June 29, 1937. W. T. DITCHAM 2,085,011

MODULATED CARRIER WAVE SIGNALING SYSTEM

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Fig. 1

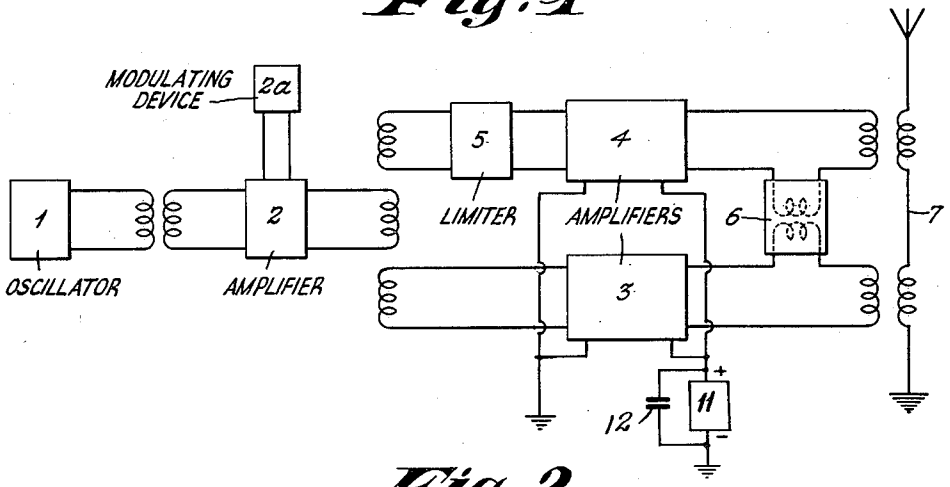
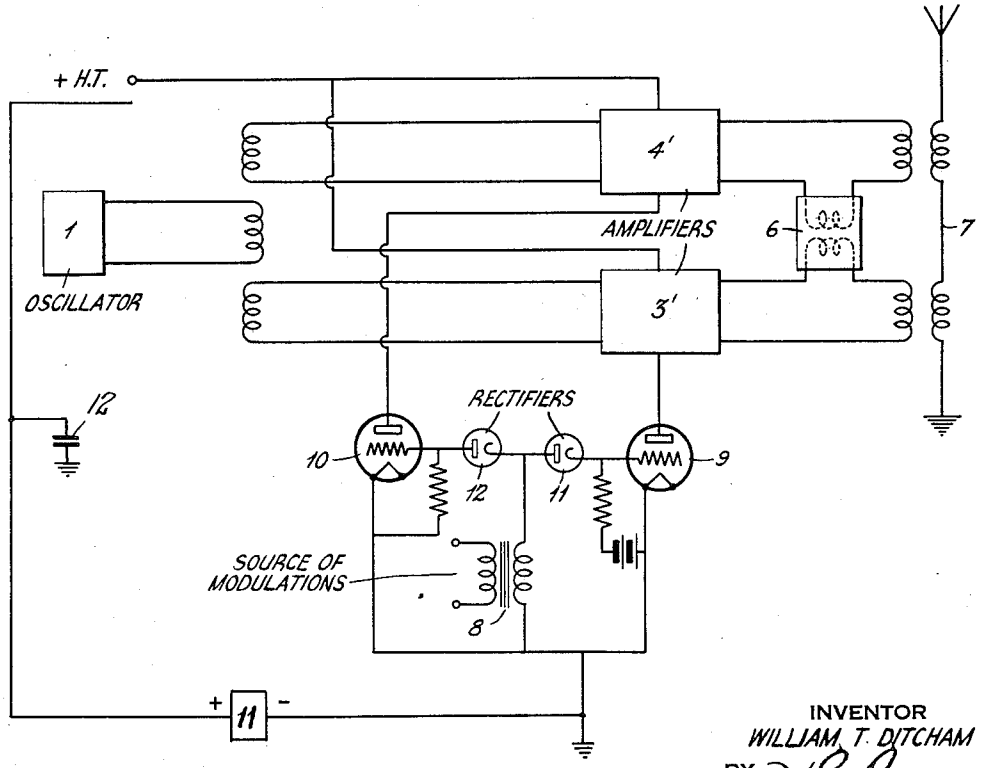


Fig. 2



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MODULATED CARRIER WAVE SIGNALING SYSTEM

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10 Claims. (Cl. 250—17)

This invention relates to radio and other high frequency modulated carrier wave systems, and has for its object to provide an improved system suitable for use for broadcasting purposes and in other cases where a wide range of degree of modulation is likely to be required. In broadcast and other similar high frequency modulated carrier systems it is usual to modulate the output from a low power oscillator or low power high frequency amplifier and to amplify the resultant modulated high frequency by means of an amplifier of high power, the amplified modulated oscillations then being transferred to the aerial or other transmitting device proper. Where, however, the degree of modulation likely to be required is liable to vary between fairly wide limits, for example in a broadcasting system where the modulation may be very weak at one moment and very strong at the next, such systems present the practical disadvantage that since the anode and grid voltages applied to the valve or valves in the high power amplifier have to be so adjusted that the necessary increments in voltage due to modulation, influence the power output of the said valve or valves in a linear manner, the efficiency of the system when the carrier is unmodulated is necessarily very low. To put the matter in another way, since the power amplifier must amplify linearly the full range of voltage input thereto, the voltages which may be applied to said power amplifier when the carrier is unmodulated are necessarily well below the best values for giving high efficiency.

The principal object of the present invention is to avoid this difficulty, and according to the invention there are provided two high frequency high power amplifiers in effective parallel relationship in the transmission channel one of these amplifiers being so adjusted and arranged as to give a varying power output corresponding to modulated carrier variations above the carrier level while the other is so adjusted and arranged as to give a varying power output corresponding to modulated carrier variations below the carrier level, the total power output corresponding to variations in modulated carrier over the whole range of modulation.

The input to the two high power amplifiers may be a modulated carrier wave or the power amplifiers may be driven by unmodulated high frequency and modulation effected in the amplifiers themselves. In the latter case two modulating circuits are provided, one for each high power amplifier, and the whole arrangement and conditions of adjustment are such that one combination of amplifier and associated modulating circuit deals with modulation of carrier wave above the carrier level and the other with modulation of carrier wave below the carrier level.

The invention is illustrated in the accompanying drawing which shows diagrammatically two arrangements in accordance therewith.

Fig. 1 shows a schematic circuit diagram of one form of my invention; and

Fig. 2 shows a circuit diagram of another embodiment of my invention.

Referring first to Figure 1 which shows one way of carrying out the invention, a radio transmitter comprises a master or drive oscillator **1** which drives a low power high frequency amplifier **2**, to which modulation from a speech, music, or other system *2a* is applied as in the usual way, the output from this low power amplifier thus consisting of a modulated high frequency carrier. There are provided two relative high power amplifiers **3** and **4** which are in effective parallel relationship in the transmission channel. For the sake of convenience in description one of these amplifiers **4** will be referred to as the limiter amplifier and the other **3** as the quiescent amplifier. The quiescent power amplifier **3** is so adjusted as regards negative grid bias and applied alternating grid voltage that at the carrier level the said amplifier is almost or quite quiescent so that in these circumstances the power output of this amplifier is small or even zero. The limiter amplifier **4** comprises or is associated with a limiting device **5** whereby the output of this amplifier is prevented from rising above the carrier level notwithstanding any increment of the output from the low power amplifier **2** during the positive half cycle of modulation. The limiting device **5** may consist of any known form of voltage limiter connected in series or in parallel with or coupled to the grid circuit of the limiter amplifier, or it may be an arrangement whereby the negative grid bias applied to the limiter amplifier **4** is automatically increased as the applied driving voltage increases. Suitable decoupling means **6**, such as any well known bridge arrangement for preventing reaction between circuits, are arranged between the output circuits of the amplifiers **3** and **4** and the two amplifiers are arranged to feed their output energy in parallel to an aerial or other load circuit **7**. Anode voltage for the two high frequency amplifiers may be provided from separate sources, but is preferably provided by the same source **11** connected as shown, and preferably also this source includes means, such as a

large capacity condenser 12 capable of handling large instantaneous overloads.

It will be seen that in operation and when the carrier is unmodulated, the limiter amplifier will be fully driven and will deliver power to the aerial at good efficiency, while the quiescent amplifier will be delivering substantially no power and taking substantially no power from the source of supply. During the positive cycle of modulation the low power amplifier 2 will provide increased driving voltages to each of the two high power amplifiers 3 and 4, but owing to the effect of the limiting device in the limiter amplifier the increased driving voltage thereto will have no effect on the power output thereof. The quiescent amplifier, however, will develop power and, of course, the adjustments are such that the increment in aerial power due to the increment in power from the quiescent amplifier is proportional to the increment in power from the low power amplifier 2. During the negative cycle of modulation or when amplitude is less than carrier level the low power amplifier 2 will provide decreased driving voltage to each of the two high frequency amplifiers 3 and 4, but this decrease will have no effect on the output from the quiescent amplifier since this does not function during modulation below carrier level. The output of the limiter amplifier 4, however, will be reduced and again the adjustments are such that this reduction is proportional to the decrement in power of the low power amplifier. In this way satisfactory modulation of the aerial current is obtained while at the same time a high degree of efficiency of the system when the carrier is unmodulated is also maintained.

Figure 2 shows another modification wherein the quiescent and limiter power amplifiers are driven by unmodulated high frequency carrier, modulation being effected at each of these amplifiers.

Referring to Figure 2, 1, is, as before, a source of high frequency oscillations, i. e., a master oscillator, the output from which is applied, after further amplification if desired, to two high power amplifiers represented respectively at 3' and 4'. The amplifier 3 is the quiescent power amplifier and the amplifier 4' is the limiter power amplifier. Associated with each amplifier is a modulator valve 9 or 10 the valve 9 being associated with the amplifier 3' and the valve 10 with the amplifier 4'. One modulator valve 9 is so adjusted and arranged as to be responsive only to the positive half cycles of modulating low frequency alternating potential while the other modulator valve 10 is responsive only to the negative half cycles. The low frequency modulation potentials are applied to the grids of the valves 9 and 10 via a common transformer 8 whose primary is connected to a source of modulating potentials or to a low frequency amplifier driven therefrom. The valves 9 and 10 are connected to effect modulation of the high frequency oscillations at 3' and 4' in accordance with any well known method, for example by the so-called "series modulation" method wherein the anode to cathode impedance of the amplifier tubes in 3' and 4' are in a direct current circuit which connects a source of potential and the impedances of the modulator tubes 9 and 10 in series. The modulator associated with the quiescent amplifier is so adjusted as regards negative grid bias that in the absence of applied modulating voltages the output of the said amplifier is zero or approximately zero while the grid bias applied to the modulator associated with the limiter amplifier in so adjusted that in the absence of applied modulating voltages the anode-to-cathode drop in its associated modulator, i. e. in the valve 10, is very small so that the whole or approximately the whole of the available anode potential is applied to the amplifier 4' whose output will therefore be of maximum or approximately maximum value. The amplifiers 4' and 3' receive anode potential as indicated from a common source 11 and of course the valves 9 and 10 are in series with these valves as is required for series modulation. It will be seen that since in the carrier condition the quiescent amplifier will be taking little or on power and the limiter amplifier will be absorbing only very small power, the adjustments may be such that a very high efficiency can be obtained in the carrier condition. The required action of the two modulators is obtainable in any of a variety of different ways and in the case illustrated in Figure 2 is obtained by including in the grid circuit of the valves 9 and 10 rectifying devices 11 and 12 respectively, these rectifying devices being constituted for example by low resistance rectifiers such as mercury vapour diodes. As will be noted the diodes 11, 12 are connected in opposite senses, that is, the grid circuit of the valve 9 is so connected that only voltages due to the positive half cycles of the applied modulating wave can affect the grid voltage of this valve 9 while the diode 12 is so arranged that the valve 10 is affected only by the negative half cycles. Suitable smoothing and damping resistances and condensers may if desired be associated with the diodes 11 and 12. In certain circumstances, as will be apparent, the rectifier in the grid circuit of the valve 9 may be dispensed with though it is preferred to provide this rectifier.

The operation is as follows:

During the positive half cycles of modulating low frequency potenial the rectifier 11 will pass current and reduce the negative bias upon the grid of the valve 9 thus permitting the amplifier 3' to deliver energy to the aerial, but the rectifier 12 in the grid circuit of the valve 10 will prevent any alteration in the bias of this valve and consequently the output from the amplifier 4' will remain unaffected. During the negative half waves of applied modulating potential the opposite effects take place.

The invention is not limited to the particular arrangement herein disclosed and illustrated and obviously the invention is of general application to most known circuit arrangements; for example the invention is not limited to arrangements wherein series modulation is effected and obviously the various valve amplifiers may be constituted by triodes or valves having more than three electrodes while the various amplifiers may be constituted by single valves or a plurality of valves in parallel or in phase opposition or in any other convenient arrangement known per se. Further, it will be apparent that it is not fundamentally necessary that the two high frequency high power amplifiers feed a common load and, if desired, each amplifier may be arranged to energize a separate aerial.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. A high frequency modulated carrier wave transmitting system comprising a source of carrier waves, means for modulating said waves, and

means for amplifying the modulated waves, said last means comprising two electron discharge device amplifiers, means for biasing the control grid of one of said devices whereby said one device amplifies only those oscillations whose amplitude is less than the carrier amplitude level and means for biasing the control grid of the other device whereby the latter amplifies only those oscillations which have an amplitude greater than the carrier amplitude level, and means for transmitting said amplified modulated waves.

2. In a high frequency signal modulated carrier wave transmitting system, a source of high frequency oscillations, an output circuit coupled with said source, two high power high frequency amplifiers effectively coupled in parallel relationship by separate input circuits to said output circuit, limiting means associated with one of said amplifiers for causing said one of said amplifiers to give a varying output corresponding to modulated carrier wave variations above substantially carrier wave level only, limiting means associated with the other of said amplifiers for causing the said other of said amplifiers to give a varying output corresponding to modulated carrier wave variations below substantially carrier wave level only, the total output corresponding to variations in modulated carrier wave over the whole range of modulation, and means coupled between the output circuits of said amplifiers for preventing reaction of either of said amplifiers on the other.

3. A system in accordance with claim 2 including means for applying modulated carrier waves to said amplifiers.

4. A system in accordance with claim 2 including means for applying unmodulated carrier waves to said amplifiers, and in which said limiting means associated with said amplifiers includes modulating circuits individual to each of said two amplifiers.

5. A high frequency modulated carrier wave transmitting system comprising a source of oscillations, means for modulating the oscillations therefrom, two high frequency high power amplifiers having outputs effectively coupled in parallel to an output circuit, means for applying the modulated oscillations in parallel to the input circuits of said two amplifiers, means for applying to one of said amplifiers a negative grid bias such that said amplifier is approximately quiescent at the carrier level, and means in circuit with the other amplifier for preventing the same from passing current above substantially carrier level.

6. A high frequency modulated carrier wave transmitting system comprising a source of oscillations, two high frequency high power amplifiers whose input circuits are effectively in parallel with respect to said source, a modulating circuit associated with each of said amplifiers for modulating the oscillations therein, means for applying modulating potentials to the two modulating circuits, means for causing one of said modulating circuits to be effectively responsive substantially only to positive half waves of modulating potentials and means for causing the other modulating circuit to be effectively responsive only to negative half waves of modulating potentials substantially as described.

7. A system in accordance with claim 6 characterized in this, that said two modulating circuits comprise modulating electron discharge tubes.

8. A system in accordance with claim 6 characterized in this, that said two modulating circuits comprising electron discharge tubes, one of said modulating circuits being effectively responsive only to positive half waves of modulating potentials while the other is effectively responsive substantially only to negative half waves of modulating potentials.

9. In a high frequency modulated carrier wave signalling system, the method of operation which comprises generating oscillations, modulating said oscillations in accordance with the message waves to be transmitted, transmitting the modulated waves over two paths, amplifying only modulated carrier waves of an amplitude below the mean carrier level in one of said paths amplifying only modulated carrier waves of an amplitude above the mean carrier level in the other of said paths, and combining the resultant amplified waves for signalling purposes.

10. In a high frequency modulated carrier wave transmitting system, the method of operation which comprises separately amplifying modulated carrier wave variations the amplitude of which is above the mean carrier level, separately amplifying modulated carrier wave variations, the amplitude of which is below the mean carrier level, and combining the resultant amplified waves in like phase relation.

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