This invention relates generally to frequency-modulation television signal receivers and, particularly, to such a receiver which is substantially unresponsive to interfering signals of frequencies in the vicinity of the frequency which represents the black shade value of the image to be reproduced.

Received undesired signals generally have a detrimental effect on the image reproduced by a modulated-carrier television receiver. Thus, received undesired signals having a reproducible characteristic similar to the reproduced characteristic of a desired signal component corresponding to the black shade value of the image being received have the effect of introducing white spots within the darker portions of the picture. Specifically, in certain cases, ignition interference or the like can produce an effect in a frequency-modulation receiver which is similar to that of a spurious frequency modulation. This is very detrimental to the effective quality of reproduction for the reason that the human eye is particularly susceptible to such white spots on a dark background. Dark spots on a white background are much more tolerable. It is, therefore, very desirable in a television receiver to provide means for minimizing the reproduction of such undesired signals as appear as white spots on the darker portions of the reproduced image. This can be done to some extent in an amplitude-modulation receiver by translating and reproducing a negatively-modulated carrier signal; that is, a signal in which increasing carrier amplitudes correspond to decreasing light values of the translated image. The reason that such a system is unresponsive to the undesired signals of the type mentioned above is that received undesired signals generally have the effect of increasing the amplitude of the signal which is reproduced. Since such increases correspond to blacker-than-black components of the received signal, the undesirable effects are minimized. However, no satisfactory way of meeting the problem has heretofore been provided in a frequency-modulation television receiving system. It is, therefore, desirable to provide a frequency-modulation television receiver in which the effect of received undesired signals in the general vicinity of the frequency of desired signal components representing the black shade value of the image reproduced is minimized.

Furthermore, in television systems, it is customary to transmit the synchronizing information of a television system as a blacker-than-black component of the modulated-carrier signal. Therefore, a receiver which is particularly susceptible to undesired received signals in the vicinity of a desired received signal level corresponding to the black shade value of the reproduced image is also very likely to be difficult to synchronize for the reason that the synchronizing signals themselves lie on the opposite side of a demarcation level, but in the immediate vicinity of the darker shade values of the transmitted picture. Furthermore, under such conditions it is difficult or impossible to stabilize the signal input to the signal-reproducing means at the amplitude level corresponding to the black shade value of the transmitted image.

It is an object of the invention, therefore, to provide an improved frequency-modulation television receiver which is effective to eliminate one or more of the disadvantages of the prior art mentioned above.

It is a further object of the invention to provide a frequency-modulation television receiver in which the tendency of undesired received signals to cause white spots in the darker portions of the reproduced image is minimized.

It is still another object of the invention to provide a frequency-modulation television receiver in which the tendency of undesired signals to interfere with the synchronization of the receiver or maintenance of the black level of the picture is minimized. In particular, this may imply that the tendency of undesired signals to prevent clean separation of synchronizing and video components of the desired signal, or to prevent proper stabilization of the video signal, is minimized.

In accordance with the invention, a television receiver adapted to receive a frequency-modulated carrier signal, in which a predetermined frequency deviation of the received signal represents a black shade value of the transmitted image, comprises a detector for deriving a video-frequency signal from the received carrier signal, which is less responsive to undesired amplitude-modulation components for one portion of its operating range than another portion thereof. The receiver also includes means for so applying received video signals to the detector that components thereof corresponding to the black shade value of the received image are detected within the above-mentioned portion of the operating range of the detector. Means are also provided for reproducing the detected video-frequency signal.

For a better understanding of the invention, together with other and further objects thereof,
reference is had to the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

Fig. 1 of the drawing is a circuit diagram, partially schematic, of a complete frequency-modulation television receiver of the superheterodyne type embodying the invention; Fig. 2 comprises a graph utilized to explain the operation of the portion of the receiver circuit of Fig. 1 comprising the present invention; while Fig. 3 illustrates a modification of a portion of the receiver circuit of Fig. 1.

Referring now more particularly to the drawing, Fig. 1 comprises a frequency-modulation carrier-signal television receiver of the superheterodyne type for receiving a signal in which a predetermined carrier-frequency deviation represents the black shade value of the transmitted image and including an antenna system 10, 11 connected to a radio-frequency amplifier 12, to which are connected in cascade, in the order mentioned, an oscillator-modulator 13, an intermediate-frequency amplifier 14, a limiter 15, a detector 16, a video-frequency amplifier 17, and an image-reproducing device 18. A line-scanning circuit 19 and a field-scanning circuit 20 are connected to the output circuit of detector 16 through a synchronizing-signal separator 21 and to the deflection elements of image-reproducing device 18 in a manner well understood in the art. A sound-signal reproducing apparatus 9 is coupled to an output circuit of limiter 15 for reproducing the sound signals accompanying the received television program. The stages or units 9-15, inclusive, and 17-21, inclusive, may all be of conventional well-known construction so that detailed illustration and description thereof are deemed unnecessary here.

Referring briefly, however, to the operation of the system described above, a frequency-modulated television signal, in which a predetermined carrier-frequency deviation of the received signal represents the black shade value of the transmitted image, is intercepted by the antenna circuit 10, 11, is selected and amplified in radio-frequency amplifier 12, and translated to the oscillator-modulator 13 wherein it is converted into an intermediate-frequency signal which, in turn, is selectively amplified in the intermediate-frequency amplifier 14, is limited to a substantially constant amplitude in limiter 15 in order to eliminate spurious amplitude-modulation components, and is delivered to detector 16. The modulation components of the signal are derived by detector 16 and are supplied to the video-frequency amplifier 17, wherein they are amplified and from which they are supplied, in the usual manner, to a brilliancy-control electrode of the image-reproducing device 18. The intensity of the scanning ray of the device 18 is thus modulated or controlled in accordance with the video-frequency voltage impressed upon the control electrode, in the usual manner.

Scanning waves are generated in the line-scanning and field-scanning circuits 19 and 20, respectively, which are controlled by synchronizing-voltage pulses supplied from detector 16 through the synchronizing-signal separator 21, and are applied to the scanning elements of the image-reproducing device 18 to produce electric scanning fields, thereby to deflect the scanning ray in two directions normal to each other, so as to trace a rectilinear scanning pattern on the screen and thereby to reconstruct the transmitted image. Sound signals are reproduced by apparatus 9 in a manner well understood by those skilled in the art.

Referring now more particularly to the portion of the system of Fig. 1 embodying the present invention, detector 16 comprises a transformer having a primary winding 25 and a secondary winding 26 tuned by a condenser 27 to the mean frequency of the signal to be received; that is, to the mean frequency of the intermediate-frequency channel of the receiver. Sum and difference voltages of the primary winding 25 and secondary winding 26 are applied, respectively, to the anodes of diodes 28 and 29 through a coupling condenser 30. Load resistors 31 and 32 by-passed, respectively, by condensers 33 and 34 are provided for the diodes 28 and 29. The common junction of condensers 33 and 34 is returned to a point common to the coupling condenser 30 and a tap 38 on winding 26, while the opposite terminal of condenser 34 is grounded. The common terminal of resistors 31 and 32 is connected to the common terminal of condensers 33 and 34.

In considering the operation of the detector circuit just described, it will be seen that, if tap 38 is adjusted to the mid-point of winding 26, the detector described above is, per se, of a conventional type in which sum and difference voltages of the primary winding 25 and secondary winding 26 are individually applied to diodes 28 and 29. Such a frequency detector has a well-known signal-input-frequency-signal-output characteristic as represented by curve A of Fig. 2; that is, the detector circuit comprises a means for deriving from the received signal a first voltage, the sum of the primary and secondary voltages, which increases with frequency in the vicinity of the mean frequency of the received signal and a means for deriving from the received signal a second voltage, the difference of the primary and secondary voltages, which decreases with frequency in the vicinity of the mean frequency of the received signal. These voltages are individually applied to diodes 28 and 29 to provide a characteristic A which is balanced or symmetrical about the mean carrier frequency $f_0$ and has a substantially linear portion over the normal operating frequency range $f_1$, $f_2$. Such a detector circuit is inherently balanced at the mean frequency $f_0$ of the range and is substantially unresponsive to noise amplitude-modulation components at this frequency; that is, the detector is less responsive to undesired amplitude-modulation components over the portion of the range including frequency $f_0$ than over another portion thereof.

However, it has not heretofore been proposed to make the frequency of the carrier signal corresponding to the black signal level fall on the balance point $f_0$ of the detector characteristic or, in most prior art arrangements, on any particular point of such characteristic, but to traverse the characteristic, including its unbalanced portions, in accordance with the nature of the signal being transmitted.

Since, as pointed out above, undesired signals are most objectionable when they are primarily ineffective in the region of the extreme value of the reproduced image, such prior art frequency-modulation receivers have been subject to disturbing reproduction of spurious noise components in the black region of the reproduced image.

Applicant, therefore, has provided a means
for translating the derived voltages in the detector so that components of the received signal having a frequency corresponding to black shade value are always detected within a portion of the operating range of the detector over which the detector is substantially less responsive to undesired signals than over the remaining portion of its operating range. That is, as the frequency characteristic of Fig. 3, it will be seen that, if equal voltages at the mean resonant frequency of the system are coupled from tuned circuits 40 and 41 to diodes 28 and 29, respectively, a balanced characteristic is obtained in accordance with that of Curve A of Fig. 2 is provided. Furthermore, it will be seen that the frequency at which the circuit is balanced can be changed to provide the characteristic B of Fig. 2, by an adjustment of the mutual inductance between winding 25 and tuned circuit 40. It is believed that the operation of the circuit of Fig. 2 will be readily apparent to those skilled in the art from this description, taken in connection with the description of the operation of the circuit of Fig. 1 given above.

It will be seen that the arrangement of the present invention provides distinct advantages with regard to stabilization of the signal at the black level. That is, since undesired signals have a relatively small effect in the circuit of the invention upon signals corresponding to the black shade value of the transmitted image, a signal which is stabilized at the black level is not materially unstabilized by the reception of undesired signals so that the resultant signal is more nearly stabilized at the input circuit of image-reproducing device 18. Furthermore, if an arrangement is provided in the video-frequency channel of the receiver for providing residual stabilization, this stabilization is more nearly exact due to the small influence of undesired signals have upon the video-frequency signals corresponding to the black shade values of the transmitted image.

A residual stabilization may be effected in the intermediate-frequency channel of the receiver, for instance, by providing a sharply-tuned circuit resonant at a frequency in the immediate vicinity of the intermediate frequency corresponding to the tips of the synchronizing signals of the transmitted signal and adapted to be excited by the intermediate-frequency signal, together with a suitable detector coupled to the tuned circuit, the output of which is utilized to control the frequency of the oscillator section of oscillator-modulator 13, to provide the desired residual stabilization in a manner analogous to automatic frequency control of conventional amplitude-modulation receivers.

While there have been described what are at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A television receiver adapted to receive a frequency-modulated carrier signal in which a predetermined carrier-frequency deviation of the received signal represents the black shade value of the transmitted image comprising, a detector for deriving a video-frequency signal from said received carrier signal, said detector being less responsive to undesired amplitude-modulation components over one portion of its operating range than over another portion thereof, means for applying received signals to said detector that frequency components thereof corresponding to said black shade value are detected with-
4. in said one portion of said operating range, and means for reproducing said video-frequency signal.

2. A television receiver adapted to receive a frequency-modulated carrier signal in which a predetermined carrier-frequency deviation of the received signal represents the black shade value of the transmitted image comprising, a detector, means included in said detector for deriving from said signal a first voltage which increases with frequency in the vicinity of the mean frequency of the received signal, means included in said detector for deriving from said received signal a second voltage which decreases with frequency in the vicinity of the mean frequency of said signal, said detector being less responsive to undesired amplitude-modulation components over one portion of its operating range than over another portion thereof, means for so translating said derived voltages in said detector that frequency components of the received signal corresponding to said black shade value are detected within said one portion of said operating range, and means for reproducing said video-frequency signal.

3. A television receiver adapted to receive a frequency-modulated carrier signal in which a predetermined carrier-frequency deviation of the received signal represents the black shade value of the transmitted image comprising, means for deriving from said signal a first voltage which increases with frequency in the vicinity of the mean frequency of the received signal, means for deriving from said received signal a second voltage which decreases with frequency in the vicinity of the mean frequency of said signal, two diodes, means for applying one of said derived voltages to one of said diodes and the other of said derived voltages to the other of said diodes to provide a frequency-modulation detector less responsive to undesired amplitude-modulation components over one portion of its operating range than over another portion thereof, means for providing that frequency components of said received signal corresponding to said black shade value are detected within said one portion of said operating range, and means for reproducing said video-frequency signal.

4. A television receiver adapted to receive a frequency-modulated carrier signal in which a predetermined carrier-frequency deviation of the received signal represents the black shade value of the transmitted image comprising, a detector, means included in said detector for deriving from said signal a first voltage which increases with frequency in the vicinity of the mean frequency of the received signal, means included in said detector for deriving from said received signal a second voltage which decreases with frequency in the vicinity of the mean frequency of said signal, said two last-named means being so proportioned that one of said derived voltages is of substantially lesser magnitude at the mean frequency of said signal than the other of said voltages, said detector being less responsive to undesired signals over one portion of its operating range than over another portion thereof, means for so translating said derived voltages in said detector that frequency components of the received signal corresponding to said black shade value are detected within said one portion of said operating range, and means for reproducing said video-frequency signal.

5. A television receiver adapted to receive a frequency-modulated carrier signal in which a predetermined carrier-frequency deviation of the received signal represents a black shade value of the transmitted image comprising, a transformer having a primary winding and a secondary winding tuned to the mean frequency of said signal, two diodes, means for individually applying to said diodes sum and difference voltages derived from said windings which are substantially different at the mean frequency of said signal to provide a detector for deriving a video-frequency signal from said received carrier signal, said detector being less responsive to undesired amplitude-modulation components over one portion of its operating range than over another portion thereof, means for so applying said received signal to said detector that frequency components thereof corresponding to said black shade value are detected within said one portion of said operating range, and means for reproducing said video-frequency signal.

6. A television receiver adapted to receive a frequency-modulated carrier signal in which a predetermined carrier-frequency deviation of the received signal represents a black shade value of the transmitted image comprising, a transformer having a primary winding and a secondary winding tuned to the mean frequency of said signal, two diodes, means for individually applying to said diodes sum and difference voltages derived from said windings which are substantially different at the mean frequency of said signal to provide a detector for deriving a video-frequency signal from said received carrier signal, said detector being less responsive to undesired amplitude-modulation components over one portion of its operating range than over another portion thereof, means for so applying said received signal to said detector that frequency components thereof corresponding to said black shade value are detected within said one portion of said operating range, and means for reproducing said video-frequency signal.

7. A television receiver adapted to receive a frequency-modulated carrier signal in which a predetermined carrier-frequency deviation of the received signal represents a black shade value of the transmitted image comprising, a transformer having a primary winding and a secondary winding tuned to the mean frequency of said signal, two diodes, means for individually applying to said diodes sum and difference voltages derived from said windings to provide a detector for deriving a video-frequency signal from said received carrier signal, said detector being less responsive to undesired signals over one portion of its operating range than over another portion thereof, means including a tap on said secondary winding for adjusting the relative values of said derived voltages at the mean frequency of said signal, thereby to vary the portion of the operating range over which the detector is less responsive to undesired signals, means for so apply said received signal to said detector that frequency components thereof corresponding to said black shade value are detected within said one portion of said operating range, and means for reproducing said video-frequency signal.

8. A television receiver adapted to receive a frequency-modulated carrier signal in which a predetermined carrier-frequency deviation of the received signal represents the black shade value of the transmitted image comprising, a detector including a circuit resonant above the range of signals to be detected and a circuit,
resonant below the range of signals to be detected, means including one of said circuits for deriving from said signal a first voltage which increases with frequency in the vicinity of the mean frequency of the received signal, means including the other of said tuned circuits for deriving from said signal a second voltage which decreases with frequency in the vicinity of the mean frequency of said signal, said detector being less responsive to undesired amplitude-modulation components over one portion of its operating range than over another portion thereof, means for translating said derived voltages in said detector so that frequency components of the received signals corresponding to said black shade value are detected within said one portion of said operating range, and means for reproducing said video-frequency signal.

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