April 28, 1942. R. HOFER 2,281,069

MODULATION SYSTEM

Filed Feb. 27, 1935

Fig. 1

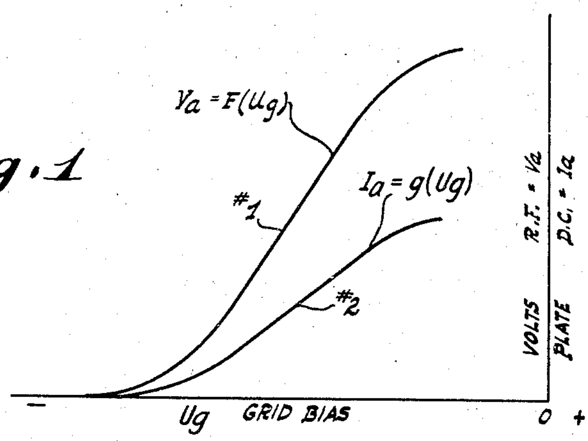


Fig. 2

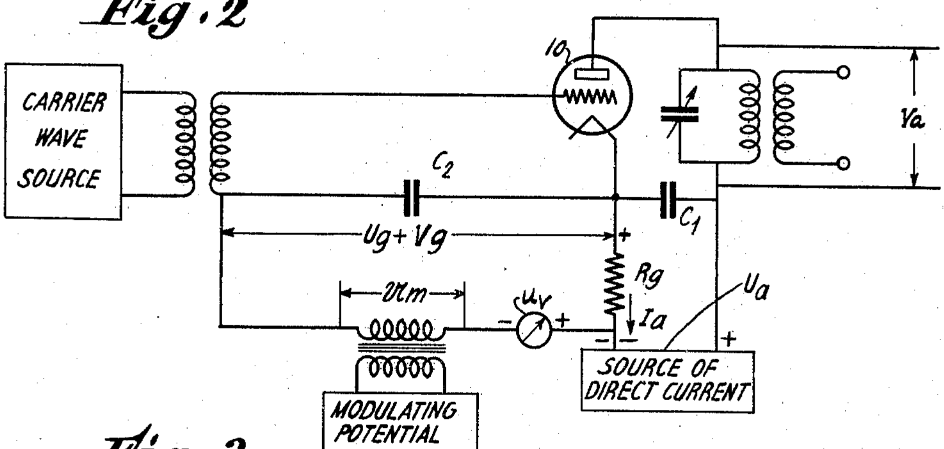
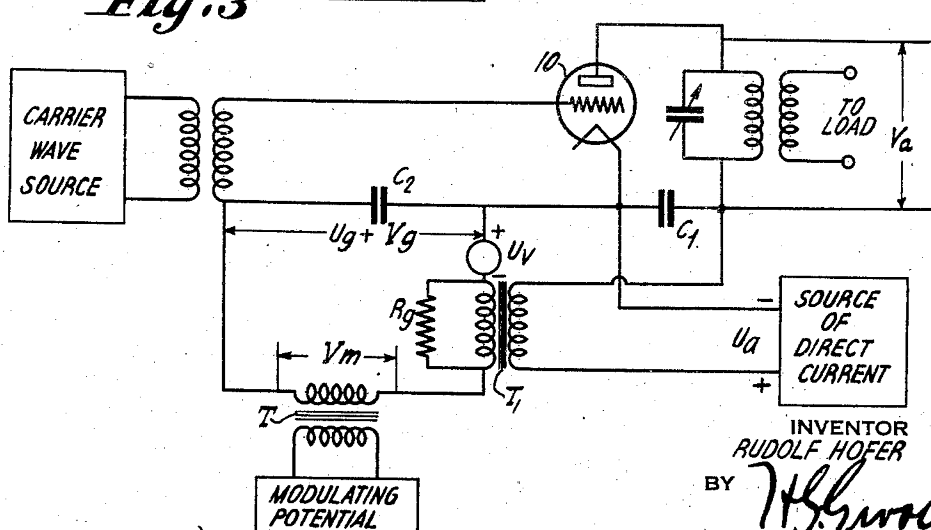


Fig. 3



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MODULATION SYSTEM

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2 Claims. (Cl. 179—171.5)

It has been suggested in the prior art to lessen distortion occasioned in amplifier stages by what has been called "counter-coupling" of the amplified oscillations from the plate circuit to the grid circuit. It has also been suggested in the prior art to correct distortion in modulated radio frequency stages by rectifying the modulated oscillations to produce audio frequency voltages of suitable value and impressing the same in phase opposition on the modulation potentials introduced at the input end of the amplifier. The correcting voltages may be impressed either on the grid circuit of the modulated radio frequency stage or on any stage of the modulation frequency amplifier. However, such an audio frequency "counter-coupling" scheme necessitates a considerable expenditure of material because a distinct linear rectifier must be provided for insuring correction of the distortion.

The present application discloses a simple and novel method of and means for correcting distortion of the type described above. In describing my invention reference is made to the drawing in which Figure 1 is a curve illustrating the nature of the correction involved, Figure 2 is a diagram of a modulator of the type involved herein, including distortion correcting means, while Figure 3 is a modified modulator including the distortion correcting means of the present invention.

Now, according to the invention the useless audio frequency currents oscillating or flowing in the plate circuit in the presence of wave modulation are to be used for effecting counter-coupling to correct for distortion. This method secures satisfactory correction of distortion inasmuch as the modulated radio frequency wave amplitude and the modulator plate direct current (current drawn by the plate) I_a depend upon the grid biasing voltage U_g according to an equivalent law as illustrated in Figure 1.

The upper graph #1 in Figure 1 represents what is known as a modulation characteristic. Such a characteristic is obtained in the following manner: the grid of an electron discharge device is given a marked negative bias and is fed with a radio frequency voltage of constant amplitude. Then, the negative grid bias voltage U_g is reduced (abscissa or graph) and the radio frequency amplitude V_a arising in the plate circuit is measured. As indicated in Figure 1, V_a is a function of U_g. The lower curve #2 represents the direct current component which arises in the plate circuit when the curve #1 is being plotted. This curve is obtained by plotting grid bias readings (which may be the same readings used in plotting graph #1), against the direct current I_a flowing in the plate circuit. It will be noted that the contours of two curves are very similar and from this fact the conclusion may be drawn that degeneration is feasible. This direct current component, in effecting control of the grid also excited by a modulation frequency, will naturally be changed into pulsating direct current components, so that in effect it will be a direct current component having an audio frequency component superimposed thereon.

In Figures 2 and 3 are shown exemplified embodiments of the basic idea of this invention. In Figure 2 I show a radio frequency stage comprising a tube 10 connected for grid modulation of carrier waves. Counter-coupling between the anode and grid circuits is insured by way of the resistance R_g which is included both in the grid cathode circuit as well as the plate cathode circuit of the tube 10. C_1 and C_2 are radio frequency short-circuiting condensers. In choosing the dimensions of condenser C_2 care must be taken so that it will not provide a short-circuit for audio frequencies. This particular instruction in reference to the dimensions of C_2 distinguishes the present circuit organization clearly from those arrangements in which a resistance traversed by the plate current serves for the production of a direct current biasing voltage for the control grid. In the later arrangements the audio frequency potentials must be shorted, or, still better, be suppressed by the provision of filter means. The grid direct current biasing voltage U_g is adjusted to the value $U_g=U_v+I_aR_g$ required for producing the required mean carrier wave amplitude. In this equation U_v is the constant or variable or regulable biasing voltage furnished from a source of direct current voltage U_v connected with the secondary winding of a transformer T on the primary of which the modulation voltage V_m is impressed. The audio frequency grid voltage $V_g=V_m-J_nR_g$ consists of the supplied modulation voltage V_m and the counter-correcting voltage (potential drop) caused by the audio frequency plate current J_n superposed on the direct plate current I_a flowing in R_g. If the potential on the grid swings up more current flows in R_g. The potential drop in R_g increases and lowers (subtracts from V_m) the grid potential. If the potential V_m on the grid swings negative the drop through R_g decreases and this change in potential drop opposes the negative swing of V_m. Thus audio frequency drop in R_g always opposes or subtracts from V_m. The resulting potential on the grid of 10 is equal to U_g+V_g. An arrangement as shown in Figure 2 allows of the plotting point by point of the modulation characteristic by stepwise variation of the adjustable grid bias source U_v, though it involves the drawback that either the negative pole of the source of filament or heating voltage or else that of the plate potential source must be above ground direct current potential.

This latter undesirable feature may be avoided if the plate circuit is as shown in Figure 3, coupled with the grid circuit by way of an audio frequency transformer T'. The audio frequency correcting potentials fed from the plate circuit to the grid circuit by way of T_1 will insure the same effect so far as correction of distortion is concerned as that insured by a circuit scheme of the kind shown in Figure 2. Of course, the audio frequency voltage derived from the plate circuit may be impressed upon the grid circuit of a stage in the modulation frequency amplifier which in practice is between T' and the modulating potential source.

I claim:

1. In a modulation system, a source of carrier wave oscillations, a source of modulating potentials, an electron discharge tube having a control grid, a cathode and an anode, a circuit coupling said source of carrier wave oscillations to said cathode and control grid, a circuit including a source of direct current potential and an impedance coupling said source of modulating potentials to the control grid and cathode of said tube to impress modulating potentials on said control grid and cathode to modulate in said tube said oscillations substantially in accordance with said modulation potentials, and means for correcting distortion inherently accomplished during modulation of said carrier wave oscillations by said modulating potentials including a source of direct current potential and said impedance connected between the anode and cathode of said tube, and means for setting up in said impedance potentials characteristic of the modulation frequency flowing in said last named circuit which oppose said modulating potentials.

2. In a modulation system, a source of oscillations of carrier wave frequency, a source of modulating potentials, an electron discharge device having a control grid, a cathode and an anode, a circuit coupling the control grid and cathode of said device to said source of oscillations, a transformer having its primary winding coupled to said source of modulating potentials, said transformer having a secondary winding in which said modulating potentials are induced, a source of direct current potential and a resistance in series with said secondary winding between the control grid and cathode of said device for applying said modulating potentials to said control grid and cathode to modulate the said oscillations substantially in accordance with said modulating potentials, an alternating current circuit connected with the anode and cathode of said device and means for compensating for distortion inherently accomplished during said modulation including, a circuit including a source of direct current potential connecting the anode to the cathode of said device, and means in said last named circuit for producing potentials in said resistance of a value characteristic of the currents in said circuit which oppose said modulating potentials induced in said secondary winding.

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