

April 25, 1944.

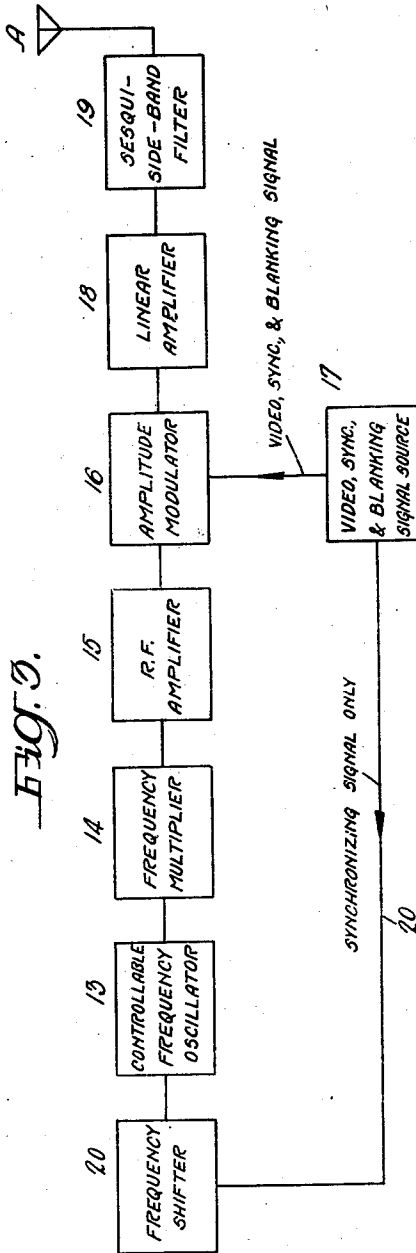
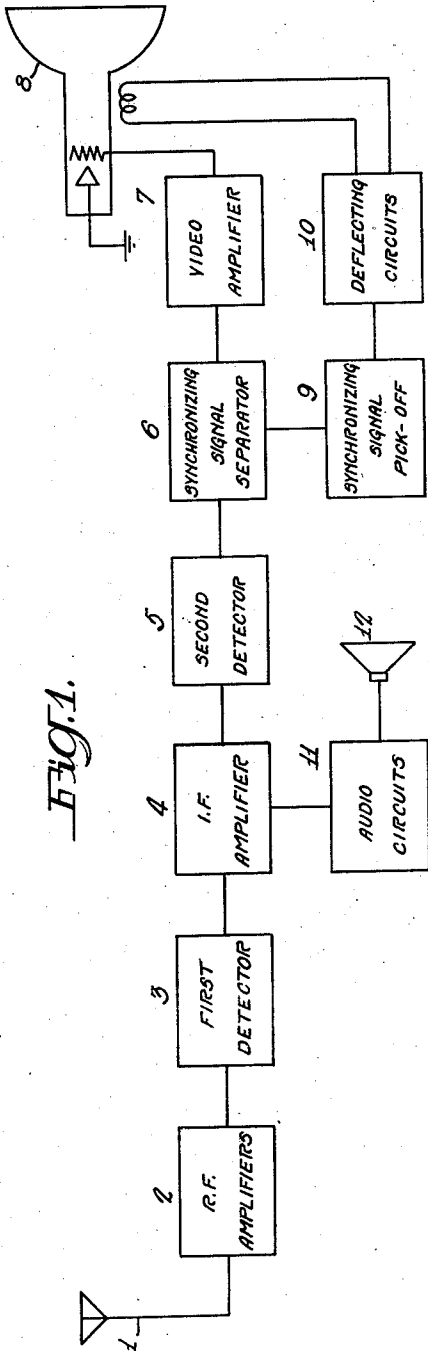
F. J. BINGLEY

2,347,248

ALTERNATE CARRIER TELEVISION SYSTEM

Filed July 8, 1941

3 Sheets-Sheet 1



Inventor:-
 Frank J. Bingley
 by his Attorneys
 Houson & Houson

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F. J. BINGLEY

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3 Sheets-Sheet 2

Fig. 2A.

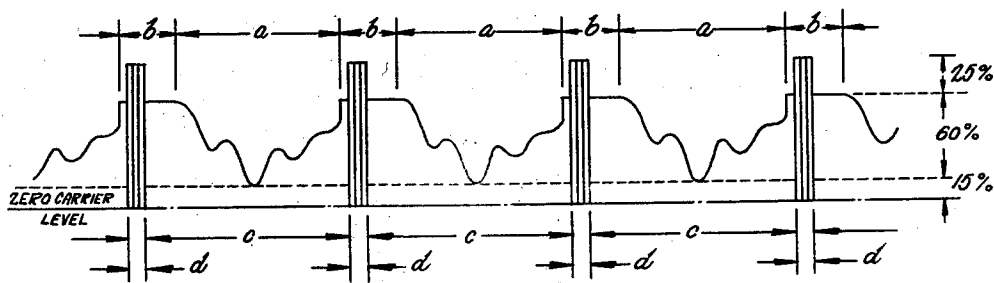


Fig. 2B.

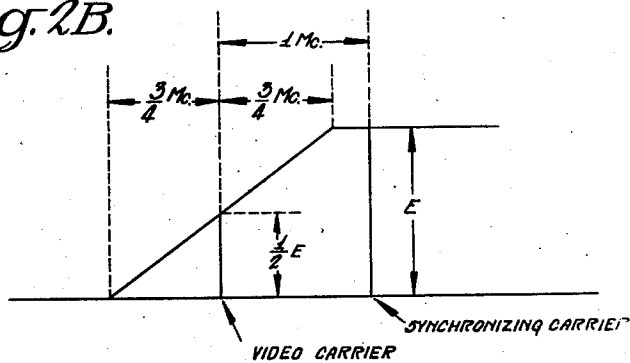
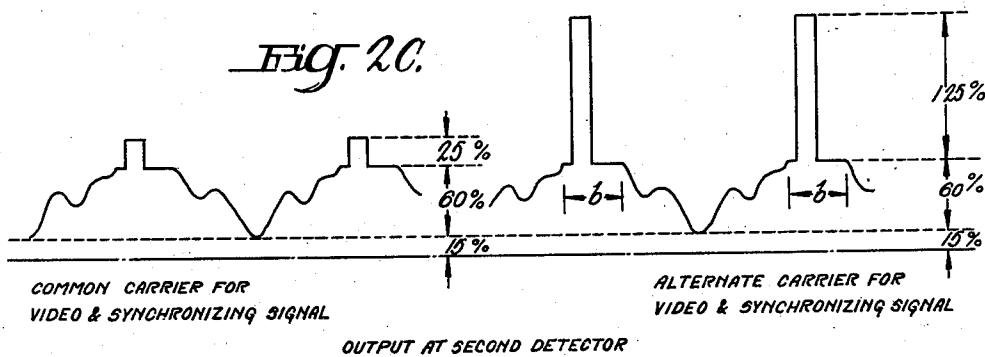


Fig. 2C.



Inventor:-
Frank J. Bingley
by his Attorneys
Hewson & Hewson

April 25, 1944.

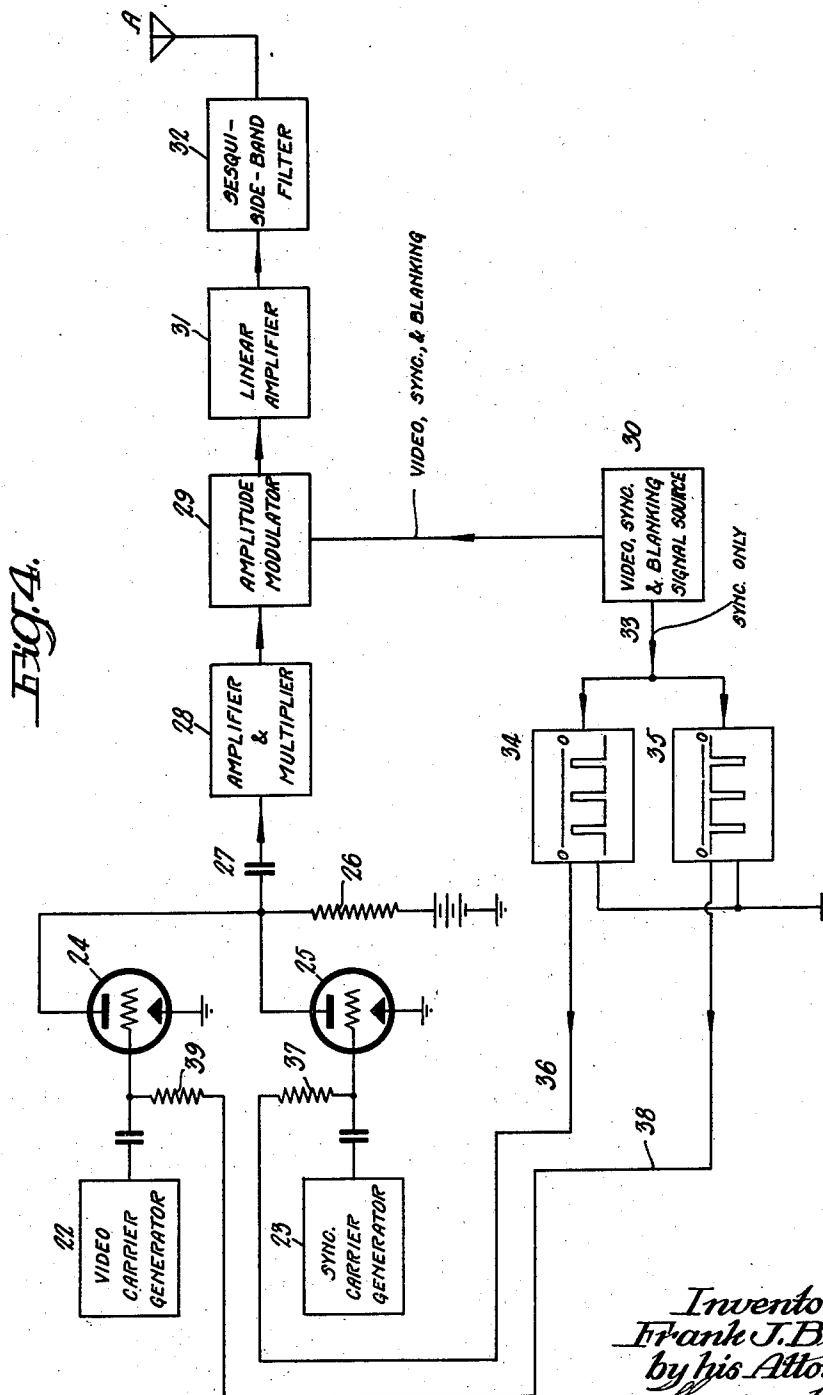
F. J. BINGLEY

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ALTERNATE CARRIER TELEVISION SYSTEM

Filed July 8, 1941

3 Sheets-Sheet 3



*Inventor:-
Frank J. Bingley
by his Attorneys
Houson & Houson*

UNITED STATES PATENT OFFICE

2,347,248

ALTERNATE CARRIER TELEVISION
SYSTEM

Frank J. Bingley, Chestnut Hill, Pa., assignor to
Philco Radio and Television Corporation,
Philadelphia, Pa., a corporation of Delaware

Application July 8, 1941, Serial No. 401,533

22 Claims. (Cl. 178—7.1)

This invention relates to a novel and improved composite modulated-carrier-wave television signal, and to a method of, and means for, generating, transmitting, and receiving such an improved signal.

In the past it has been customary to transmit the video and synchronizing signal components of the composite television signal by causing them to amplitude-modulate the same carrier. It is customary to do this in such a manner that the two components can readily be separated one from the other in order that they may perform their respective functions at the receiver. This has generally been done by dividing the time axis of the carrier wave signal into regularly spaced intervals of alternately long and short duration. During the long intervals the carrier wave is modulated by the video signal, and during the shorter intervals by synchronizing signal. In order to permit amplitude separation of the video and synchronizing signals, it is customary to establish these signals at relatively different amplitude levels. Usually from 20 to 25% of the overall carrier amplitude is reserved for the synchronizing component.

Recently there has been suggested (Electronics, Feb. 1940, pp. 27-30, Article by A. V. Loughren) an improved form of signal for transmitting the video and synchronizing intelligence which effectively increases the amplitude of the synchronizing signal relative to the video signal, and thus improves the relative synchronizing signal-to-noise ratio, without detracting from the amplitude of the video signal. In certain respects the signal employed in the present invention is similar to that described by Loughren. The video and synchronizing intelligence is segregated into alternative long and short time intervals along the time axis of the signal as it is transmitted. During the long intervals the video signal is caused, in the preferred embodiment, to amplitude-modulate the carrier wave in accordance with the aforementioned practice. During the short interval, however, the synchronizing intelligence is made to shift the carrier wave and simultaneously to increase the amplitude level of the shifted carrier with respect to the blanking level of the video signal. Consequently, the present system may be regarded as one employing two carrier waves, the video carrier and the synchronizing carrier. As will be pointed out hereinafter, the gain vs. carrier frequency characteristic of the television receiver enables synchronizing signals so transmitted to be received in a highly favorable manner.

A primary object of the present invention, therefore, is to provide a novel and highly effective form of modulation for a carrier wave television signal comprising both video and synchronizing intelligence.

A further object of the invention is to provide a television signal of novel character, capable of being favorably received through severe electrical interference.

Another object of the invention is to provide a composite television signal of such character that, without requiring increased transmitter power, and without reducing the transmitted video intelligence with respect to the synchronizing intelligence, the said composite signal may be so received that the effective synchronizing signal derived therefrom is very substantially increased over that obtainable heretofore.

Another object of the invention is to provide a system for transmitting a composite television signal in which the transmitter may be driven to an extent closely approaching a full load condition during the video and blanking intervals, but is momentarily overdriven during the alternate frequency (synchronizing) intervals, so that the transmitter is operated at its maximum possible usefulness.

Still another object of the invention is to provide an improved composite television signal capable of effecting highly accurate synchronizing in districts of low signal strength, or in districts subject to unusually severe electrical noise conditions.

Other objects and advantages of the invention will be apparent from the following description and the accompanying drawings in which:

Fig. 1 is a block diagram of a conventional television receiver;

Fig. 2 illustrates the improved form of signal above referred to and the advantages thereof;

Fig. 3 is a block diagram of a system constructed in accordance with the invention for generating the new type of signal illustrated in Fig. 2; and

Fig. 4 is a block diagram of an alternative system for generating the new type of signal.

The present invention may best be understood by first considering in greater detail the new type of signal and its reception by a receiver. Although a special receiver may be employed, having particular adaptation for separating the video and synchronizing components of the signal, the signal may be efficiently received by a conventional receiver, such as shown

in Fig. 1, commonly employed to receive the purely amplitude-modulated signal used in the past. Not only is such a conventional receiver adapted to receive the new signal, but, when supplied therewith, it will operate more satisfactorily than with the old form of purely amplitude-modulated signal. The reasons for this will now be set forth with reference to Figs. 1 and 2.

Referring first to Fig. 1, the conventional receiver there shown comprises a signal-collecting antenna 1, a radio frequency amplifier 2, a first detector 3, an intermediate frequency amplifier 4, a second detector 5, a synchronizing signal separating stage 6, a video signal amplifier 7, and a visual reconstructing device or picture tube 8. In general, the synchronizing signal pick-off stage 6, which derives signal from stage 5, may comprise a tube whose bias is so controlled that it selects only that portion of the composite signal which exceeds the so-called blanking level, which portion comprises synchronizing pulses of the known type. These pulses are utilized to control the deflecting circuits 10 which generate sawtooth wave forms of the well known type for accomplishing the deflection of an electron beam in the picture tube 8. As in the usual television receiver, the audio-modulated carrier signal may be amplified in the radio frequency amplifier 2, its frequency may be translated in the first detector 3, and it may be fed from the output of the said detector or from a point in the intermediate frequency amplifier 4 to the audio frequency circuits 11. The latter may include an intermediate frequency amplifier, a second detector, and an audio amplifier from which signal is supplied to the sound reproducing device 12.

The manner in which the conventional receiver of Fig. 1 operates when supplied with the new type of signal may best be understood by reference to Figs. 2—A, 2—B, and 2—C. This signal is shown in Fig. 2—A, only the portion above the zero carrier level being illustrated since the signal is symmetrical with respect thereto. During the intervals *c* the frequency of the carrier wave is maintained at a substantially constant value which will hereafter be referred to as the "video carrier frequency." During the shorter intervals *d*, the frequency of the carrier wave is shifted to a different value which may be either higher or lower than the carrier frequency. This frequency will hereafter be referred to as the "synchronizing carrier frequency." In a signal adapted to be received by a conventional television receiver, the synchronizing carrier frequency may, for example, be located approximately one megacycle above the video carrier frequency. During the intervals *a*, which in general may be slightly shorter than the intervals *c*, the video carrier is amplitude-modulated by means of the signal containing the video intelligence. During the portion of intervals *b* preceding and succeeding the intervals *d*, the video carrier is preferably established at a substantially constant amplitude. This amplitude may correspond approximately to a "black" picture signal. According to the invention, the frequency of the carrier wave is not only shifted during the synchronizing interval *d*, but also the amplitude thereof is increased very appreciably over the blanking level of interval *b*, as illustrated in Fig. 2—A. This amplitude may correspond to a "blacker than black" picture signal, i. e., to an "infra-black" signal. Thus the synchronizing signals are enabled to manifest themselves at the

receiving station not only by a variation or shift in the carrier frequency, but also by a variation or change in carrier amplitude. The characteristics and advantages of such a hybrid synchronizing signal will be explained more fully hereinafter.

For purposes of simplifying the explanation of the invention, the exemplary signal shown in Fig. 2—A has been used. However, it should be understood that this is not the only specific form of signal which can be generated. For instance, the intervals *a* during which amplitude-modulation of the video carrier obtains, the intervals *b* separating the intervals *a*, and the intervals *d* during which the carrier frequency is shifted to the predetermined frequency may all be varied in duration. Furthermore, the respective intervals need not all be of the same duration, nor need the frequency of the carrier be changed to the same extent in every interval *d*. Under the present practice it has been found desirable, in forming a television signal of this type, to establish the synchronizing carrier 15,750 times per second (for 525 line, 30 frame, interlaced television) to effect horizontal synchronization, while further establishing the said carrier 60 times per second to effect vertical synchronization. In order that the horizontal synchronizing intelligence may be separated from the vertical, it is possible to make the intervals during which the 60 cycle signals occur longer than those during which the 15,750 cycle signals occur. To avoid interference between the two, the longer intervals may be serrated to provide for horizontal synchronization during the vertical synchronizing intervals in the same manner as is done when the synchronizing signals are caused merely to vary the amplitude of a single carrier wave as has been the practice heretofore.

It will be recognized that in the signal represented in Fig. 2—A, the intervals *b* may be the horizontal synchronizing intervals. Assuming this to be the case, the respective durations of the intervals *a*, *b*, and *d* (for the case of 525 line, 30 frame, interlaced television) might be approximately as follows:

$$\begin{aligned} a &= 55 \text{ microseconds} \\ b &= 9 \text{ microseconds} \\ d &= 5 \text{ microseconds} \end{aligned}$$

It will, of course, be understood that Fig. 2—A does not purport to show the longer duration vertical synchronizing intervals.

In Fig. 2—B there is represented approximately the standard frequency response characteristic of those stages preceding the second detector in a standard television receiver adapted for operation with the conventional sesqui-sideband or vestigial sideband transmissions. In order to equalize the percentage of modulation of the sideband components in the vicinity of the carrier, the response is made substantially uniform down to a point approximately 0.75 megacycle above carrier from which point it decreases substantially uniformly to zero at a point approximately 0.75 megacycle below carrier. Thus, the response at carrier frequency will be approximately 50% of maximum. As is well known to those skilled in the art, such a response characteristic serves to restore to their proper relative amplitudes the sideband components whose amplitudes are distorted in the course of transmission by the so-called vestigial sideband method. Such a response characteristic is of decided assistance in the utilization of the new type of sig-

nal under discussion for reasons which will appear presently.

When the signal of the type shown in Fig. 2—A is applied to a receiver with a response characteristic of the type shown in Fig. 2—B, the response to the carrier frequency during the intervals c will, as shown in Fig. 2—B, be proportional to $\frac{1}{2} E$, where E is the maximum response. However, during the intervals d when the synchronizing carrier is established, operation will be upon the upper and level portion of the frequency response curve, so that the response to the synchronizing carrier will be proportional to E or twice the response to the video carrier. Of course, in order for this to be the case, the video carrier frequency must be shifted to such an extent as to cause operation upon the upper part of the response curve. In the case shown in Fig. 2—B, where the response begins to fall off at a point 0.75 megacycle above carrier, it will be sufficient to shift the carrier frequency upward by approximately 1 megacycle.

The advantages to be gained by utilizing this improved form of transmitted signal will be apparent from a comparison of the detected signals obtained at the second detector when the old and new signals are used. The two signals are shown, respectively, to scale at the left and at the right in Fig. 2—C. Both signals may be thought of as resulting from the detection of carrier waves having the amplitude modulation envelope of Fig. 2—A. The signal to the left, however, results from the reception of a carrier wave in which both video and synchronizing signals are applied to the same carrier. The signal to the right, i. e., the new signal, results when the video and synchronizing signals are transmitted by means of separate or alternate carriers differing in frequency. In the case of the old signal, it is customary that about 25% of the amplitude of the signal be occupied by the synchronizing component. This will leave approximately 60% available for the video signal since, due to limitations in the capabilities of modulating equipment, it is generally difficult to obtain more than about that much picture modulation.

In the signal utilized in the new method, the amplitude of the synchronizing signal modulation may be maintained at its previous value of 25%, while the amplitude of the video modulation may be maintained at its previous value of about 60% of peak carrier, but by the establishment of a new synchronizing signal carrier at a frequency for which the receiver gain is double that of the video carrier (see Fig. 2—B) the detector output during synchronizing signal will be double that obtained in the case of the old signal, as illustrated in Fig. 2—C. On the basis of the percentages shown for the left-hand signal of this drawing, the new synchronizing signal amplitude will be 125% of the original peak carrier. Thus, while the peak detected synchronizing signal for the new system is twice that of the old system, the new system yields a synchronizing signal pulse which is five times as great as that obtained in the old system, i. e. 125% as compared with 25%. This voltage gain of five times is equivalent to what could only be obtained, under the old system, by a transmitter power increase of twenty-five times. Obviously, the new system will enable the receiver to be maintained in synchronism with weak signals, or through strong interference, much more reliably than was the case in the old system. Actual field tests which were carried out to compare the two systems under

various conditions of noise and signal strength fully bear out these theoretically determined advantages.

Referring now to Fig. 3, which shows in block form a complete system for generating the new signal, it will be noted that the controllable frequency oscillator 13 constitutes the prime source of radio frequency energy. This oscillator may operate at the assigned carrier frequency of the station, or at some sub-multiple thereof, in which latter case a frequency multiplier 14 may be added to supply a carrier wave of the desired frequency. The output of the multiplier may be amplified in a suitable radio frequency amplifier 15, whence the carrier wave may be passed to an amplitude modulator 16 for modulation. The video, blanking, and synchronizing signals, in response to which the carrier amplitude is modulated, may be supplied to the modulator 16 from a suitable composite signal source 17. The modulated carrier output of the modulator 16 may be further amplified, if desired, in a suitable linear amplifier 18 before it is supplied to the sesqui-side-band filter 19 and to antenna system A for radiation.

In order that the carrier frequency, as well as the carrier amplitude, may be varied in response to the synchronizing signals supplied by the source 17, there may be connected to the oscillator 13 a suitable frequency shifter or frequency control device 20. This device, when supplied by way of the connection 21, with synchronizing signal pulses from the signal source 17, functions to vary or shift the frequency of the oscillator 13, and thus also the frequency of the wave radiated by the antenna system A. Suitable frequency control circuits are now well known in the art, and are described in detail in U. S. Patent No. 2,240,428 of Charles Travis, assigned to the Philco Radio & Television Corporation. Other suitable circuits are described in the copending application of David B. Smith, Serial No. 401,494, filed July 8, 1941. Certain specific circuits and devices particularly adapted for use with the system shown diagrammatically in Fig. 3 are fully illustrated and described in the said copending application of David B. Smith.

According to one of the features of this invention, the transmitter is driven, during the video and blanking intervals (excluding the synchronizing intervals), to an extent closely approaching full load, but during the brief synchronizing intervals is overloaded to an extent approximating the instantaneous maximum current capabilities of the transmitter. In television transmitters, as presently designed, the continuous full-load current which can be delivered by a given installation may be of the order of 75% of the maximum instantaneous current supplying capabilities of the transmitter. The full-load current rating of a transmitter having negative picture modulation is usually based upon the operation of the transmitter while transmitting a black or an almost black picture, since under these conditions the system is most heavily loaded, the carrier level corresponding, throughout the intervals a , to approximately the carrier level during the blanking portions of the intervals b .

Within the normal full-load range of operation of the transmitter the modulation characteristic thereof can be made relatively linear, but between full-load current and maximum current the characteristic may be highly non-linear. According to the present invention advantage is taken of these limitations by restricting the carrier ampli-

tude, during the video or picture intervals, to say 75% of the maximum instantaneous carrier amplitude. In this relatively linear portion of the transmitter's operating range the relation between the shades of white and gray in the picture may be faithfully transmitted and this is particularly true of the 60% range denoted in Fig. 2—A. However during the brief synchronizing intervals d the carrier frequency is shifted as already explained while at the same time the transmitter is driven to its maximum extent to supply a wave having an amplitude corresponding to the 100% level reached by the peak of the synchronizing pulses d of Fig. 2—A. The fact that the linearity of the transmitter may be very poor throughout this upper 25% range is of little or no consequence, since the synchronizing pulses are similar and of a generally rectangular wave shape, there being accordingly no amplitude relations to maintain between various parts of the pulse or pulses.

Since the synchronizing periods d are very short compared to the periods d plus c (e. g. 5 microseconds as compared to 63 microseconds) it will be seen that if the transmitter is operated only very slightly underloaded during the periods c the momentary overloads corresponding to the synchronizing pulses of periods d , even though they may be relatively high, will not be substantial when integrated over a time corresponding, e. g., to one picture line or one picture frame (525 lines); consequently the increased heating of the power amplifiers due to the increased amplitude of the synchronizing pulses will not be substantial. On the other hand, as shown above, the improvement in receiver operation and synchronization is very substantial, and makes possible a much improved television system.

Reference is now made to Fig. 4 in which there is shown, largely in block diagram, an alternative embodiment of a television transmitter constructed according to the invention. This embodiment, rather than employing a single master oscillator of controllable frequency, employs two separate oscillators, or carrier generators, of substantially fixed frequency. The video carrier generator 22 is adapted to generate a carrier frequency corresponding to that which is amplitude modulated during the interval c (Fig. 2—A) by the video and blanking signals. The synchronizing carrier generator 23 is adapted to generate a carrier frequency different from that supplied by the generator 22 and corresponding to that carrier which is amplitude modulated during the interval d by the synchronizing signal. The output of each of these generators, 22 and 23, may be supplied respectively to a pair of triodes, 24 and 25, having a common anode load resistor 26, the signal across which may be supplied, by way of the coupling condenser 27, to an amplifier and frequency multiplier (optional) 28. While triodes have been illustrated in Fig. 4 in the interests of simplicity, it will be desirable in practice to substitute one or two pentodes (in cascade, if two) for each of the triodes illustrated in order to make the keying or switching more positive. The elements 24 to 28 constitute the basic elements of one form of electron switch by which, in response to a predetermined signal, the input to the device 28 may be selectively switched from one of the generators 22, 23 to the other. The operation of this electron switch will be described in greater detail hereinafter.

Following the amplifier and multiplier stage 28 there may be provided an amplitude modulator

stage 29 adapted to modulate the amplitude of the carrier wave in response to a composite video, blanking, and synchronizing signal derived from a suitable source 30. The modulated output of the modulator stage 29 may, if desired, be amplified further by means of a linear amplifier stage 31 before supplying it to an antenna system A for radiation. If the transmissions are to be of the vestigial sideband or sesqui-sideband type, a sesqui-sideband filter 32 may be connected between the amplifier 31 and the antenna system A.

The electron switching system for establishing the appropriate carriers during the intervals d and c may be operated in response to a signal derived from the source 30 as follows. By way of a conductor 33 a signal, comprising synchronizing signal components only, may be applied to a pair of networks 34 and 35. The network 34 is adapted to supply, in response to the applied synchronizing signal, a signal which is highly negative with respect to the cathode of triode 25 during the interval c , but only slightly negative during the synchronizing interval d . Such signal is illustrated within the rectangle 34, the zero level being indicated by the line $o-o$. Accordingly when this signal is applied to the grid of triode 25 by way of the conductor 36 and the resistor 37 the triode 25 is enabled to transfer the synchronizing carrier from source 23 to the amplifier stage 28 during the synchronizing interval d , but is blocked during the longer interval c by the application to its grid of the highly negative potential supplied by the device 34.

The network 35 supplies a signal which is substantially the reverse of that supplied by the network 34, as illustrated within the rectangle. This signal, which is applied to the control grid of the triode 24 by way of the lead 38 and resistor 39, is only slightly negative during the longer intervals c , but is highly negative during the synchronizing intervals d . As a result of the operation of the devices 24, 25 and 34, 35, there is provided a system wherein the video carrier is switched on during the intervals c , and off during the intervals d , while the synchronizing carrier is switched off during the intervals c , and on during the intervals d . Accordingly it will be seen that during the interval c the modulator stage 29 amplitude modulates the video carrier with the video and blanking signals derived from the source 30, while during the interval d the modulator 29 amplitude modulates the synchronizing carrier with the synchronizing signals derived from source 30.

Devices of the type represented by 34 and 35 are well known and require no detailed illustration.

An obvious equivalent of this system would be one in which the source 30 supplied only a video and blanking signal to the modulator 29, and in which the amplitude of the synchronizing carrier supplied by the generator 23 was somewhat greater than that of the video carrier supplied by the source 22. The ratio of the carrier amplitudes supplied by the sources might be such that the radiated carrier would have an envelope similar to that illustrated in Fig. 2—A.

In the several embodiments of the invention hereinbefore described it has been assumed that the video and blanking portions of the composite signal are imparted to the carrier wave by amplitude modulation thereof. The invention is not, however, limited to such a system, for if desired the video and blanking portions of the composite signal may be imparted to the carrier by the fre-

quency modulation thereof. Under these conditions, the carrier amplitude may be set to correspond, for example, to the 75% blanking level of Fig. 2—A throughout, with the exception of the short synchronizing periods *d*. During the latter periods the carrier is preferably shifted in frequency by an amount somewhat greater than the maximum frequency deviation obtaining during the video and blanking portions of the line. Simultaneously, during the synchronizing intervals, the amplitude of the carrier may be established at an overload level corresponding to the 100% level illustrated in Fig. 2—A, wherein the 75% level is approximately full load.

The transmitting system illustrated diagrammatically in Fig. 3 may be utilized without substantial change to generate a modulated carrier signal of this character. Assume for example that it is desired to transmit the video and blanking signals by frequency modulation, and the synchronizing signals by effecting sudden changes in the amplitude and frequency of the carrier wave as already described. This mode of operation could be effected with the apparatus of Fig. 3 by supplying synchronizing, video, and blanking signals from the source 17 to the frequency shifter 20, while supplying only synchronizing signals to the amplitude modulator 16. With this mode of operation the frequency shifter 20 might more correctly be referred to as a "frequency deviator."

Under some conditions it may be desirable to employ a combination of frequency and amplitude modulation in imparting the video intelligence to the carrier wave, and the invention should be understood to contemplate such operation. Generally, however, it seems preferable that the video modulation should be largely one type of modulation or the other, in contradistinction to the synchronizing signal modulation which should be characterized by substantial shifts or changes in both amplitude and frequency.

Although the invention has been described with reference to certain specific embodiments, it will, of course, be understood that it is capable of expression in other physical forms which will occur to those skilled in the art after reading the foregoing description. The scope of the invention is to be subjected only to those limitations imposed by the following claims.

I claim:

1. In a system for generating a composite negatively-modulated carrier-wave television signal containing both video and synchronizing intelligence, a transmitter having a full-load current level and an overload current level, a source of signals of video frequency, means included in said transmitter for generating a first carrier wave for the transmission of said video signals, means for amplitude modulating said carrier wave with said video signals over a predetermined range, the maximum extent of said range being limited to a level which is slightly below said full-load level, a source of synchronizing signals, means for generating a second carrier wave for the transmission of said synchronizing signals, the frequency of said second carrier wave differing substantially from the frequency of the first carrier wave, means for amplitude modulating said second carrier wave with said synchronizing signals to an extent substantially exceeding the full-load current level of said transmitter and corresponding to said overload level, means normally operative for establishing said

video carrier, and means operative during the presence of said synchronizing signals for temporarily suppressing said video carrier and establishing said synchronizing carrier.

2. In a system for generating a composite negatively-modulated carrier-wave television signal containing both video and synchronizing intelligence, a transmitter having a full-load current level, said transmitter having a relatively linear modulation characteristic below said full load level, a source of signals of video frequency, a source of synchronizing signals, means in said transmitter for generating a carrier wave of predetermined frequency for the transmission of said video signals, means for amplitude-modulating said carrier wave with said video signals over a predetermined range, the maximum extent of said range being limited to a level which does not exceed said full-load level, and means responsive to said synchronizing signals for amplitude-modulating said carrier wave in substantial excess of said full load level and substantially simultaneously shifting said wave to a different predetermined frequency.

3. In a system for generating and transmitting a negatively modulated carrier-wave television signal containing both video and synchronizing intelligence, a source of video signals, a source of blanking signals, a source of synchronizing signals, a vacuum tube transmitter having means for generating a carrier wave for the transmission of all of said signals, means responsive to said blanking signals for periodically establishing the amplitude of said carrier wave at a level corresponding approximately to the maximum continuous output level of said transmitter, means responsive to said video signals for amplitude-modulating said carrier wave between levels corresponding to said blanking level and a predetermined relatively low level, and means responsive to said synchronizing signals for periodically shifting the frequency of said carrier wave and substantially simultaneously establishing the amplitude of said carrier wave at a level corresponding approximately to the instantaneous peak output level of said transmitter.

4. In a modulated carrier-wave television system comprising transmitting and modulating apparatus, the method of transmitting video and synchronizing intelligence, which comprises operating said transmitting apparatus at approximately full-load during the transmission of the video intelligence, substantially overloading said transmitting apparatus during the transmission of the synchronizing intelligence, imparting the video intelligence to the carrier wave by varying only one characteristic thereof, and imparting the synchronizing intelligence to the carrier wave by changing both the amplitude and frequency thereof.

5. In a system for generating a composite modulated-carrier-wave television signal containing both video and synchronizing intelligence, a source of signals of video frequency, means for generating a first carrier wave for the transmission of said video signals, means for amplitude-modulating said carrier wave with said video signals, a source of synchronizing signals, means independent of said first carrier wave generating means for generating a second carrier wave for the transmission of said synchronizing signals, means for amplitude-modulating said second carrier wave with said synchronizing signals, the frequency of said first carrier wave differing from the frequency of said second carrier wave, means

normally operative for establishing said video carrier, and means operative during the presence of said synchronizing signals for temporarily suppressing said video carrier and establishing said synchronizing carrier.

6. In a system for generating a composite modulated-carrier-wave television signal containing both video and synchronizing intelligence, a source of signals of video frequency, a source of synchronizing signals, means for generating a carrier wave of predetermined frequency for the transmission of said video signals, means for amplitude-modulating said carrier wave with said video signals during predetermined video intervals, means responsive to said synchronizing signals for amplitude-modulating said carrier wave during predetermined synchronizing intervals, and means responsive to said synchronizing signals for shifting said wave to a different predetermined frequency during the synchronizing intervals.

7. In a system for generating a composite negatively-modulated carrier-wave television signal containing both video and synchronizing intelligence, a source of signals of video frequency, means for generating a first carrier wave of predetermined frequency, means for amplitude-modulating said carrier wave with said video signals, the maximum amplitude of said modulated carrier wave corresponding to black, means for generating a second carrier wave of predetermined frequency differing from the frequency of said first carrier wave, a source of synchronizing signals, and means operative during the presence of said synchronizing signals for periodically suppressing said video carrier and for establishing said second carrier at an amplitude greater than the said maximum amplitude of said video carrier and corresponding to infra-black.

8. In a system for generating a composite negatively modulated carrier-wave television signal containing both video and synchronizing intelligence, a source of signals of video frequency, a source of synchronizing signals, means for generating a carrier wave of predetermined frequency for the transmission of said video signals, means for amplitude-modulating said carrier wave with said video signals, the maximum amplitude of said modulated carrier wave corresponding to black, and means responsive to said synchronizing signals for periodically shifting said carrier wave to a different predetermined frequency and for establishing said carrier wave at an infra-black level, said level corresponding to a carrier wave amplitude greater than said maximum amplitude.

9. In a system for generating a composite negatively-modulated carrier-wave television signal containing both video and synchronizing intelligence, a source of signals of video frequency, a source of blanking signals, a source of synchronizing signals, means for generating a carrier wave of predetermined frequency for the transmission of said video signals, means for amplitude-modulating said carrier wave with said video signals, means responsive to said blanking signals for periodically establishing said carrier wave at an amplitude level corresponding to black, and means responsive to said synchronizing signals for periodically shifting said carrier wave to a different predetermined frequency, and for establishing said carrier wave at an amplitude level corresponding to infra-black.

10. In a vestigial sideband television transmission system, a source of signals of video frequency,

a source of synchronizing signals, means for generating a carrier wave of predetermined frequency for the transmission of said video and synchronizing signals, means for amplitude-modulating said carrier wave with said video signals, means for amplitude-modulating said carrier wave with said synchronizing signals, means for attenuating a portion of one of the sidebands generated in the modulating process, and means responsive to said synchronizing signals for periodically shifting the frequency of said carrier wave in the direction of the unattenuated sideband, said shifted carrier being returned to said predetermined frequency prior to the transmission of said video signals.

11. In a vestigial sideband television transmission and reception system, a source of signals of video frequency, a source of synchronizing signals, means for generating a carrier wave of predetermined frequency for the transmission of said video and synchronizing signals, means for amplitude-modulating said carrier wave with said video signals, means for amplitude-modulating said carrier wave with said synchronizing signals, means for attenuating a portion of one of the sidebands generated during modulation of the carrier wave, means responsive to said synchronizing signals for periodically shifting the frequency of said carrier wave in the direction of the unattenuated sideband, said shifted carrier being returned to said predetermined frequency prior to the transmission of said video signals, and a television receiver for the reception of said transmission, said receiver being characterized in having a gain-versus-frequency characteristic such that the gain thereof is substantially greater at said shifted carrier frequency than at said predetermined carrier frequency.

12. In a vestigial sideband transmission system, apparatus for generating a composite negatively-modulated carrier-wave television signal containing both video and synchronizing intelligence, comprising means for generating a first carrier wave of predetermined frequency, a source of signals of video frequency, means for amplitude-modulating said carrier wave with said video signals, the maximum amplitude of said modulated carrier wave corresponding to black, means for attenuating a portion of one of the sidebands generated in the process of modulation, means for generating a second carrier wave, the frequency of said second carrier wave differing from that of said first carrier wave and lying within the unattenuated sideband, a source of synchronizing signals, and means operative during the presence of said synchronizing signals for periodically suppressing said video carrier and for establishing said second carrier at an amplitude greater than the said maximum amplitude of said video carrier and corresponding to infra-black.

13. In a vestigial sideband television transmission and reception system comprising the apparatus claimed in claim 12, a television receiver therefor characterized in having a gain-versus-frequency characteristic such that the gain thereof is substantially greater at the frequency of said second carrier wave than at the frequency of said first carrier wave.

14. In a vestigial sideband transmission system, apparatus for generating a composite negatively-modulated carrier-wave television signal containing both video and synchronizing intelligence, comprising means for generating a first carrier wave of predetermined frequency, inde-

pendent means for generating a second carrier wave of different frequency, a frequency multiplier, means responsive to video and blanking signals for varying the amplitude of the carrier wave output of said multiplier between levels corresponding substantially, in the reproduced television signal, to extremes of white and black, means responsive to synchronizing signals for increasing the carrier wave output of said multiplier to a level corresponding to infra-black, and electronic switching means operative in response to an electrical signal for normally connecting the input of said multiplier to said first carrier wave generating means, and for connecting the input of said multiplier to said second carrier wave generating means during the synchronizing-signal intervals.

15. In a television transmitter having apparatus for generating a carrier wave of controllable amplitude and frequency, the method of alternately transmitting video and synchronizing intelligence, which comprises imparting the video intelligence to the carrier wave largely by the variation of one of the characteristics thereof, imparting the synchronizing intelligence to the carrier wave by changing both the amplitude and frequency thereof, driving said transmitter at approximately its maximum continuous output level during the video intervals, and driving said transmitter at approximately its instantaneous peak output level during the synchronizing intervals.

16. In a television transmitter having apparatus for generating a carrier wave of controllable amplitude and frequency, the method of alternately transmitting video and synchronizing intelligence, which comprises imparting the video intelligence to the carrier wave by frequency modulating said wave, imparting the synchronizing intelligence to the carrier wave by changing both the amplitude and frequency thereof, driving said transmitter at approximately its maximum continuous output level during the video intervals, and driving said transmitter at approximately its instantaneous peak output level during the synchronizing intervals.

17. In a system for generating a composite modulated-carrier-wave television signal containing both video and synchronizing intelligence, a source of signals of video frequency, a source of synchronizing signals, means for generating a carrier wave for the transmission of said video signals, means for frequency-modulating said carrier wave with said video signals during predetermined video intervals, means responsive to said synchronizing signals for amplitude-modulating said carrier wave during predetermined synchronizing intervals, and means responsive to said synchronizing signals for shifting said wave to a different predetermined frequency during the synchronizing intervals.

18. In a system for generating a composite modulated-wave television signal containing both video and synchronizing intelligence, a transmitter having a full-load current level and an over-

load current level, a source of signals of video frequency, a source of synchronizing signals, means for generating a carrier wave for the transmission of said video signals, the amplitude of said carrier being established at a level approximating said full-load level, means for frequency-modulating said carrier wave with said video signals, and means responsive to said synchronizing signals for shifting said wave to a different predetermined frequency while substantially simultaneously establishing the amplitude of said wave at a level approximating said overload current level.

19. In a carrier-wave television transmitter, means for generating a carrier wave, said generated wave having predetermined characteristics of amplitude and frequency, a source of video signals, a source of synchronizing signals, means for imparting the video intelligence to said carrier wave during predetermined video intervals, said means including apparatus for varying at least one of the said characteristics of said carrier wave, and means for imparting the synchronizing intelligence to said carrier wave during predetermined synchronizing intervals, said last-named means including apparatus for changing both the amplitude and frequency of said carrier wave.

20. A carrier-wave television system as claimed in claim 19, characterized in that said transmitter is driven at approximately its maximum continuous output level during the video intervals, and at approximately its instantaneous peak output level during the synchronizing intervals.

21. In a television transmitter, a carrier wave generating means, signal-responsive frequency shifting means associated with said generating means and adapted to shift the frequency of the carrier wave from one predetermined value to another predetermined value, an amplitude modulator coupled to said generating means, means for supplying video, blanking and synchronizing signals to said modulator, thereby to amplitude-modulate the carrier wave with the video, blanking and synchronizing signals during different intervals, and means for supplying synchronizing signals to said frequency shifting means, thereby to shift the frequency of the carrier wave during the synchronizing intervals.

22. In a television transmitter, a video carrier wave generator, a synchronizing carrier wave generator, the frequencies of the two carriers differing substantially from one another, a common output circuit for said generators, switching means for selectively connecting said generators to said output circuit, an amplitude modulator coupled to said output circuit, means for supplying video, blanking and synchronizing signals to said modulator, and means for actuating said switching means so as to connect said video carrier generator to said output circuit during the video intervals and to connect said synchronizing carrier generator to said output circuit during the synchronizing intervals.

FRANK J. BINGLEY.