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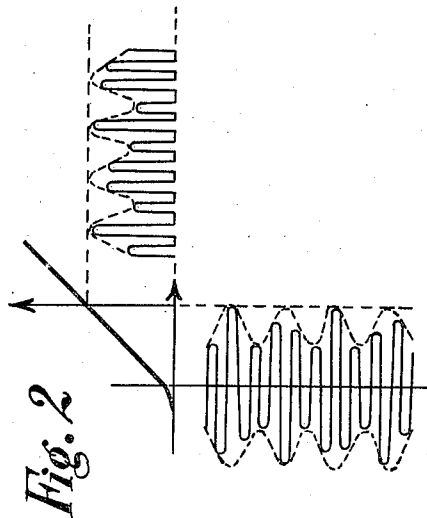
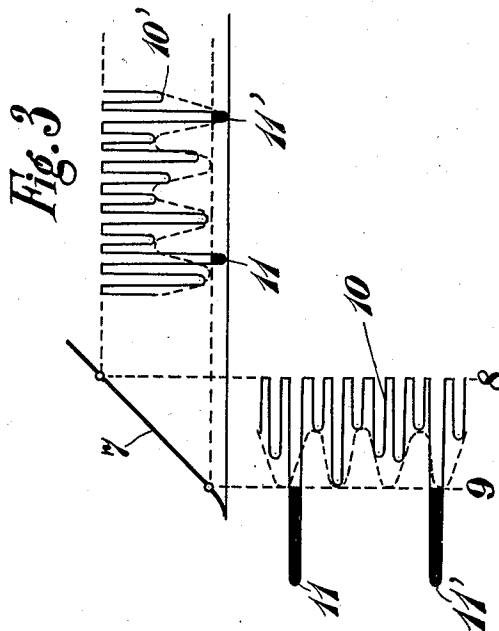
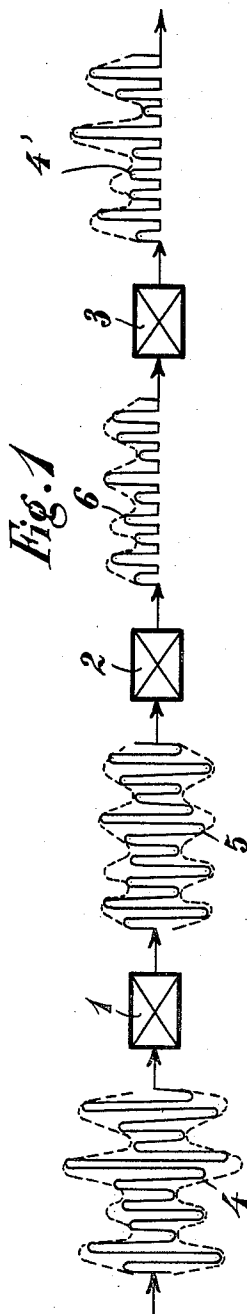
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METHOD AND MEANS FOR REDUCING DISTURBANCES IN WIRELESS RECEPTION

Filed July 20, 1938

2 Sheets-Sheet 1



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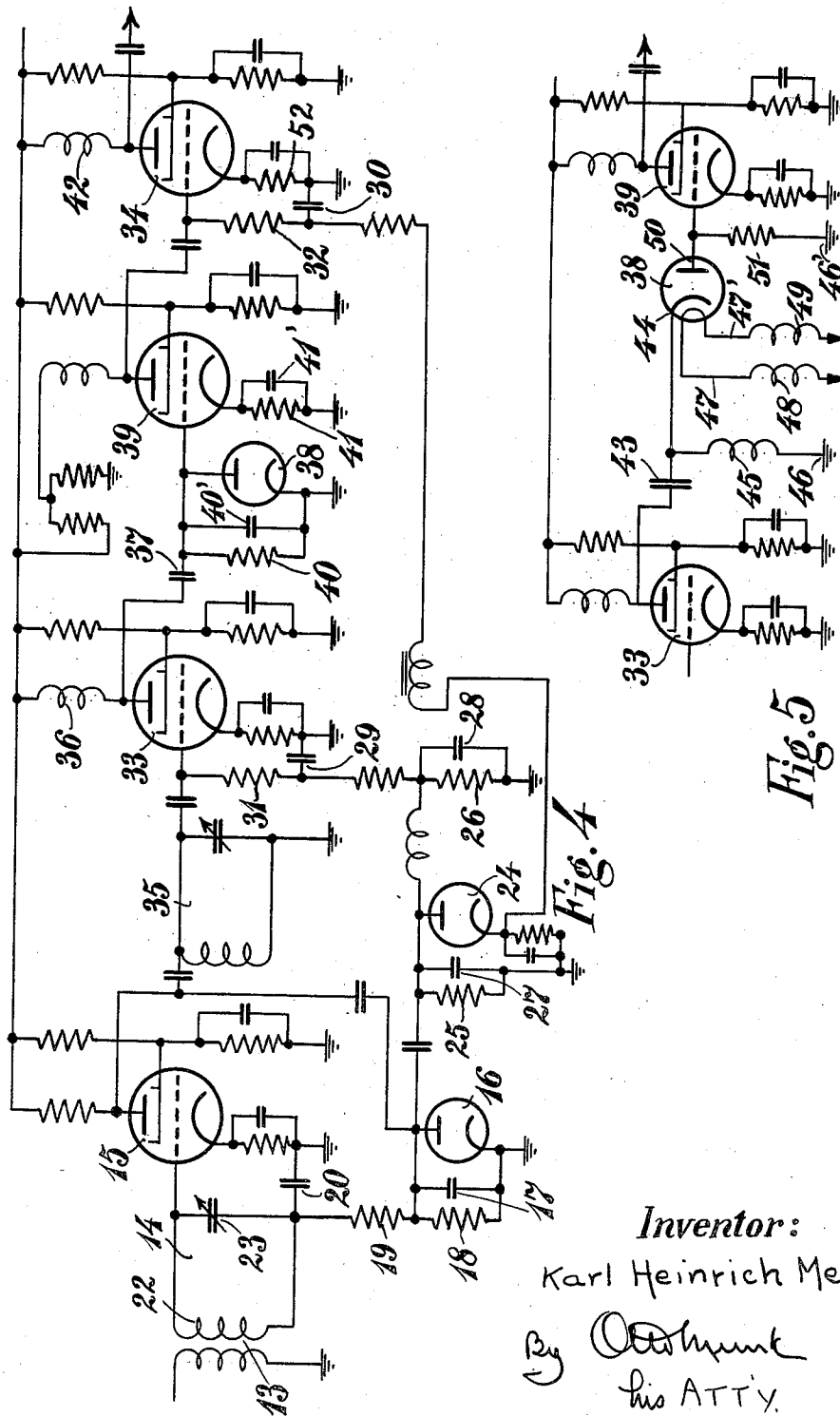
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METHOD AND MEANS FOR REDUCING DISTURBANCES IN WIRELESS RECEPTION

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UNITED STATES PATENT OFFICE

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METHOD AND MEANS FOR REDUCING DISTURBANCES IN WIRELESS RECEPTION

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4 Claims. (Cl. 250—20)

High frequency disturbances which become superimposed upon a transmission are regarded as particularly troublesome and unpleasant if the noise intensity resulting therefrom exceeds considerably the momentary sound intensity of the transmission. With local storms at the reception point, the electrical disturbance phenomena accompanying the storm may assume such high values that the resulting noise intensity produces a sensation of pain in the listener. In general conditions are considerably better than this since such high disturbance voltages are as a rule only present under abnormal conditions. Nevertheless, even under more favourable reception conditions, there may still arise a few disturbance voltage peaks per second, which substantially exceed the transmission in their intensity.

The present invention relates to a method and an arrangement for carrying this method into effect, by which all suddenly occurring disturbance voltage peaks which exceed in amplitude the transmitter amplitudes are cut off or limited in amplitude to such an extent that the amplitudes of these disturbance voltages can no longer substantially exceed the instantaneous amplitude value of the transmission.

The method of suppressing high voltage peaks is carried out, according to the invention, by arranging that the transmission is maintained, by means of a control device constructed as a compressor, at a constant sound intensity, that is to say is controlled to a constant mean amplitude value, that is to say is smoothed, that the low frequency components of the transmission, controlled to a constant mean amplitude value, are impressed upon the grid circuit of an amplifier tube, connected as amplitude filter, in such a way that the whole straight part of the grid characteristic is swept over, the amplitude filter being impassable on account of cessation or saturation of the anode current by voltages which are greater than the range of grid swing, and that the low frequency components of the transmission which are allowed to pass through the amplitude filter are influenced by a second control device constituted by an expander in such a manner that the smoothing of the variations in sound intensity effected by the compressor stage is compensated for in such a manner that the original variations in sound intensity are re-established in the transmission.

The high frequency influences upon wireless receiving apparatus, in general known as disturbances of reception, are composed of indi-

vidual, strong, disturbance voltage peaks which become superimposed upon the signals to be received.

These disturbance voltage peaks which in general arise from atmospheric disturbances, arise from the sudden collapse of electric fields in the atmosphere (fork and sheet lightning and the like).

Whilst disturbance voltage peaks, arising from the collapse of electric fields last only for a relatively short time (of the order of 10^{-3} seconds), the variations of intensity arising from differences in sound intensity can be regarded as very slow. As example it may be mentioned that in a piece of music which is very rich in contrast, often many tenths of a second elapse before a piano part of the piece swells to fortissimo. As a rule it can therefore be assumed that variations in sound intensity which take place in less than $\frac{1}{20}$ second will arise extremely seldom.

On the other hand the control process should in any case not take place too quickly, if a cutting off of the lower frequencies is to be avoided. The time constant of this control device is therefore determined by the lowest frequency to be transmitted.

It is now clear that, relatively to the time constants of the variations in sound intensity, effects which can be regarded as exceptionally rapid will not be affected by a control arrangement which only compensates for these variations in sound intensity. Their amplitudes will not, therefore, be reduced to the mean amplitude of the transmission but will extend beyond this. They will therefore be cut off since the grid control range of the amplitude filter is only capable of passing the intensity threshold value of the transmission. There is no noticeable deterioration of the transmission by these individual disturbance peaks which are reduced to the mean value of the transmission, since, on the one hand, the time during which these disturbance peaks act is very short and, on the other hand, even with very strong disturbances only a few of such disturbance peaks arise per second. This cutting off of the disturbance peaks has therefore for consequence only a distortion of the low frequency amplitudes. The effect of this is as if the harmonic distortion of the low frequency stage were to increase from about 1% to 5% and this only during the very short spaces of time of the average of a millisecond per disturbance peak.

Even disturbances which have an apparently coherent disturbance spectrum, as for example electric railways, show on a high frequency os-

cillograph individual disturbance peaks of varying amplitude and frequency, but once more only a few disturbance peaks occur per second. This is quite clear if it is remembered that with this kind of disturbance, disturbances can only arise if an interruption occurs between the current pick-up shoe and the conductor rail. That these interruptions occur only a few times per second, is quite comprehensible. In any case, considerably more interruptions may occur if the conductor rail has a rough surface. (Extended oscillographic investigations of the disturbance spectra of the wireless interference arising from the Swiss Federal Railway have indicated a maximum of 50-60 disturbance peaks per second. This maximum was only present with a very rippled conductor rail whilst with the conductor rail in good condition an average maximum of 20 disturbance peaks per second occurred.)

Figures 1 to 3 show how the method according to the present invention may be carried out.

Figure 1 illustrates graphically the individual phases of the method according to the invention;

Figure 2 is a graph showing the operation and effectiveness of rectification;

Figure 3 illustrates graphically the limits of the amplitudes;

Figure 4 illustrates the electric circuit connection of one form of apparatus according to the present invention; and

Figure 5 shows a modification of the circuit of the receiving station.

In what follows the mode of operation of one form of the process by way of example will be more fully explained with reference to Figs. 1-3, the first control means 1 being shown as a compressor and the second control means 3 as expander. These control means 1, 3, which are known in themselves, consist for example of electron discharge tubes having exponential characteristics, whereby the amplification of these tubes can be varied within wide limits corresponding to the grid bias applied.

From the incoming transmitter wave 4 there is derived, in a branch circuit which is shown, a control voltage, and this is smoothed by resistances and condensers to such an extent that the potential variations of this control voltage represent the variations in the sound intensity of the transmission. This control voltage which is to be regarded as a dynamic voltage, is led to the grid circuit of the compressor 1, whereby variations in the sound intensity of this transmission 4 are compensated, in such a way that with soft passages in the transmission a high amplification takes place whilst, conversely, the amplification decreases with loud passages, in such a manner that all acoustic frequencies of the transmission are controlled to the same mean amplitude value, as for example is shown in Fig. 1 with the frequencies 5. The high frequency 5, controlled to constant mean amplitude value by the compressor 1, after subsequent rectification by a rectifier which is not shown but which advantageously consists of a hot cathode system, and which operates according to the characteristic of Fig. 2, is led to an amplitude filter 2, consisting of an electron discharge amplifier tube. The mode of operation of this amplitude filter is as follows:

The positive terminal of the high frequency rectifier referred to is connected to the common potential point, or the cathode, of the receiving system so that there remains only one half 6 of the high frequency wave whose frequencies swing in the negative potential range relatively to the

cathode. On the grid side of the tube serving as amplitude filter 2, which has a small or no grid bias, is impressed the rectified high frequency 6, according to the characteristic diagram of Fig. 3, in which the characteristic 7 represents the function $I_a(E_g)$ whilst the dotted line 8 corresponds to the grid bias 0 of the tube and the dotted line 9 is located at the bottom bend of the tube characteristic. The mode of operation of the amplitude filter 2 is also to be derived from this diagram. The rectified high frequency 10 is so adjusted in amplitude that its low frequency components swing over substantially the whole range of the characteristic of the amplitude filter. If there are superimposed upon this rectified high frequency 10 a few high disturbance voltage peaks 11 and 11', whose amplitudes are not reduced by the control process to the mean amplitude value of the transmission, since their duration is at a maximum a few milliseconds per impulse, these practically cannot be further amplified because the range of grid control of this amplitude filter is insufficient for such a high voltage, as follows from the diagram of Fig. 3, where the frequencies 10' allowed to pass by the amplitude filter 2 are shown.

If individual voltage impulses of large amplitude reach the filter 2, they will swing so far into the negative or positive range of the tube characteristic 7 that the anode current becomes zero or saturated and hence the filter 2 is impassable by such high amplitudes.

The low frequency allowed to pass by the amplitude filter 2 is led to a second control stage 3, the so-called expander stage which receives the same grid control voltage as the compressor stage 1, but with the difference that when the stage controls upward, the stage 3 controls downward and vice versa, so that by this expander stage the frequencies 4' are so controlled that the original variations of sound intensity of the transmission 4 are re-established.

The arrangement for carrying out the method has, according to the invention, the following members: a control means by which the sound intensity variations of the transmission are so influenced that the transmission then only consists of different frequencies of the same mean amplitude values; an amplitude filter to which are led these frequencies which remain constant in their mean amplitude values, and by which individual voltage impulses, which arise from a disturbance and whose amplitudes are greater than the amplitudes of the reception frequencies, are reduced to the amplitude value of the reception frequencies; and a second control means to which are led the frequencies which are allowed to pass by the amplitude filter, whereby the original variations in sound intensity are re-established in the transmission.

Fig. 4 shows a circuit diagram of an embodiment of such an arrangement by way of example.

Fig. 5 shows a modification of a part thereof.

The high frequency received from an antenna is, in known manner, after passing selecting and amplifying means, amplified by the amplifier tube 15. This amplifier tube, which is constructed as an exponential tube delivers its amplified high frequency to a rectifying stage 16, which delivers a control voltage for the control of amplification 70 to this first stage. This control voltage, whose time constant is suitably determined by the condensers 17 and 20 and also the resistances 18 and 19, is led to the grid circuit of this tube 15 whereby a substantial compensation of the incident 75

transmitter field strength is obtained. (Fading compensation.)

In parallel to the rectifier tube 16 is connected a second rectifier tube 24 which also receives the high frequency coming from the anode of the tube 15. This rectified high frequency is smoothed by the resistances 25, 26 and also the condensers 27, 28, 29, 30 to such an extent that the potential variations of this control voltage follow the intensity changes arising from the variations in sound intensity. This control voltage is led through the grid resistances 31, 32 to the compressor stage 33 and to the expander stage 34. The high frequency delivered by the first amplifier stage 15 is impressed upon the tuned circuit 35 and after this tuned circuit upon the grid circuit of the compressor tube 33.

The frequencies amplified and controlled to a constant mean amplitude value by the compressor means 33 are led through the condenser 37 to the anode of the hot cathode rectifier 38. In parallel to the anode-cathode path of the rectifier 38 are arranged the load resistance 40 and the condenser 40'. The grid of the amplitude filter 39 is also conductively connected with the anode side of the rectifier 38. This amplitude filter advantageously consists of a screen grid valve which receives a screening grid voltage of about 30 volts whilst the anode voltage amounts only to 8 volts. Under these voltage conditions there is obtained a characteristic whose curvature is so small that it can practically be regarded as rectilinear. This amplitude filter may be suitably biased by means of the cathode resistance 41 with the by-pass condenser 41'. A high frequency choke of 95 milli-Henry has been found satisfactory for the anode impedance of this amplitude filter. This can however be replaced by a resistance of 4000-6000 ohms without the characteristic being thereby substantially altered. The frequencies allowed to pass by the amplitude filter 39 are impressed upon the grid circuit of the expander 34. This expander, which may also consist of an electron discharge tube having an exponential characteristic, has its cathode biased by a resistance 52 relatively to the grid circuit to such an extent that, when the positive control voltage increases, the grid bias decreases, so that a reversed amplifier characteristic relatively to the compressor is obtained.

Instead of connecting the high frequency rectifier 38 according to the circuit diagram of Fig. 4, it is advantageous to connect this rectifier 38 according to Fig. 5. The high frequency from the compressor 33 reaches the cathode 44 of the rectifier 38 through the condenser 43. This cathode 44 is connected with the common potential point 46 through a high frequency choke 45. So that the high frequency voltage to be rectified cannot flow through the capacitive shunt between cathode 44 and heaters 47, 47' of the indirectly heated hot cathode rectifier, high frequency chokes 48, 49 are inserted in the heater leads. The anode 50 of the rectifier 38 is connected conductively with the control grid of the amplitude filter 39 and through a suitably chosen resistance 51 to the common potential point 46'. The mode of operation of this arrangement follows clearly from the drawings, so that a description thereof is superfluous.

In the example herein described, the compression is effected in the high frequency part of the apparatus. It is of course readily possible to arrange the compression stage after demodulation has taken place. In this case the amplitude

filter should be biased negatively with negative grid bias to such an extent that the low frequency of the transmission once more swings over the whole straight part of the grid characteristic of this amplitude filter. It is also possible, moreover, to construct the disturbance removing device in accordance with the drawings, whilst the frequencies leaving the expander device are then led to a modulator tube which produces superposition of the incoming frequencies upon the frequencies of a local generator so that there is obtained an intermediate frequency which can be further amplified as such. It is also possible to derive the dynamic voltage for amplification control after the expander, instead of from a separate shunt branch as in the example of Fig. 4.

I claim:

1. Method of suppressing high voltage peaks at a radio receiving station which, due to disturbances, become superimposed upon the transmitted signal during wireless transmission, comprising the steps of adjusting, at the receiving station, the signal level of the received signal with such a time constant that amplitude fluctuations in the signal caused by the modulation are reduced, reducing the disturbing amplitudes to approximately the highest signal amplitude, and thereafter enlarging the signal for contrast, whereby the amplitude fluctuations of the signal which were evened out by said signal level control, are compensated for, so that the original amplitude fluctuations are restored.

2. In a wireless receiver, means for controlling the signal level, said means comprising a compressor having such a time constant as to reduce, at the receiver, the amplitude fluctuations in the signal caused by modulation, an amplitude filter for reducing the disturbing amplitudes to approximately the highest signal amplitude, a control element for enlarging the signal contrast, whereby the amplitude fluctuations of the signal, which were evened out by the said signal level control, are compensated for, so that the original amplitude fluctuations are restored.

3. In a wireless receiver at a radio receiving station having signals and disturbances arriving thereat, means for controlling the signal level, said means comprising a compressor having such a time constant as to reduce, at the receiving station, the amplitude fluctuations in the signal caused by modulation, an amplitude filter for reducing the disturbing amplitudes to approximately the highest signal amplitude, a control element for enlarging the signal contrast, whereby the amplitude fluctuations of the signal, which were evened out by the said signal level control, are compensated for, so that the original amplitude fluctuations are restored, said amplitude filter at the receiving station comprising an electron discharge amplifier tube having a grid bias which is so small that signals can swing the grid thereof over substantially the whole straight part of the tube characteristic, means for rectifying the transmission from said first control means, which is in the form of a high frequency wave and for applying the rectified high frequency wave to the grid of said amplitude filter, the positive terminal of said rectifying means being connected to the common potential point of the receiver so that the rectified high frequency wave swings out over the negative range of potential and is impressed upon the grid of the amplitude filter, whereby individual voltage impulses of larger amplitude swing so far into the negative range of the char-

acteristic of said amplitude filter that they are substantially not amplified.

4. The device according to claim 2, wherein said amplitude filter consists of an electronic
5 amplifier tube having at least two grids, one of said grids being connected as control grid and the other of said grids being connected as screening grid, the voltage applied to said anode not

exceeding one half of the voltage applied to said screening grid, and means being provided for applying to said amplitude filter a grid bias such that the incoming signal swings over substantially the whole straight part of the grid characteristic. 5

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