

Oct. 13, 1942.

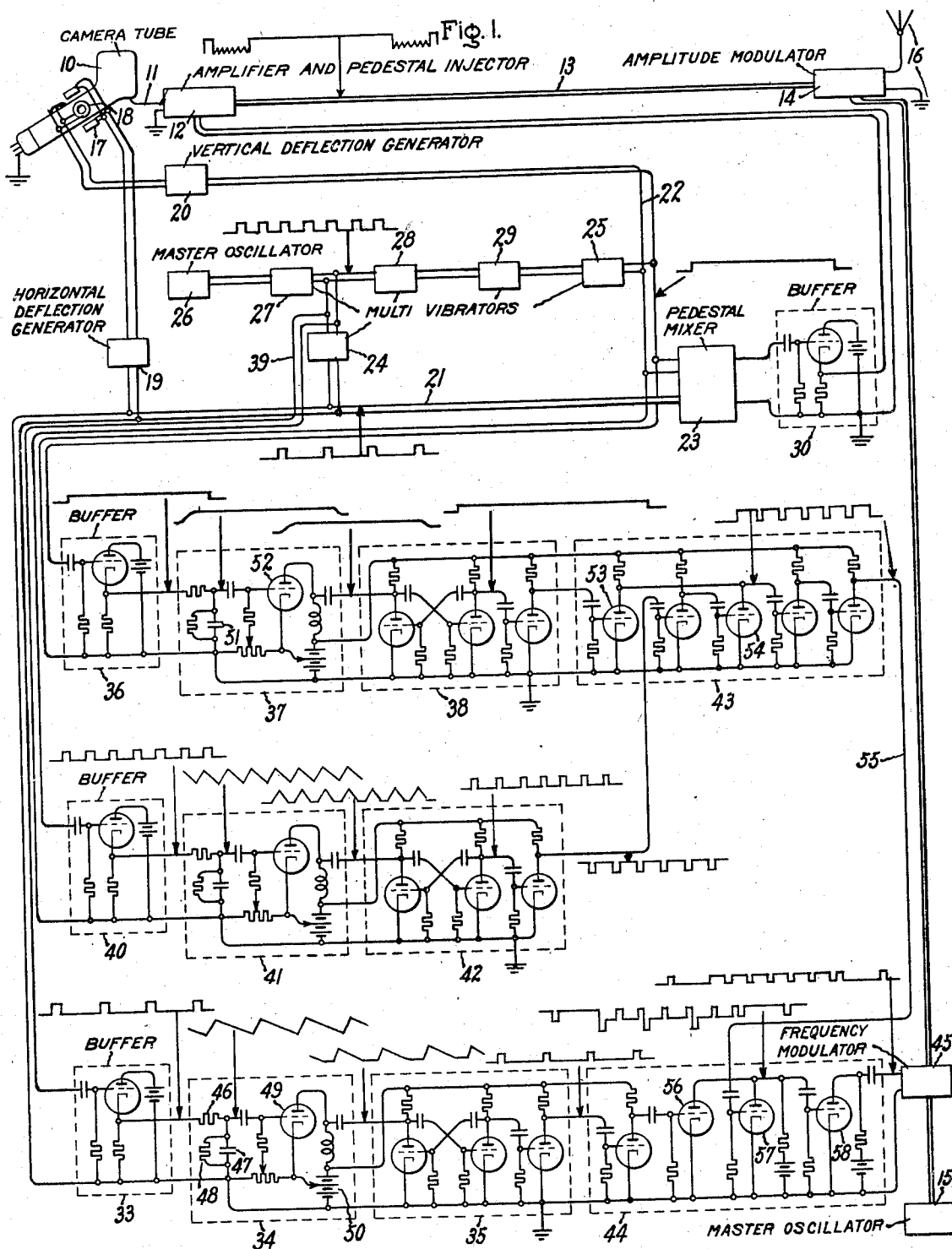
E. H. B. BARTELINK

2,298,863

IMAGE TRANSMISSION SYSTEM

Filed April 24, 1940

2 Sheets-Sheet 1



Inventor:
Everhard H. B. Bartelink,
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IMAGE TRANSMISSION SYSTEM

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2 Sheets-Sheet 2

FIG. 2.

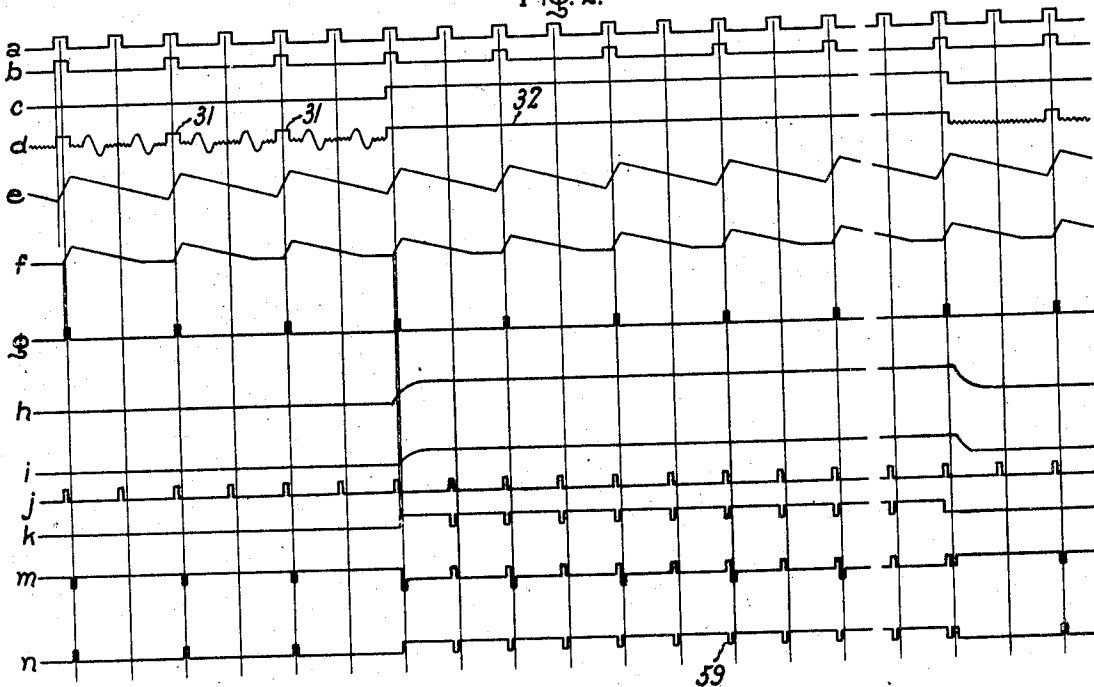
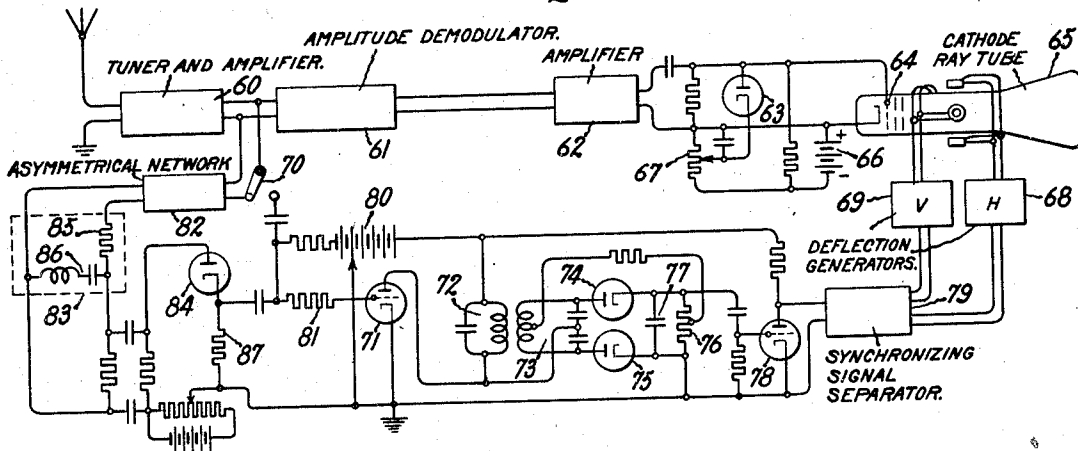


FIG. 3.



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UNITED STATES PATENT OFFICE

2,298,863

IMAGE TRANSMISSION SYSTEM

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Application April 24, 1940, Serial No. 331,349

19 Claims. (Cl. 178-7.2)

This invention relates to systems for transmitting visual images by means of electrical impulses and more especially to television systems and the like.

Television systems commonly used at the present time transmit two types of intelligence, namely—video signals and synchronizing signals, by modulating the amplitude of a carrier wave in accordance with each type of intelligence in such a way that suitable apparatus at the receiver may separate the types of intelligence. Much distortion of a received image is caused by noise pulses of high momentary value, which may produce false synchronizing signals. Such false synchronizing signals in present day receivers commonly cause irregular shifting of the scanning lines, wavering of the edges of the picture, and result in a considerable loss of definition or detail of the received image. It is a principal object of my invention to provide means for transmitting synchronizing signals to a visual image receiver with a high degree of fidelity and with minimum possibility of false synchronization.

It is a further object of my invention to provide a television system which utilizes a television signal having video and synchronizing pulses, the signal being impressed on a carrier wave to produce side bands which occupy a spectrum no broader than the frequency band of the video signals, and which system at the same time produces an image at the receiver whose scanning synchronization is effected with a high degree of fidelity, and hence whose reproduction of detail more nearly approaches the amount ultimately obtainable.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawings in which Fig. 1 illustrates a television transmitter embodying my invention; Fig. 2 illustrates certain characteristics of the apparatus illustrated in Fig. 1; and Fig. 3 illustrates a television receiver embodying my invention.

Fig. 1 illustrates my invention as applied to a television transmitter constructed as in present day practice. The transmitter comprises a camera tube 10, means 14 for modulating the amplitude of a carrier wave in accordance with video signals produced by the camera tube, and means

19, 20 for producing scanning action in the camera tube 10 and for modulating the frequency of the carrier wave in accordance with the scanning action. Video signals from the camera tube 10 are transmitted through a channel 11 to an amplifier and pedestal injector 12, where the video signals are amplified to high intensity and the pedestal or blanking interval is injected into the signal. The amplified video signals with the injected pedestals are transmitted through a channel 13 to the amplitude modulator 14, which modulates the amplitude of a carrier wave generated by a master oscillator 15. The output of the amplitude modulator 14 is radiated into space through an antenna and ground system 16.

Scanning action in the camera tube 10 is produced by horizontal deflecting coils 17 and vertical deflecting coils 18. These coils 17 and 18 are energized respectively by waves of suitable form generated respectively in the horizontal and the vertical deflection generators 19 and 20 and are utilized in a well known manner to produce appropriate scanning action.

The horizontal and vertical deflection generators 19 and 20 are maintained in properly synchronized operation by waves fed respectively from a horizontal narrow pulse generator 24 and a vertical pulse generator 25, which are both operated in synchronism with a master oscillator 26. The oscillator 26 drives a multi-vibrator 27, which produces narrow pulses at a frequency which is twice the frequency of the horizontal scanning. The generator 24 is a multi-vibrator which is operated synchronously with the multi-vibrator 27, except that the frequency of multi-vibrator 24 is half of the frequency of multi-vibrator 27. The generator 25 is also a multi-vibrator which is operated synchronously with the multi-vibrator 27 through the agency of two cascade connected multi-vibrators 28 and 29, and its frequency is much lower than that of multi-vibrator 27, being the vertical scanning or framing frequency.

The nature of the pulses produced by the generators 24 and 25 may be better understood by reference to Fig. 2, where the curve *a* represents the voltage of the wave produced by the multi-vibrator 27, and the curve *b* represents the wave produced by generator 24 and impressed on a channel 21 through which pulses are transmitted to the generator 19. Similarly, the curve *c* represents the voltage of the wave produced by the generator 25 and impressed on a channel 22, through which pulses are transmitted to the generator 20. Waves developed at certain points in

the circuits of Fig. 1 are illustrated above such points, and are generally similar to the waves illustrated in Fig. 2, except that the time base for the waves shown in Fig. 1 is compressed somewhat more than the time base for Fig. 2, and the vertical pedestals are illustrated as being shorter than is usual. That is, the time required for the transmission of a vertical pedestal or blanking signal usually is about 18 to 24 times the time between two successive horizontal pedestals, while it is illustrated in Fig. 1 as being only about three times.

The waves from the generators 24 and 25 are transmitted also to a pedestal mixer 23, where they are mixed. The resultant, which is the pedestal wave to be injected in the video signal wave, is amplified through a buffer amplifier 30 and transmitted to the amplifier and pedestal injector 12. The resultant video signal, including the video pulses and the injected pedestal wave, appears in the channel 13 and has the general form indicated by curve *d* of Fig. 2. The short or horizontal pedestals 31 and the long or vertical pedestal 32 are of such polarity as to produce blocking of the cathode ray beam in the receiver cathode ray tube, so that no light elements are generated during pedestal or blanking intervals, while the cathode ray beam is rapidly returning to begin tracing a new picture line or frame. The portions of this curve *d* between pedestals 31 represent the image to be reproduced.

The portions of the apparatus 19 to 30 thus far described comprise ordinary present day television apparatus and its construction, interconnection, and method of operation are well understood in the art. Such apparatus is fully described in the publication "Principles of Television Engineering," by Donald G. Fink (McGraw-Hill Book Co., Inc., 1940). The pedestal mixer 23 of Fig. 1, which is supplied with horizontal and vertical pedestals, or blanking signals, from multivibrators 24 and 25 respectively, is like that illustrated schematically in the publication on page 412 in Fig. 255. In this figure, horizontal blanking signals from an amplifier at the top of the figure and vertical blanking signals from an amplifier at the central part of the figure are mixed in the input circuit of a triode. The pedestal mixer 23 includes such circuits in which horizontal and vertical blanking signals are mixed.

The amplifier and pedestal injector 12 is similar to a portion of the circuit shown in the publication on page 398 in Figs. 243 and 244. In these figures, of which 243 is diagrammatic and is drawn in block form, the blanking amplifier 3 (Fig. 243) corresponds to the buffer amplifier 30 of Fig. 1 of the present application. The amplifier tube 1 and mixer tube 2 (Fig. 243) corresponds to the amplifier and pedestal injector 12 of Fig. 1 of the present application. The output wave *d* in conductors 13 never rises above the horizontal blanking or pedestal level because of clipping, or limiting, which is provided in tube 6 (Fig. 243), and which limiting is likewise accomplished in amplifier and pedestal injector 12 of Fig. 1 of the present application. Such mixing of pedestals or blanking signals and video signals, and consequent clipping or limiting of the composite signal, is described on pp. 398-399 of the publication referring to Figs. 243, 244 and 245.

The channels 21 and 22 are connected also to means for modulating the frequency of the carrier wave to convey synchronizing pulses to the

image receiver. The channel 21 transmits pulses from the generator 24 through a buffer amplifier 33 to a delay circuit and clipper 34, through which a horizontal narrow pulse generator 35 may be synchronized in variable phase with the wave from the generator 24. The wave from the generator 25 is transmitted through the channel 22 to similar apparatus including a buffer amplifier 36, a delay circuit and clipper 37, and a vertical pulse generator 38. The wave from the multivibrator 27 is transmitted through a channel 39 and a buffer amplifier 40 to a delay circuit and clipper 41 and a narrow pulse generator 42. The generator 42 produces a very narrow pulse whose frequency is twice the horizontal scanning frequency. The generator 38 produces a wave which is similar to the vertical pedestal 32 but whose leading edge is delayed in an adjustable amount by the relay circuit and clipper 37, whose operation will be explained later.

The waves generated by the generators 38 and 42 are mixed in proper phase and amplified in the mixer and amplifier 43, whose output is a serrated vertical pedestal. The wave produced by the generator 35 is a series of narrow pulses of the horizontal scanning frequency whose leading edges may be delayed adjustably by the delay circuit and clipper 34, whose operation will be explained later. The outputs of the generator 35 and the mixer and amplifier 43 are mixed in proper phase, amplified, and clipped in the mixer and amplifier 44. The output of the mixer and amplifier 44 resembles a form of synchronizing wave which is used at the present time where interlacing in scanning is desired. This wave is impressed on a frequency modulator 45 through which the wave from the master oscillator 15 is transmitted to the amplitude modulator 14.

The operation of the various circuits used for producing such a synchronizing wave will now be explained in greater detail. The output wave from the buffer amplifier 33 has the form indicated by curve *b* of Fig. 2. This wave is impressed across a resistor 46 and a condenser 47 connected in series in the delay circuit and clipper 34. The condenser 47 is shunted by a resistor 48. When no voltage is impressed on this delay circuit from the amplifier 33, the resistor 48 tends to discharge condenser 47 at a predetermined rate. During existence of a pulse of voltage from the amplifier 33 the condenser 47 tends to become charged through the resistor 46 at a relatively much faster rate than when it is discharging, which is preferably as nearly linear as possible. The voltage across the condenser 47 therefore varies in the manner indicated by the curve *e* of Fig. 2. This voltage is transmitted to the generator 35 through an electron discharge device 49, whose control electrode is maintained at such a negative bias potential with respect to its cathode by a source 50 of voltage that current normally cannot flow in its anode circuit. When the control electrode is increased in potential a certain amount with respect to the cathode of the device 49 by the wave represented by the curve *e*, current flows in the anode of the device 49, as represented by the curve *f*. The anode current of the device 49, when the bias potential is properly adjusted, has a form such as that indicated by the curve *f* of Fig. 2. The generator 35 preferably comprises a multivibrator which is adjusted to produce a leading edge of a very narrow pulse at each time when the anode of the device 49 begins to drop

in voltage. This narrow pulse has such short duration that it disappears some time before the horizontal pedestal disappears. The wave produced by the generator 35 is indicated by curve *g* of Fig. 2.

The wave impressed by the buffer amplifier 36 on the delay circuit and clipper 37 is of the form indicated by curve *c* of Fig. 2. The delay circuit and clipper 37 is identical in construction and operation with the delay circuit and clipper 34, but its adjustments are somewhat different. The delay circuit includes a condenser 51 across which a voltage appears, whose form is indicated by the curve *h* of Fig. 2. The clipper includes an electron discharge device 52, whose anode current is represented by a curve *i* of Fig. 2. The generator 38 is illustrated as a multi-vibrator and it is adjusted to produce a leading edge of an impulse, which is no longer than the vertical pedestal 32, each time when the anode voltage of the device 52 begins to drop.

The buffer amplifier 40 impresses pulses from the multi-vibrator 27, of a form indicated by the curve *a*, upon the delay circuit and clipper 41, which produces only a very slight delay so that the following edge of the very narrow pulse produced by the generator 42, which is illustrated as a multi-vibrator, occurs alternatively in synchronism with the leading edge of the narrow pulse produced by the generator 35. These narrow pulses, whose form is illustrated by curve *j* of Fig. 2, are thus formed in order to maintain synchronism between the horizontal deflection generators at the transmitter and receiver during vertical synchronization and to allow for interlacing action.

The waves from the generators 38 and 42 are impressed respectively on electron discharge devices 53 and 54 in the mixer and amplifier 43. The anodes of these two devices are connected together. The wave from the generator 42, represented by curve *j*, is impressed on the device 54 with such polarity as to make the potential of the control electrode thereof more positive and the anode thereof correspondingly more negative during each pulse. When no pulse is transmitted to the device 53 from the generator 38, its anode maintains the anode of the device 54 sufficiently negative so that pulses from the generator 42 cannot make it substantially more negative. There is therefore no output from the mixer and amplifier 43 under these conditions. When the generator 38 produces a wide pulse, so that the anode of the device 53 becomes more positive, the wave from the generator 42 then periodically is enabled to make the anode of the device 54 more negative. The resultant wave which is transmitted from the mixer and amplifier 43 therefore appears in channel 55 as indicated by the curve *k* in Fig. 2.

The generator 35 transmits its output wave, indicated by curve *g* of Fig. 2, to an electron discharge device 56 in the mixer and amplifier 44 and the channel 55 transmits the wave indicated by the curve *k* of Fig. 2 to an electron discharge device 57 in the mixer and amplifier 44. The anodes of these devices 56 and 57 are connected together so that the waves impressed on their control electrodes are simply added, in inverted relation, in their anodes, as indicated by curve *m* of Fig. 2.

The wave appearing on the anodes of the devices 56 and 57 is inverted and clipped in an electron discharge device 58 in the mixer and amplifier 44, so that the output wave therefrom

which is transmitted to the frequency modulator 45 appears as is indicated by curve *n* of Fig. 2.

The operation of the transmitter may now be described. All synchronizing signals are transmitted while maintaining the carrier at maximum amplitude, by varying its frequency, preferably over a considerable range in order to take advantage of noise suppression produced when a frequency modulated wave swept over a wide range is limited in amplitude at the receiver. If this variation of the carrier frequency be produced immediately upon transmission of a pedestal, before side bands arising from amplitude modulation by video signals and by leading edges of horizontal and vertical pedestals disappear, the overall band width is increased by virtue of the fact that the shifted carrier shifts its related side bands in the same amount to a region which may be outside the allowable operating range of frequencies. In order therefore to conserve space in the frequency spectrum when using a television signal of the nature described herein, it is highly desirable to provide a slight delay, amounting to 1 or 2 per cent of the time of one horizontal scanning operation, after the leading edge of a pedestal before the frequency of the carrier is changed in response to a synchronizing signal.

In Fig. 2 the delay is graphically illustrated by comparing curves *b* and *g* and curves *c* and *k*. It may be seen that the leading edge of a horizontal pedestal, shown in curve *b*, coincides with the beginning of a period of rising voltage in curve *c* and that the delay circuit and clipper 34 produces a slight delay in the point of curve *f* at which the current begins to rise, so that a corresponding pulse of the curve *g* has its leading edge at least 1 or 2 per cent later than the leading edge of the corresponding horizontal pedestal shown in curves *b* and *d*.

Similarly the beginning of a period of rising voltage, illustrated by curve *h*, coincides in time with the leading edge of the vertical pedestal 32 of curve *c*. The delay circuit and clipper 37 produces at least a delay of 1 or 2 per cent of a horizontal line period, so that the beginning of a period of rising current, indicated by curve *i*, is delayed after the leading edge of the pedestal 32.

The curve *n* may be considered as a graph of time, plotted as abscissa, against frequency, plotted as ordinate, since it actually represents the modulating voltage applied to the frequency modulator 45. A change of the carrier wave from the normal carrier frequency to the synchronizing frequency never occurs until a time at least 1 or 2 per cent of a horizontal line period later than the leading edge of a corresponding pedestal, either horizontal or vertical. Side bands which tend to persist for a short time after the leading edge of a horizontal pedestal 31, for example, are therefore allowed sufficient time to be dissipated, both in the transmitter and in the receiver. The possibility of shifting side bands outside of the allowable range of frequencies is therefore avoided by delaying the transmission of frequency modulated signals for an appreciable time in which amplitude modulated signals may disappear. Serrations, indicated in curve *n* as at 59, whose following or rising edges maintain horizontal synchronization in a receiver, and which are produced only during a vertical synchronizing pulse in curve *n*, of course, occur only during a period when no amplitude modulation of the carrier wave exists. There is, therefore,

no problem of delay as to these serrations to avoid shifting side bands out of the operating frequency range.

Fig. 3 illustrates a receiver adapted to reproduce an image from a television signal transmitted by the above described transmitter. This receiver includes a tuner and amplifier 60 of usual construction, an amplitude demodulator 61, and a video amplifier 62, whose output is transmitted, through a simple noise clipper including a diode 63, to the control electrode 64 of a cathode ray tube 65. The cathode of the diode 63 is supplied with a bias, positive with respect to its anode, from a source 66 of bias potential for the control electrode 64. The positive potential of the cathode of the diode 63 may be conveniently adjusted by a potentiometer 67, so that video signals may be transmitted through the noise clipper without being affected, but the bias potential is adjusted so that signals of somewhat greater amplitude than the video signal cause the anode of the diode 63 to become positive with respect to its cathode and the diode conducts to prevent further rise in voltage.

A noise clipper of this simple form gives good results in suppression of blooming of the received image on the fluorescent screen of the cathode ray tube 65, since a bloom is not noticeable unless the cathode ray intensity increases to about twice the average signal intensity or more. If the noise clipper be adjusted so that noise of greater than about twice signal intensity makes the diode 63 conductive, blooms are substantially eliminated from the image. It is very desirable to avoid blooming in the image when synchronizing signals are transmitted as described above, since synchronization is much better than when it is transmitted by amplitude modulation. Blooming is more noticeable upon a clear and steady, fine-detailed picture and should be eliminated.

The receiver includes apparatus for maintaining a pair of horizontal and vertical deflection generators 68 and 69 in synchronism, respectively, with the generators 24 and 25 in the transmitter. The amplified high frequency signal from the tuner and amplifier 60 is transmitted through a switch 70, in its righthand position, to the control grid of a limiting amplifier device 71, whose anode transmits waves to a discriminator or frequency demodulator having a tuned primary circuit 72 and a tuned secondary circuit 73.

In the discriminator the two circuits 72 and 73 are tuned near the frequency to which the carrier is shifted during the transmission of synchronizing pulses. A pair of diodes 74 and 75 are connected in opposite polarity across the ends of the tuned circuit 73 through a load resistor 76 shunted by a high frequency by-passing condenser 77. An intermediate point on resistance 76 is connected to an intermediate point on the inductance of circuit 73 for direct current. When the carrier frequency from the tuner and amplifier 60 is changed to the synchronizing level, a voltage appears across the load resistor 76. The voltage wave on the load resistor 76 has the form indicated by curve *n* of Fig. 2. This synchronizing wave is amplified by an electron discharge amplifying device 78 and transmitted to a synchronizing signal separator 79, of usual form, where the wave represented by curve *n* is separated into two components which respectively maintain synchronization of the horizontal and vertical deflection generators 88 and 89.

In order to take advantage of the noise suppression achieved by frequency modulation, the limiting amplifier 71 is provided with bias potential for its control electrode from a source 80 of potential. The bias of this control electrode is so adjusted that signals from the tuner and amplifier 60 of greater than a predetermined intensity tend to make the control electrode of the device 71 so far positive in potential that it draws electron current. When the control electrode draws current, a potential drop is produced across a grid resistor 81 through which the signals are supplied to the control electrode. The anode of the device 71 accordingly repeats only those variations of control electrode potential below a certain predetermined magnitude. The device 71 thus acts as a clipper or limiter.

While good synchronization may be obtained with the provision of a receiver such as has been described, false synchronization may be effected occasionally when the video signals fortuitously have a frequency characteristic such that the discriminator, separator, and deflection generators respond. To avoid the possibility of false synchronization in this manner, means are provided for discriminating in amplitude between the side bands produced by amplitude modulation and the wave of full carrier intensity produced by frequency modulation. The side bands of an amplitude modulated carrier wave are predominately less than half the intensity of the unmodulated carrier. It is pointed out on page 395 of the publication "Radio Engineering," by Frederick E. Terman (McGraw-Hill Book Co., 2nd ed., 1937), that, when a carrier wave is completely modulated by sinusoidal variation of the carrier amplitude, there are two side band components, each having an amplitude half that of the carrier. The reason for this may be seen by examination of an analysis of modulation presented by Henri Lauer and Harry L. Brown in the publication "Radio Engineering Principles," (McGraw-Hill Book Co., 1928). In this publication on page 259 an expression (a) is derived in which the amplitude of the unmodulated carrier is *A*, the amplitude of the signal, or modulating, wave is *B*, the frequency of the carrier wave is *ω*, and the signal frequency *Ω*. The amplitude *B* of the signal must never exceed the amplitude *A* of the carrier wave in order to avoid production of so-called overmodulation with accompanying distortion. Accordingly, the expression (a)

$$A \cos \Omega t + B/2 \cos (\Omega + \omega)t + B/2 \cos (\Omega - \omega)t$$

indicates that the upper and lower side band components, respectively represented by the factors $B/2 \cos (\Omega + \omega)t$ and $B/2 \cos (\Omega - \omega)t$, can never exceed half the amplitude of the carrier wave *A*. The above expression does not apply in cases in which *B* exceeds *A*, because the carrier wave amplitude cannot be reduced to a value less than zero. Even though the signal amplitude *B* should exceed the carrier wave amplitude *A*, thereby reducing the instantaneous carrier wave amplitude at times to zero, no component at any particular frequency in the side band region can exceed in amplitude substantially half the amplitude of the carrier wave. Means are accordingly provided to prevent the unmodulated carrier wave, and also any wave of less than, for example, three-quarters of the intensity of the full carrier wave, from entering the synchronizing channel. False synchronization

from fortuitous characteristics of the video signal or noise is thereby substantially eliminated.

As illustrated by Fig. 3, if the switch 70 be moved from the position described above to its left or full line position as shown, the wave from the tuner and amplifier 60 passes to the limiting amplifier 71 through an asymmetrical network 82, a carrier filter 83, and a bottom clipper 84. The asymmetrical network 82 attenuates side bands on one side of the amplitude modulated carrier more than side bands on the other side of the carrier. Its function is to aid in amplitude discrimination against side bands in favor of the frequency modulated carrier. Without the network 82, side bands equally spaced on opposite sides of the unmodulated carrier might be so phased as to add in intensity so as to pass the bottom clipper, which removes all waves below three-quarters of full wave intensity. If the network 82 be designed to have twice the attenuation for one set of side bands as it has for the set on the opposite side of the carrier, such side bands cannot pass a bottom clipper, adjusted to reject all waves below three-quarters of full carrier intensity.

The carrier filter 83 comprises a resistor 85 in series with the synchronizing channel followed by a series tuned circuit 86, shunted across the channel, and resonant to the unmodulated carrier. Since the impedance of the series tuned circuit 86 approaches zero at the frequency of the unmodulated carrier, all waves of unmodulated carrier frequency produce a voltage drop across the resistor 85 and are not substantially transmitted further in the synchronizing channel.

The bottom clipper 84 comprises a diode which has its cathode biased positively with respect to its anode, and through which signals are transmitted from the carrier filter 83 to a load resistor 87. The bias potential, supplied to maintain the cathode of the diode 84 positive with respect to its anode should be of sufficient magnitude to prevent conduction through the diode except when waves of greater than, for example, three-quarters carrier intensity are transmitted from the filter 83. Only when waves of greater than this intensity are transmitted through the diode 84, do voltage variations appear across the load resistor 87 to be repeated through the limiting amplifier 71. The bottom clipper thus is adjusted to discriminate in amplitude between waves above and below three-quarters carrier intensity, rejecting all waves below that level and transmitting to the amplifier 71 only waves above that level.

While the asymmetrical network 82 is illustrated as being separately provided in the receiver, it may comprise a portion of the tuner and amplifier 60. For example, the radio frequency amplifier may be asymmetrically tuned to the unmodulated carrier so that side bands on one side are transmitted in greater amplitude than those on the other side. This asymmetrical network 82 may even be a part of the transmitter, which in such case may even be a single side band transmitter.

It is to be understood that I have illustrated my invention as embodied in apparatus much like standard apparatus used at the present time in order that the principles thereof may be more easily understood. By the use of other forms of synchronizing signals much simplified circuits may be used.

While I have shown a particular embodiment

of my invention, it will, of course, be understood that I do not wish to be limited thereto, since different modifications may be made both in the circuit arrangement and instrumentalities employed, and I aim by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The signaling method which comprises producing a wave, modulating the amplitude of the wave intermittently in accordance with a signal, modulating the frequency of the wave in accordance with a second signal in the intervals between modulation of the amplitude of said wave, transmitting said wave so modulated to a receiving position, reproducing said first signal from the amplitude modulation of said wave, transmitting only the portions of said wave above a magnitude sufficiently great substantially to eliminate amplitude modulation of said portions, and reproducing said second signal from the frequency modulation of said transmitted wave portions.

2. The signaling method which comprises producing a wave, respectively modulating the amplitude and the frequency of said wave in accordance with a first and a second signal, transmitting said wave so modulated to a receiving position, reproducing said first signal from the amplitude modulation of said wave, transmitting only the portions of said wave above a magnitude sufficiently great substantially to eliminate amplitude modulation of said portions, and reproducing said second signal from the frequency modulation of said transmitted wave portions.

3. The signaling method which comprises producing a wave, modulating the amplitude of the wave during intermittent time intervals in accordance with a signal thereby producing side bands within a predetermined band of frequencies, modulating the frequency of the wave within said band in accordance with a second signal in time intervals between said intermittent intervals, there being an additional substantial time elapsing between any two successive intervals during which time previous modulation effects are dissipated, and reproducing said first and second signals from said wave.

4. The signaling method which comprises producing a wave, modulating the amplitude of the wave intermittently in accordance with a first signal thereby producing side bands within a predetermined band of frequencies, modulating the frequency of the wave within said band in accordance with a second signal in the intervals between modulation of amplitudes of said wave, producing intervals between modulation of the frequency and modulation of the amplitude of said wave sufficiently great that previous modulation effects are dissipated in said interval, and translating said wave to reproduce said signals.

5. The method of reproducing a signal from a frequency modulated carrier wave, which comprises transmitting only the portion of the wave above a predetermined magnitude, and reproducing said signal from the frequency modulation of said portion of the wave after said transmission.

6. The method of reproducing a signal which is frequency modulated on a wave having amplitude modulation thereon, which comprises unequally attenuating the side bands of said wave, transmitting only the portions of said wave so attenuated above a magnitude lower than the magnitude of the wave unmodulated in ampli-

tude and greater than the sum of any two corresponding side bands, and reproducing said signal from the frequency modulation of said portions of the wave after said transmission.

7. Signal apparatus comprising means for producing a carrier wave, two sources of signals to be transmitted, means for modulating the amplitude of said wave intermittently in accordance with a signal from one of said sources, means for modulating the frequency of said wave in accordance with a signal from the other of said sources in the intervals between modulation of the amplitude of said wave, and means to transmit said wave to a receiver, said receiver comprising means for reproducing said first signal from the amplitude modulation of said wave, means for transmitting only the portions of said wave above a magnitude sufficiently great substantially to eliminate amplitude modulation of said portions, and means for reproducing said second signal from the frequency modulation of said transmitted wave portions.

8. Signal apparatus comprising means for producing a carrier wave, two sources of signals to be transmitted, means for modulating the amplitude of said carrier wave during intermittent time intervals in accordance with a signal from one of said sources to produce side bands within a predetermined band of frequencies, means for modulating the frequency of said wave in said band in accordance with a signal from the other of said sources in time intervals between said intermittent intervals, there being an additional substantial time elapsing between any two successive intervals during which time previous modulation effects are dissipated, and means for reproducing said signals from said carrier wave.

9. Signal apparatus comprising means for producing a carrier wave, two sources of signals to be transmitted, means for modulating the amplitude of said wave intermittently in accordance with a signal from one of said sources to produce side bands within a predetermined band of frequencies, means for modulating the frequency of said wave in said band in accordance with a signal from the other of said sources in the intervals between the modulation of the amplitude of said wave, means providing intervals between modulation of the frequency and modulation of the amplitude of said wave sufficiently great that dissipation of previous modulation effects on said wave occurs during said intervals, and means for reproducing said signals from said carrier wave.

10. Television image transmission apparatus comprising means for producing a carrier wave, a source of video signals and a source of synchronizing signals, means for modulating the amplitude of said wave during intermittent time intervals in accordance with a signal from said video source, to produce side bands within a predetermined band of frequencies, the intensity of said carrier wave in time intervals between said intermittent intervals being substantially a maximum, means for modulating the frequency of said wave in said band in accordance with a signal from said synchronizing source in time intervals between said intermittent intervals, there being an additional substantial time elapsing between any two successive intervals during which time previous modulation effects are dissipated, and means for transmitting said wave to a signal reproducing agency.

11. Television image transmission apparatus comprising means for producing a carrier wave,

a source of video signals and a source of synchronizing signals, means for modulating the amplitude of said wave in accordance with a signal from said video source to produce side bands within a predetermined band of frequencies, the intensity of said carrier wave in intervals between said amplitude modulations being substantially a maximum, means for modulating the frequency of said wave in said band in accordance with a signal from said synchronizing source in the intervals between said video modulations, means providing intervals between modulation of the frequency and modulation of the amplitude of said wave sufficiently great that dissipation of previous modulation effects on said wave occurs in said intervals, and means for transmitting said wave to a signal reproducing agency.

12. Television image transmission apparatus comprising means for producing a carrier wave, a source of video signals and a source of synchronizing signals, means for modulating the amplitude of said wave during intermittent time intervals in accordance with a signal from said video source to produce side bands within a predetermined band of frequencies, the intensity of said carrier wave in time intervals between said intermittent intervals being substantially greater than during said intermittent intervals, means for modulating the frequency of said wave in said band in accordance with a signal from said synchronizing source in time intervals between said intermittent intervals, there being an additional substantial time elapsing between any two successive intervals during which time previous modulation effects are dissipated, and means for transmitting said wave to a signal reproducing agency.

13. Signal apparatus for reproducing a signal which is frequency modulated on a carrier wave, comprising means for transmitting only the portions of said wave above a predetermined magnitude, and means for reproducing said signal from the frequency modulation of said transmitted wave portions.

14. Signal apparatus for reproducing a signal which is frequency modulated on a wave having amplitude modulation thereon, comprising means for unequally attenuating the side bands of said wave, means for transmitting only the portions of said wave so attenuated above a magnitude greater than the less attenuated side band and less than the intensity of the carrier, and means for reproducing said signal from the frequency modulation of said transmitted wave portions.

15. Signal apparatus for reproducing a television image comprising a channel including an image forming device responsive to video signals amplitude modulated on a carrier wave, a second channel responsive to synchronizing signals frequency modulated on said wave in substantially the same frequency range as side bands produced by said amplitude modulation, means excluding amplitude modulation sidebands from said second channel while transmitting said frequency modulated wave, and means for reproducing said synchronizing signals from the frequency modulation of said transmitted wave and for applying said synchronizing signals to said image forming device.

16. Signal apparatus for reproducing a television image comprising a channel including an image forming device responsive to video signals amplitude modulated on a carrier wave, a second channel responsive to synchronizing signals frequency modulated on said wave, means for trans-

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mitting only the portions of said wave through said second channel above a predetermined magnitude sufficiently great substantially to eliminate amplitude modulation of said wave portions, and means for reproducing said synchronizing signals from the frequency modulation of said transmitted wave portions and for applying said synchronizing signals to said image forming device.

17. Signal apparatus for reproducing a television image comprising a channel including an image forming device responsive to video signals amplitude modulated on a carrier wave, a second channel responsive to synchronizing signals frequency modulated on said wave, means for unequally attenuating the side bands of said wave, means for transmitting only the portions of said wave so attenuated through said second channel above a magnitude sufficiently great substantially to eliminate amplitude modulation of said wave portions, and means for reproducing said synchronizing signals from the frequency modulation of said transmitted wave portions and for applying said synchronizing signals to said image forming device.

18. Signal apparatus for reproducing a television image comprising a channel including an image forming device responsive to video signals amplitude modulated on a carrier wave, a second channel responsive to synchronizing signals frequency modulated on said wave, means for trans-

mitting only the portions of said wave through said first channel below a predetermined magnitude, means for transmitting only the portions of said wave through said second channel above a second magnitude sufficiently great substantially to eliminate amplitude modulation of said second wave portions, and means for reproducing said synchronizing signals from the frequency modulation of said second transmitted wave portions and for applying said synchronizing signals to said image forming device.

19. Signal apparatus for reproducing a television image comprising a channel including an image forming device responsive to video signals amplitude modulated on a carrier wave, a second channel responsive to synchronizing signals frequency modulated on said wave, means for unequally attenuating the side bands of said wave, means for transmitting only the portions of said wave through said first channel below a predetermined magnitude, means for transmitting only the portions of said wave so attenuated through said second channel above a second predetermined magnitude sufficiently great substantially to eliminate amplitude modulation of said second wave portions, and means for reproducing said synchronizing signals from the frequency modulation of said second transmitted wave portions and for applying said synchronizing signals to said image forming device.

EVERHARD H. B. BARTELINK.

CERTIFICATE OF CORRECTION.

Patent No. 2,298,863.

October 13, 1942.

EVERHARD H. B. BARTELINK.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, line 19, for "relay" read --delay--; page 6, second column, line 3, claim 11, after "wave" insert --intermittently--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 1st day of December, A. D. 1942.

Henry Van Arsedale,
Acting Commissioner of Patents.

(Seal)