Sept. 3, 1946. H. G. BUSIGNIES 2,406,799

DISTORTION CORRECTIVE ARRANGEMENT

Filed March 6, 1941 2 Sheets-Sheet 1

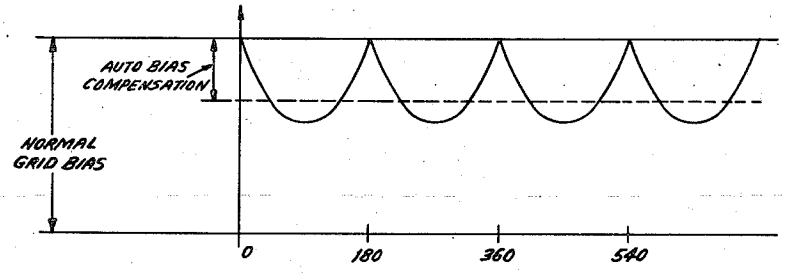

FIG.1.

FIG.2.

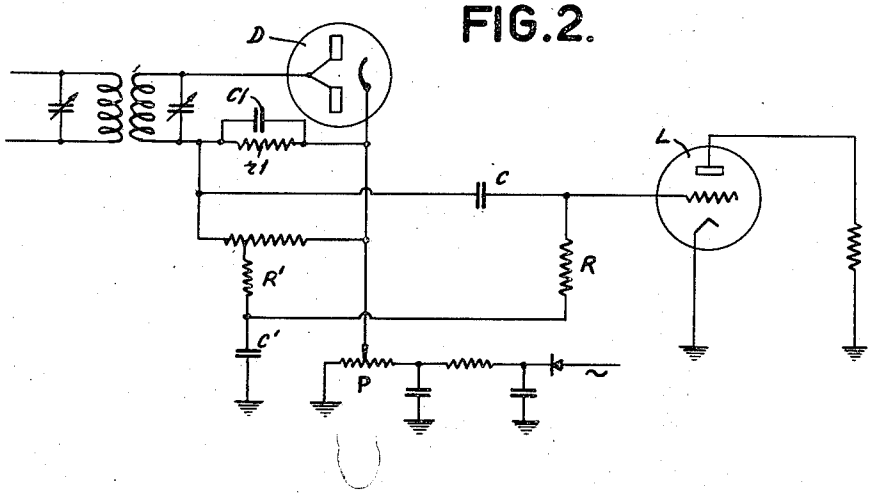

FIG.4.

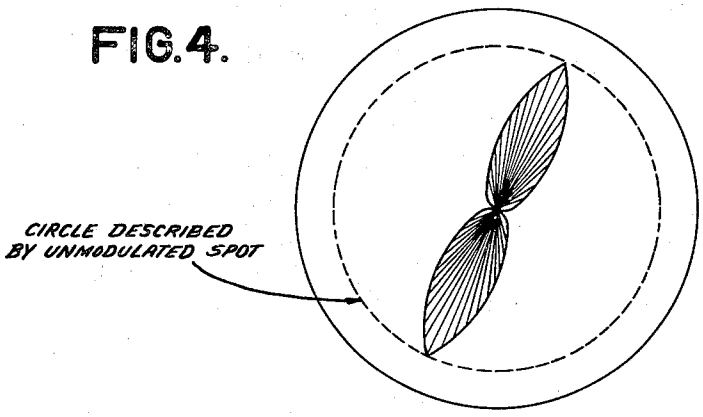

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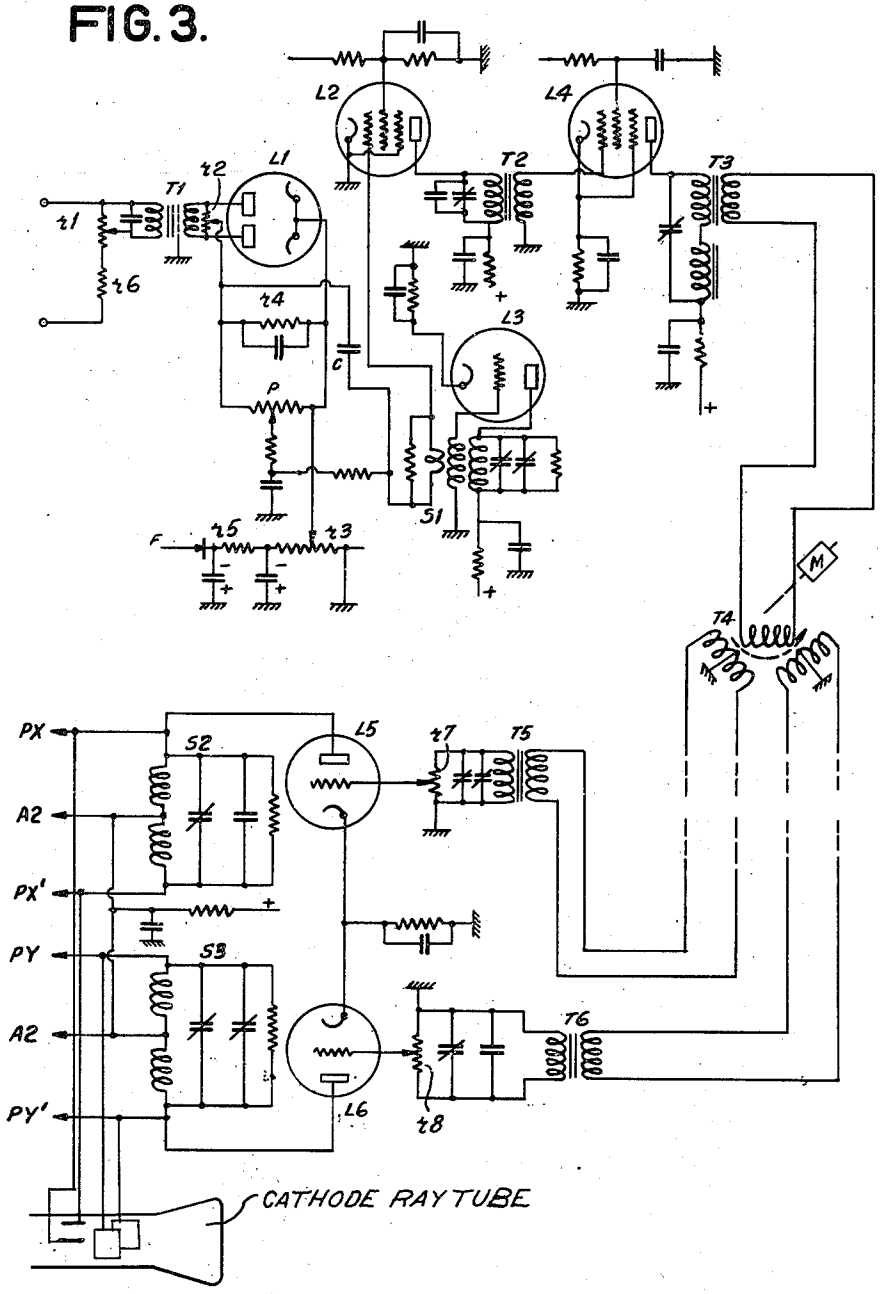
FIG. 3.



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DISTORTION CORRECTIVE ARRANGEMENT

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6 Claims. (Cl. 250—27)

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My invention relates to improvements in distortion corrective devices, particularly in vacuum tube circuits.

It is an object of my invention to provide an improved corrective circuit for substantially eliminating distortion.

Another object is to provide means for improving direction readings in direction finding devices.

A further objective is to provide means for supplying asymmetrical energy to the input of a vacuum tube so that the peak of such energy will not be distorted by said tube.

A more specific object of the invention is to provide improved means for maintaining a steady and undistorted cathode ray image when an amplifier in the circuit of such cathode ray is supplied with asymmetric energy.

Other objects and various further features of novelty and invention will hereinafter be pointed out or will become apparent from a reading of the following specification in conjunction with the drawings included herewith. In said drawings—

Fig. 1 is a graphical showing of a wave form for illustrative purposes;

Fig. 2 represents a circuit embodying features of my invention;

Fig. 3 represents a circuit illustrating a possible practical application of my invention; and

Fig. 4 is an illustrative showing in connection with the circuit of Fig. 3.

After amplification in a receiver, the high frequency energy from the search coil of a radiogoniometer is usually rectified and has a low-frequency form of envelope curve, which curve is asymmetric with respect to its mean axis (Fig. 1). This mean axis begins at zero for no signal and increases with increasing signal.

Generally, because of this fact, a direct coupling is employed between rectifier and amplifier stages in the receiver output in order to obtain distortionless modulation of the circle on the cathode-ray indicating tube employed. Direct coupling avoids two kinds of distortion arising from the capacity element in a resistance-capacity coupling arrangement, namely, the phase distortion due to these coupling elements, and distortion giving rise to image instability—which gives the appearance of a "floating" image, due to varying grid bias when the amplitude of the signal changes abruptly, as in the case of a carrier modulated by telegraph signals. There are circuits and circumstances in which the amplifier elements must be separated to avoid counter effects or disturbances from other circuits. We shall now examine, in a general manner, under what conditions a capacity coupling may be employed in a particular circuit.

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Such a circuit is shown by way of example in Fig. 2, in which a diode D, shown in simplified form but actually a full wave rectifier as shown at L1, Fig. 3, provides rectification and tube L is an amplifier. The detected signal may be supplied from a receiver and energy from the last stage is applied to the diode circuit. The intermediate frequency has been suppressed, and after rectification at D only the envelope curve (Fig. 1) due to rotation of the search coil remains. This curve is of demi-sinusoidal form; there are two poorly defined maxima per revolution, and two minima 180° from each other, which may correspond to goniometer positions of no antenna pick-up. These minima are very clear, and they indicate the passage of the search coil past zero. The mean value of the voltage thus created does not equal half the amplitude of the rectified voltage, since it increases proportionally as the amplitude increases, but is always something other than half the amplitude.

The problem is to transmit voltage of this particular form to the tube L, by way of a coupling condenser C. If no particular precautions are taken, the tube will be biassed at some mean value in accordance with the magnitude of the signal received, because of the asymmetry of this voltage. The circuits R'—C' and R—C have special features permitting a voltage, similar to that across resistance r_1, to appear at the input of tube L, as will later be clear.

Since we are applying an asymmetric signal, the latter produces a charge in condenser C giving rise to a bias on tube L. As a result, if we, for example, should feed such energy to a cathode ray sweep circuit rotating in synchronism with a search coil, we would observe a circle having a diameter varying with the magnitude of modulation. Compensation must, therefore, be made for this self-biasing effect. To that end I propose to supply compensating inverse grid bias by automatically decreasing the bias an amount equal to the difference between the mean and peak values of the asymmetric signal. Such a bias compensating voltage may be obtained from impedances R'—C' (Fig. 2) for example, of 1 megohm and 1 microfarad, respectively, and by making current through R return to the point of juncture of R' and C'. This may be readily seen from the following considerations. When the signal is first applied to r_1 by rectifier D, a

charging current flows into C due to the D. C. component of the rectified current. This charging current produces a potential drop in R which tends to make the grid of tube L more negative. At the same time a charging current for condenser C' through resistance R' and potentiometer P to ground tends to make the grid more positive. By properly choosing the tapping point of R' and the size of condenser C' complete compensation may be obtained. It will likewise be clear that upon reduction of signal voltage the discharge of condenser C and C' will serve to maintain the desired condition. Condenser C' bypasses the desired signal component so that neutralization of this desired signal is not produced. At the same time condenser C serves to communicate the signal wave in its pure form to the grid of tube L for amplification. It will be apparent, then, that by appropriate control of the magnitude of R', a counterbiassing effect may set up in step with and of magnitude equal to the above-mentioned self biassing effect, that is, the mean effective value of the asymmetric signal, without affecting the uniform magnitude of the signal peaks transmitted.

By way of example, I shall illustrate a possible embodiment of features of my invention in a useful circuit. Fig. 3 shows such a circuit embodying that of Fig. 2.

The circuit shown is a probing system for repeating at regular intervals radio-goniometric indications. In this system a rectifier tube L_1 rectifies the characteristic signal in such a way as to produce, at the ends of resistances R_4, half sinusoids representing the envelope curve of a high-frequency voltage as formed by means including a radiogoniometric search coil. This voltage after such rectification may be means of a tube L_2 modulate high-frequency energy supplied by an oscillator L_3.

High frequency energy is thus present in the output of tube L_2, that is, in the output transformer T_2, and the amplitude variation of this energy is very much the same as if the secondary of transformer T_2 were the search coil of a radiogoniometer. These voltage variations differ, however, in that rectification may be exaggerated in such a way as to produce more accentuated points characterizing the search coil minima. A power amplifier tube L_4 may then transmit modulated high-frequency through a transformer T_3 and the search coil of a goniometer or distributor T_4, having two stators feeding two transmission lines.

The search coil of goniometer T_4 may be driven by motive means M in synchronism with the goniometer at the receiver input so that the modulating sinusoid entering the circuit of Fig. 3 at transformer T_1, is of appropriate phase and in synchronism therewith. For example, the motor means M may be rotated at such a speed as to obtain, say a 50-cycle modulation frequency at the output of T_4. A 50-cycle alternating voltage will be supplied to transformer T_1 by rotation of the receiving goniometer search coil. Thereafter the detector tube L_1 rectifies this 50-cycle voltage to apply demi-sinusoids, similar to those obtained by detecting the current of a rotating search coil, across an output resistor r_4.

At the other end of the transmission lines is a receiver including two tubes L_5, L_6 and circuits tuned to the above-mentioned high-frequency energy. The plate circuits of these tubes supply energy to an output transformer which may supply sweep circuit energy to the deflection plate leads P_x, P_y, P_x', and P_y' of a cathode ray tube.

If we consider the case of no modulation of energy passing through detector L_1, that is, when the high frequency, passing through transformer T_3, is of constant amplitude and the motor M has stopped in a position related to that of rotor T_4, it will be appreciated that the combination of the high frequency energy applied to lines feeding the cathode ray tube causes the appearance of a diametrically extending line, the angular disposition of which corresponds to the angular swing of the search coil of goniometer T_4. Now, if a controlled rotary motion be imparted to the search coil of T_4, a succession of diametrically extending lines will appear on the cathode ray screen, and each of these lines will make a small angle with respect to the one preceding it in such a way as to give appearance of a uniformly illuminated circular area. Again, if sinusoidally modulated energy be fed into transformer T_1, a modification of the high-frequency signal corresponding to the characteristic radiogoniometric image (Fig. 4) may appear on the cathode ray tube screen, as will be clear. The modified image may permit a direct reading of the phase relationship of the input modulating sinusoid with respect to that of the distributor-goniometer T_4, and hence, may also show radiogoniometric angular direction indications.

As above-stated Fig. 4 represents the envelope of the image obtained. The diametrically extending lines which give the apparance of uniform illumination may be seen within the contours of the image. When demi-sinusoids are supplied to the modulator tube L_2, deformation of the image on the cathode ray tube will immediately indicate phase distortion in this transmission, as will be remembered from discussion in connection with the simplified circuit of Fig. 2. If, on the other hand, there is any self-biassing effect due to poorly compensated capacitative coupling, the two extreme points of the image produced thereby will not extend as far as the steady circle produced by an unmodulated sweep circuit.

It will be seen, then, that the circuits R-C and R'-C' serve to eliminate distortion. Moreover, it is to be observed that in the case of simpler arrangements involving direct coupling or insufficiently stabilized supply, any substantial modulation of the high-frequency energy may correspondingly alter the operating characteristics of tubes L_2 and L_4; and different diameter indications will appear on the cathode ray tube.

Furthermore, by compensating out the self-biassing effect, the capacitative coupling circuit described permits compensation at the same time for overall amplitude variation due to lack of stability, as will be clear. It is thus possible in circuits including above-indicated features of my invention not only to obtain appropriate compensation of the self-biassing effect, but also to keep the image diameter constant, even when completely unstabilized feeding energy is employed.

It will be understood that, thanks to certain features of the invention, the circuit of Fig. 3 has been vastly improved in efficiency in the manner indicated, which circuit may be susceptible to numerous practical applications. Generally speaking, the invention permits isolation of two elements, not of the same polarity, by interposing a condenser, and it permits realization of distortionless interstage couplings when the problem of transmitting a particular asymmetrical wave presents itself.

Although the invention has been described in particular detail in connection with the preferred forms shown, it is of course to be understood that many modifications, additions, and omissions may be made without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. In a distortion-corrective circuit of the character indicated, a vacuum tube including a grid, means for providing a uniformly amplified output voltage when an asymmetric input voltage is applied, said means including series and shunt impedance means responsive to said asymmetric input voltage for presenting the asymmetric input voltage to said grid of said tube tending to produce an unwanted bias on said grid and other series and shunt impedance means responsive to said asymmetric input voltage for producing counter bias on the grid of said tube equal to the effective value of said asymmetric input voltage.

2. Means for coupling a source of fluctuating unidirectional potential to an amplifier for said potential comprising a resistance-capacity network, means for coupling said network to said source, means for coupling said network to the input of said amplifier, an impedance network, means for coupling said impedance network to said source, and means for coupling said impedance network to the input of said amplifier, said networks being so related that the effective potential produced on said impedance network is substantially equal in magnitude and opposite in polarity to the effective potential produced in the portion of said resistance-capacity network coupled to the input of said amplifier.

3. Means for coupling a source of fluctuating unidirectional potential of low frequency to an amplifier for said potential comprising a first condenser, means for coupling said condenser to said source and the input of said amplifier, a first resistance, a second condenser, means for coupling said resistance and said condenser in series and to said source, a second resistance, and means for coupling said second resistance to said first condenser and to the junction of said first resistance and said second condenser, said first resistance and second condenser being related to

said first condenser and second resistance that the effective potential produced across said first resistance is substantially equal and opposite to the effective potential produced across said second resistance.

4. A vacuum tube circuit comprising a source of fluctuating potential, a vacuum tube having an anode, a cathode and a control electrode, a first condenser and a first resistance connected in series, a second resistance connected in shunt with said series condenser and resistance, a second condenser, means for coupling said second condenser to the common terminal of said first and second resistance, means for coupling said second condenser to said source, means for coupling said source to the common terminal of said resistance and said first condenser, and means for coupling said control electrode to the common terminal of said first condenser and said first resistance, said second resistance and second condenser being so related to the first resistance and first condenser that the effective biasing potential across said second resistance is substantially equal to the effective biassing potential across said first resistance.

5. In an amplifier circuit having a vacuum tube, a distortion correcting network comprising means for biassing said vacuum tube in accordance with the mean amplitude of the potential to be amplified and means for oppositely biassing said tube an amount equal to the difference between the mean and peak values of said potential.

6. In a direction finding system comprising a source of modulated high frequency potential and cathode ray indicating apparatus, detecting and amplifying apparatus comprising rectifying means coupled to said source, amplifier means, means for coupling said rectifying means to said amplifier means comprising a resistance-capacity network, means for compensating for the bias produced in said resistance-capacity network comprising a second resistance-capacity network coupled to said rectifying means and said amplifier, and means for coupling said amplifier means to said indicating apparatus.

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