and it exemplifies in what way the three rectifier processes which have to be distinguished from one another, namely, rectification to result in the regulator voltage for automatic volume control (decrease of radio-frequency or intermediate-frequency energy at  $G_3$  of the hexode), rectification for producing the audio-frequency (oscillation circuit *c*, diode), and rectification for the production of the unblocking voltage (oscillation circuit *d*, grid-rectifier contained in combination tube), may be united inside one and the same circuit organization.

Another circuit organization associated with a four-grid tube in which the unblocking voltage is obtained by rectification of signal oscillations inside one and the same tube is illustrated in Fig. 5. In this circuit arrangement, two electrode paths of the tube are employed to act as diode rectifiers, that is to say, the path between the cathode and the first grid for the production of the unblocking potential, and the path between cathode and plate for the object of demodulation. The second and the fourth grids are screen grids, and they may be inter-connected. The screen-grid voltage and the voltage for the third grid are adjusted to suitable values so that both the cathode as well as the third grid will have a positive potential to ground. When an oscillation having the same frequency as the resonant circuit *K* is fed into this circuit, then by grid rectification in the diode path filament and first grid (audion) the current flowing through the tube and through the filament resistance *R* is diminished.

As a consequence, also, the drop of potential across the resistance *R* decreases, while the potential difference between the third grid and the filament is altered in such a sense that the third grid which acts as a stopper grid for the plate current, becomes then more positive in reference to the cathode. As a result, a larger current is directed towards the plate from the virtual cathode formed by the third grid; in other words, the characteristic of the tube (mutual conductance) becomes steeper. Thus, the effectiveness of rec-

tification between cathode and plate is increased so that a demodulation of the incoming oscillations between plate and cathode is produced. The audio-frequency may be taken off between the slide of resistance *W* and ground.

What is claimed is:

1. In a wave transmission system, a transmission tube of the type including at least a cathode and at least two cold electrodes arranged in the electron stream therefrom, a wave input circuit connected between one of the cold electrodes and the cathode, means for establishing the second cold electrode at a direct current potential with respect to said cathode such that the gain of the tube is a minimum when the wave amplitude is a minimum, and additional means responsive to amplitude increase of waves for varying said direct current potential of the second cold electrode in a polarity sense such as to oppose the said gain-reducing effect, an output electrode in said tube, a wave output circuit connected between the cathode and output electrode, said additional responsive means including a wave rectifier having an input circuit reactively coupled to said output circuit, and said two cold electrodes being disposed in the electron stream between the cathode and output electrode.

2. In a wave transmission system, a transmission tube of the type including at least a cathode and at least two cold electrodes arranged in the electron stream therefrom, a wave input circuit connected between one of the cold electrodes and the cathode, means for establishing the second cold electrode at a direct current potential with respect to said cathode such that the gain of the tube is a minimum when the wave amplitude is a minimum, and additional means responsive to amplitude increase of waves for varying said direct current potential of the second cold electrode in a polarity sense such as to oppose the said gain reducing effect, said tube including an output plate, a tuned wave output circuit connected to the plate, and said additional responsive means including a wave rectifier having an input circuit tuned to the wave frequency of said output circuit and coupled to said output circuit.

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