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Zelenz

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[54] **TELEVISION SIGNAL ENHANCEMENT AND SCRAMBLING SYSTEM**

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[73] Assignee: **Andrew F. Tresness**, Syracuse, N.Y.

[21] Appl. No.: **61,924**

[22] Filed: **May 14, 1993**

Related U.S. Patent Documents

Reissue of:

[64] Patent No.: **5,022,078**
Issued: **Jun. 4, 1991**
Appl. No.: **490,788**
Filed: **Mar. 8, 1990**

[51] **Int. Cl.**[5] **H04N 7/167**

[52] **U.S. Cl.** **380/7**; 380/15; 380/17

[58] **Field of Search** 380/7, 15, 17

[56] **References Cited**

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4,074,311	2/1978	Tanner et al. .	
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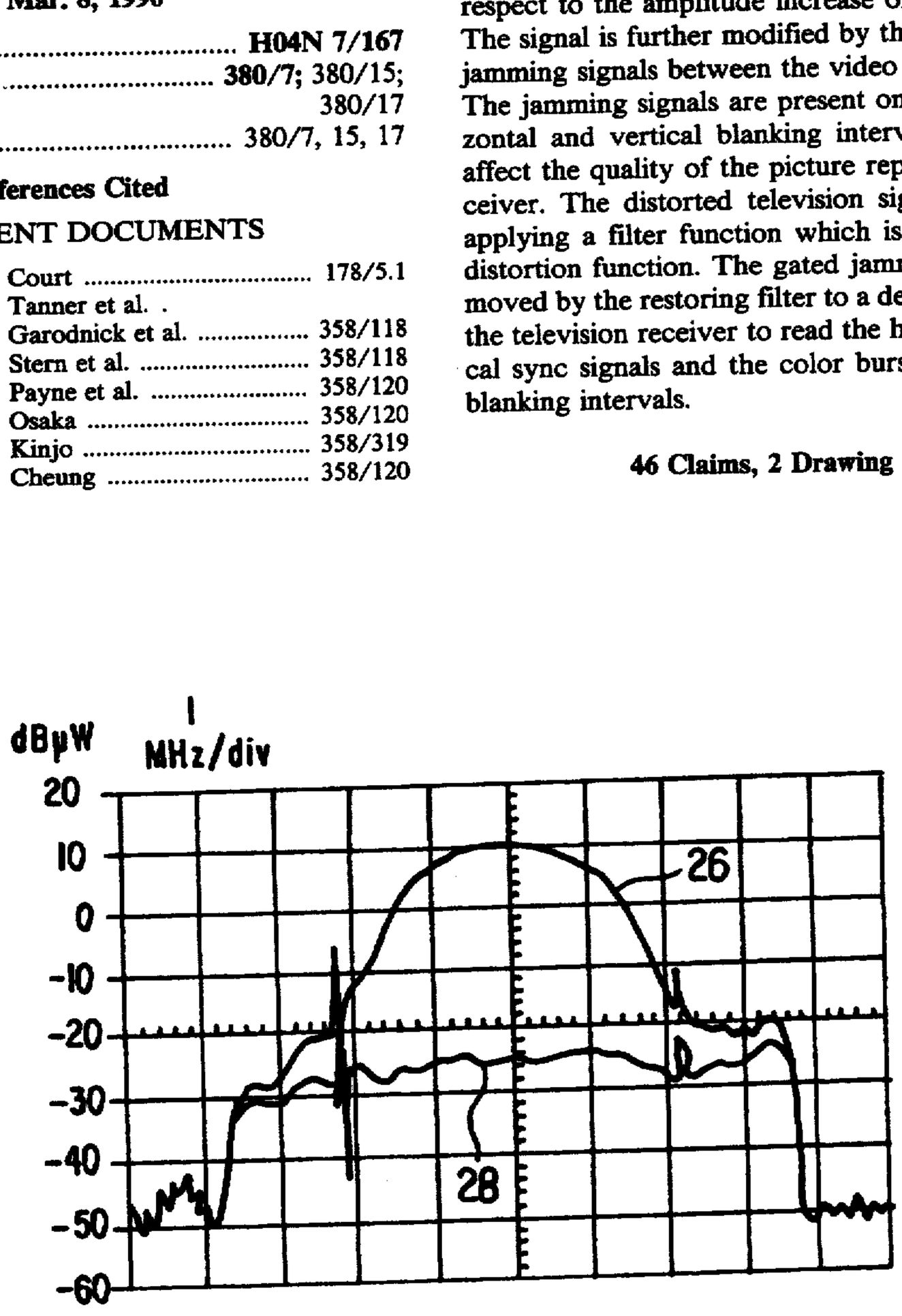
Primary Examiner—Stephen C. Buczinski
Attorney, Agent, or Firm—Lawrence P. Trapani

[57] **ABSTRACT**

A television signal is distorted by passing it through a distortion amplifier which applies a Gaussian distortion curve to the signal. The curve has a maximum increase in amplitude of about 38 dB, which is about 30 dB with respect to the amplitude increase of the video carrier. The signal is further modified by the addition of gated jamming signals between the video and audio carriers. The jamming signals are present only during the horizontal and vertical blanking intervals and so do not affect the quality of the picture reproduced by the receiver. The distorted television signal is restored by applying a filter function which is the inverse of the distortion function. The gated jamming signals are removed by the restoring filter to a degree which permits the television receiver to read the horizontal and vertical sync signals and the color burst signal during the blanking intervals.

46 Claims, 2 Drawing Sheets



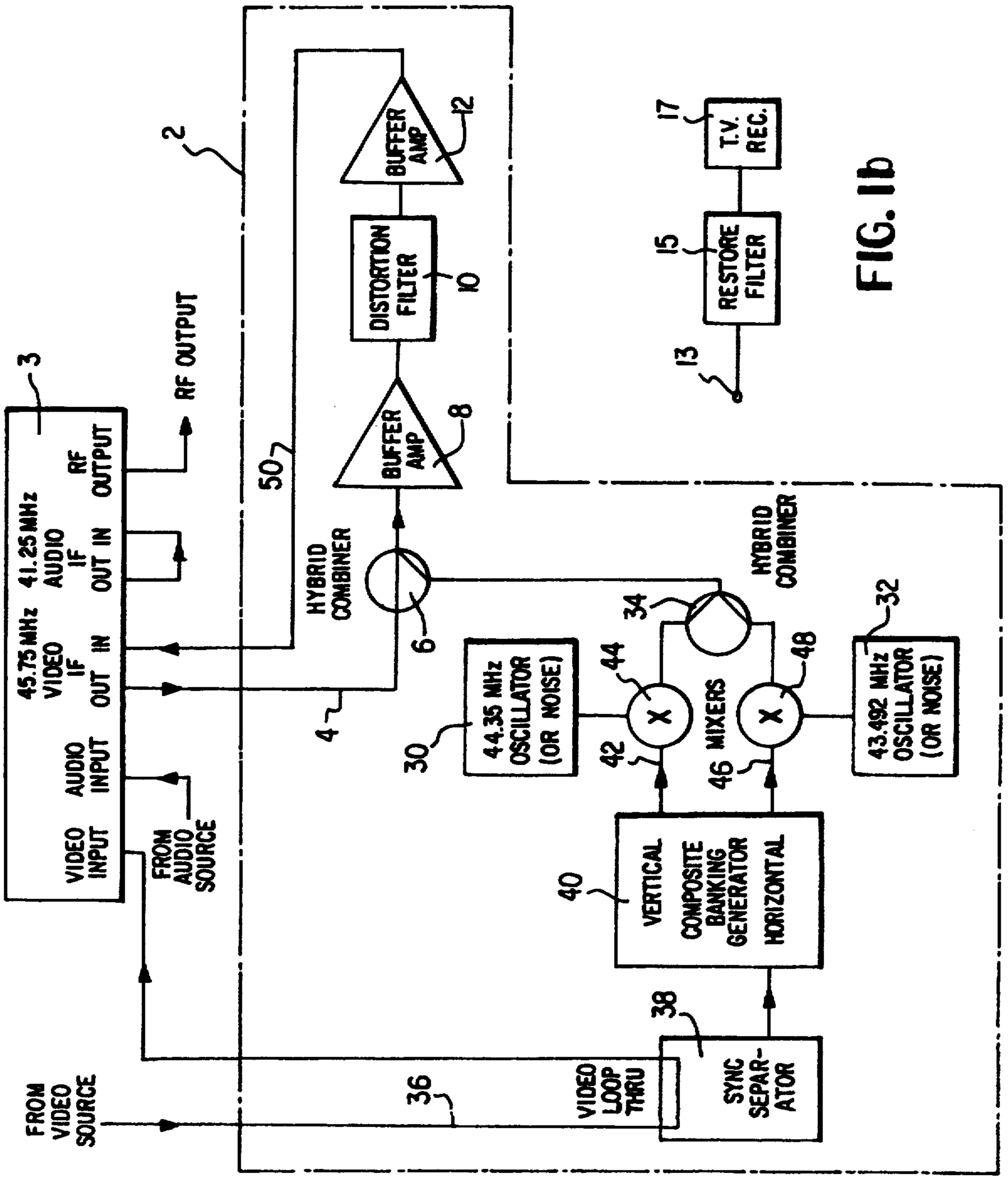

RF OUTPUT
2
3
45.75 MHz VIDEO IF OUT IN
41.25 MHz AUDIO IF OUT IN
RF OUTPUT
VIDEO INPUT
AUDIO INPUT
FROM AUDIO SOURCE
FROM VIDEO SOURCE
4
50
6
HYBRID COMBINER
BUFFER AMP 8
DISTORTION FILTER 10
BUFFER AMP 12
30
44.35 MHz OSCILLATOR (OR NOISE)
42
44
X
34
HYBRID COMBINER
46 MIXERS
48
X
43.492 MHz OSCILLATOR (OR NOISE)
32
15
RESTORE FILTER
17
T.V. REC.
13
40
VERTICAL COMPOSITE BANKING GENERATOR HORIZONTAL
38
SYNC SEPAR-ATOR
36
VIDEO LOOP THRU

FIG. 1b

FIG. 1a

FIG. 2

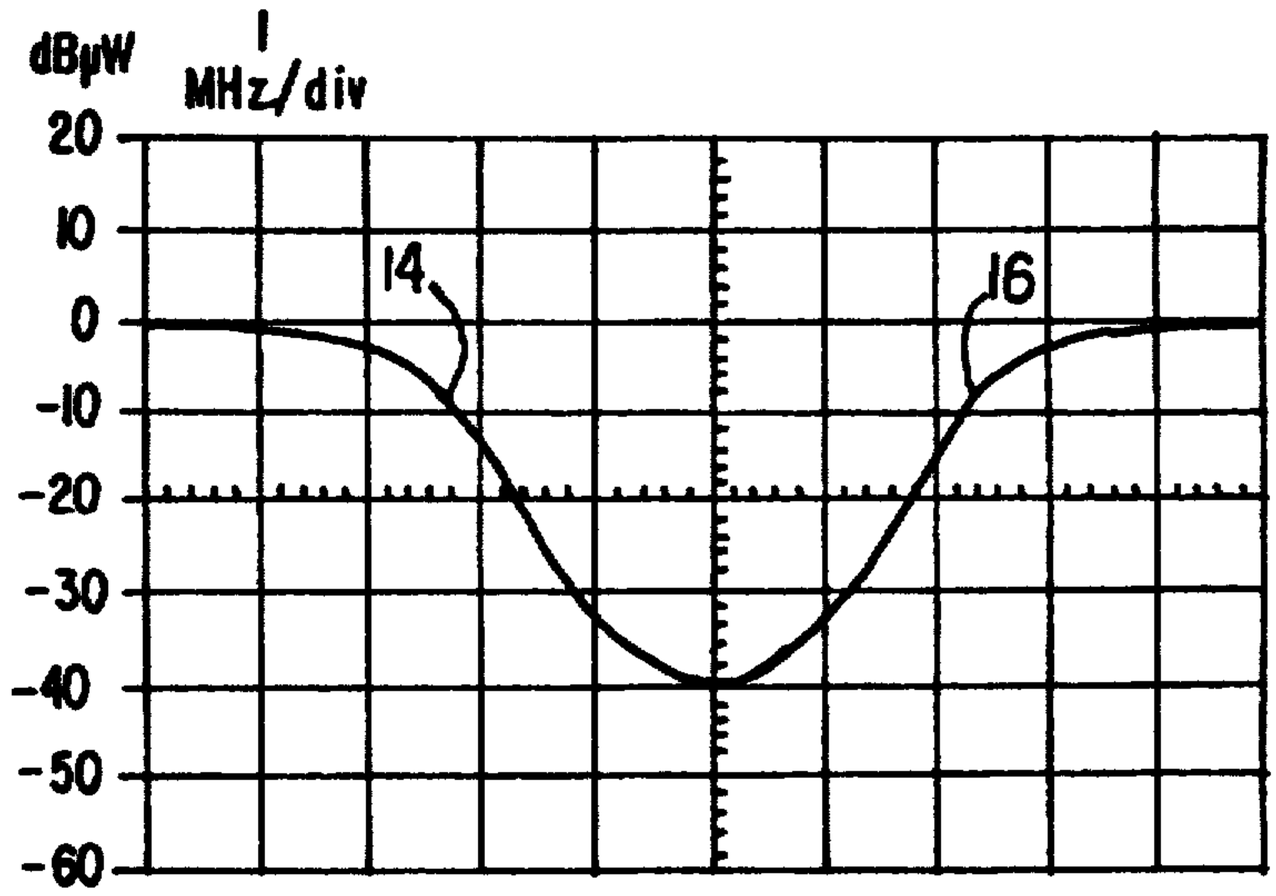


FIG. 3

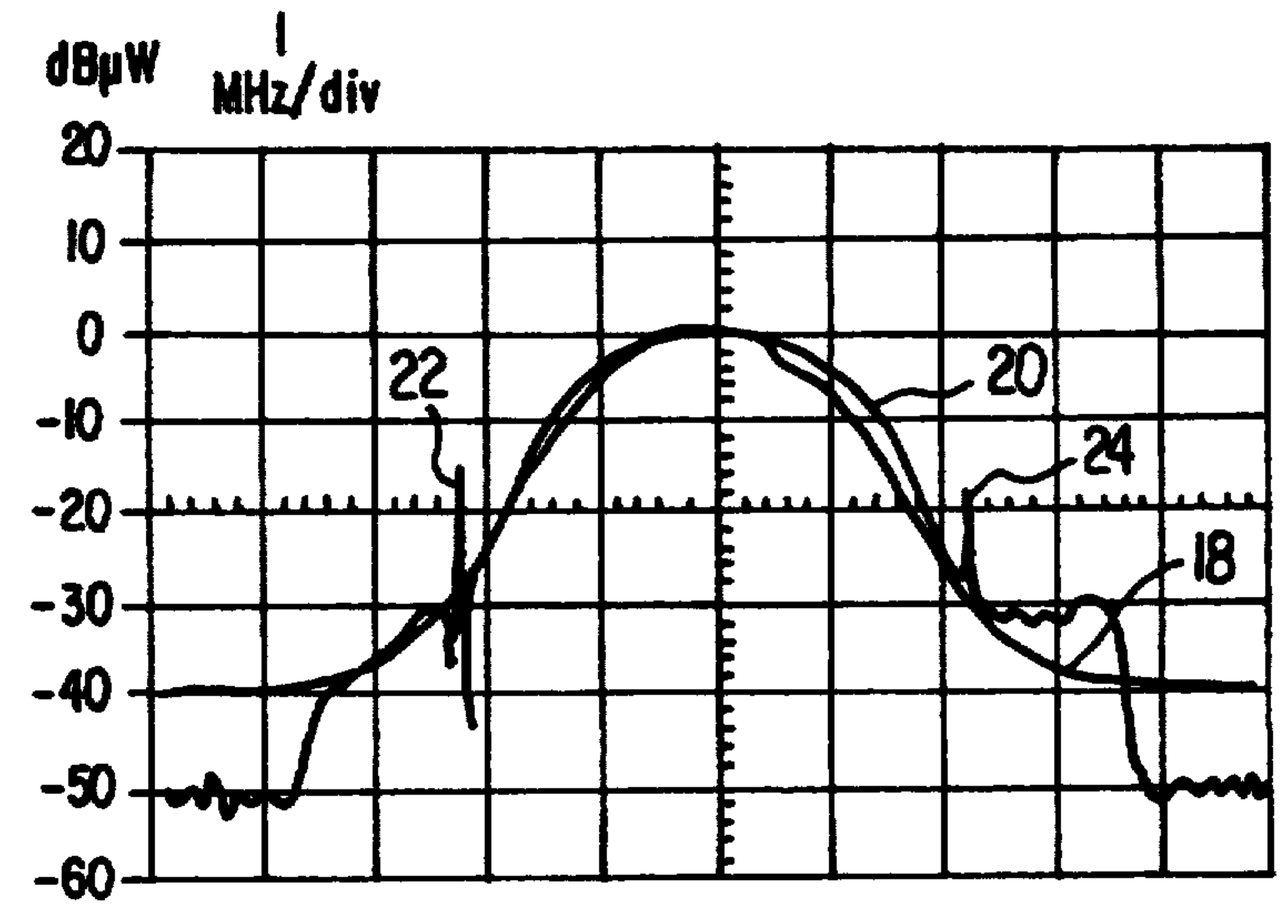
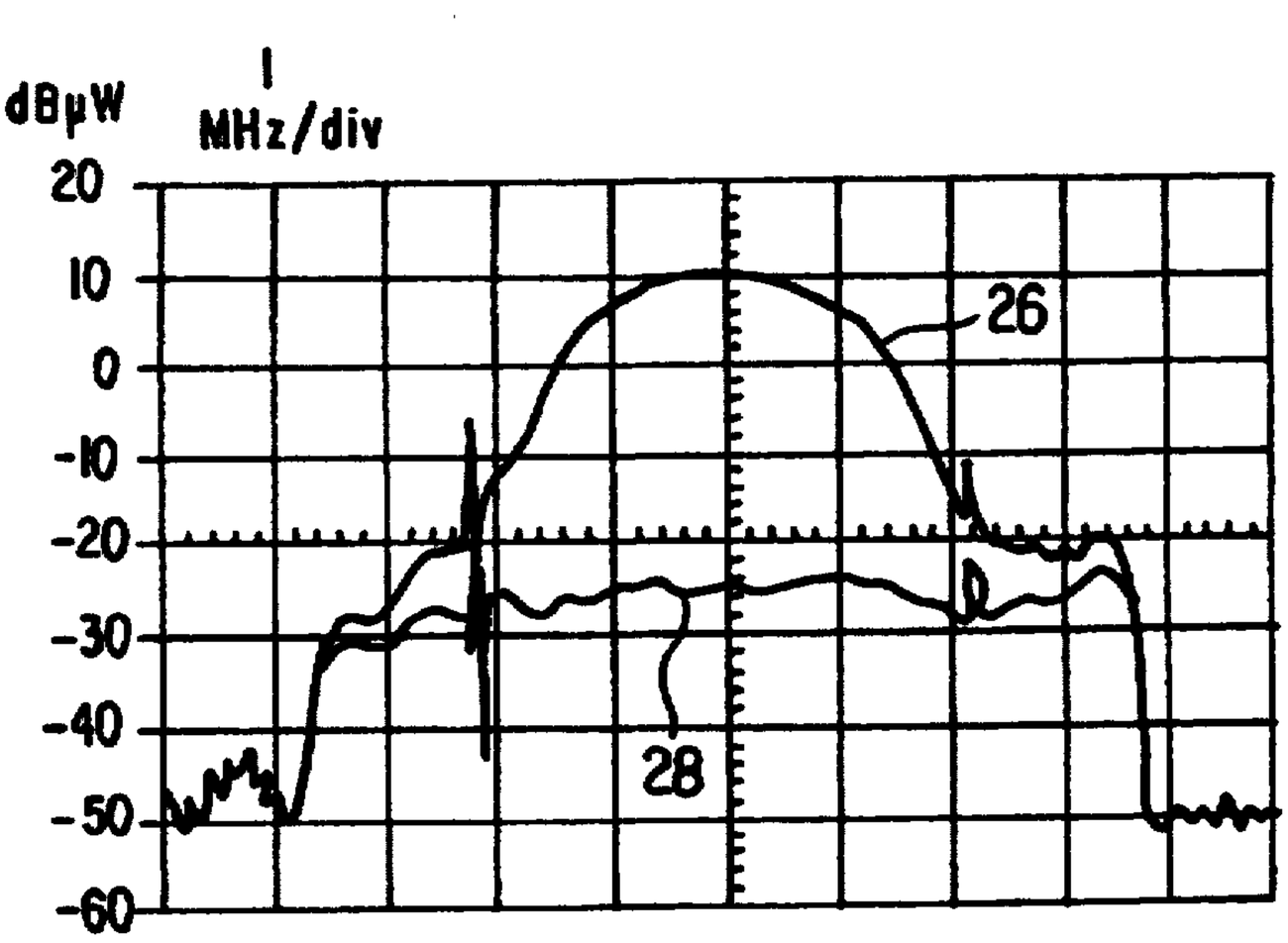


FIG. 4



TELEVISION SIGNAL ENHANCEMENT AND SCRAMBLING SYSTEM

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

TECHNICAL FIELD

This invention relates to a system for modifying a television signal to increase the quality of the received picture while also providing scrambling.

BACKGROUND ART

In a known television scrambling system described in U.S. Pat. No. 4,074,311 (Tanner et al.), a scrambling signal is injected into the television signal between the video and audio carriers. The signal is removed by a notch filter for decoding.

Tanner et al. also teach signal preemphasis centered on the frequency of the scrambling signal to compensate for signal degradation due to the removal of the scrambling signal by the notch filter signal during decoding.

The Tanner system suffers from several disadvantages. For example, the signal preemphasis is generally inadequate to compensate for the degradation which results from the removal of the scrambling signal, particularly when the picture includes high spatial frequency components which require a high spectral content of the transmitted signal. This degradation is manifested by a blurring of the received picture which in some cases, for example, makes it difficult to read textual parts of the picture.

SUMMARY OF THE INVENTION

In accordance with a first aspect of the invention, a television signal is subjected to preemphasis which is so large that it is properly termed distortion. The distortion is applied in the region of the signal between the video and audio carriers [and causes the demodulated video signal to experience carrier "pinch off" which results from over modulation of the carrier]. This distortion is so large that most television sets are unable to produce an acceptable picture unless the signal is properly treated.

The signal can be restored to allow the television set to produce an acceptable picture by applying the signal to an amplifier or passive filter having a response characteristic which is the inverse of the distortion characteristic.

In the preferred embodiment, the distortion curve and the restoring curve have Gaussian shapes which limit the number of inflections to substantially reduce group delay. The maximum distortion is 38 dB, and the audio and video carriers are increased by 8 dB.

In accordance with a second aspect of the invention, at least one jamming signal is applied to the television signal only during the horizontal and vertical blanking pulses. The signal is gated to be applied only during these portions of the signal and prevents the television from detecting the real sync pulses, which assists in preventing the detection of a usable signal.

In a preferred embodiment, two such gated jamming signals are used, and they are spaced by a small frequency to prevent unauthorized decoding of a signal by application of a single, home made notch filter.

In an alternative embodiment, the gated jamming signals comprise noise, e.g. random frequencies within a selected band.

It has been found that a signal subjected to the distortion and restoration amplifiers of the invention produces a picture having a quality which is better than that which is presently available using jamming signals because the deleterious effects of the notch filter are greatly reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1a** is a block diagram of a encoder in accordance with the invention.

FIG. **1b** is a block diagram of a decoder in accordance with the invention.

FIG. **2** is a graph showing a preferred restoration curve.

FIG. **3** is a graph showing a preferred distortion curve and the effect of distortion of a television signal.

FIG. **4** is a graph comparing the distorted television signal with the restored signal.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1a** is a block diagram of a system in accordance with the invention for use with a cable television system. A head end encoder **2** includes a video input line **4** which receives the video signal from modulator **3** wherein the video carrier is at an intermediate frequency of 45.75 MHz. The video signal is combined with gated jamming signal at a combiner **6**, these jamming signal being described more fully below. The video signal is passed through a first buffer amplifier **8**, a distortion amplifier **10**, and a second buffer amplifier **12**. The distorted signal is then returned to the modulator **3** for combination with the audio signal and subsequent transmission to a cable distribution network.

FIG. **1b** illustrates a typical decoder and receiver for the transmitted signals. The signal from the cable television distribution system is received at **13** and is supplied to a passive filter **15**. The signals from the filter are then supplied to a known television receiver **17** for reproduction of the picture and sound. The decoder thus preferably comprises a set of filters which restore the signal by providing the inverse of the distortion effected in the amplifier **10** whereby the television receiver can produce an acceptable picture.

FIGS. **2** thorough **4** illustrate the preferred distortion characteristics of the distortion amplifier **10**. FIG. **2** is a graph of the amplitude versus frequency response of the restoring filter and represents the inverse of the distortion caused by the amplifier **10**. This curve is substantially Gaussian and the characteristics are as follows:

Frequency (from center)	Attenuation
0 MHZ	−38.7 dB
−2.25 MHz	−7.5 dB
−1.5 MHz	−22.5 dB
+1.33 MHz	−26.7 dB
−6.0 MHz	0.0 dB
+6.0 MHz	0.0 dB

The approximate location of the video carrier is shown at **14**, and the approximate location of the audio carrier is shown at **16**. The maximum attenuation is 38.7

dB, and this is located at the frequency of the carrier plus 2.25 MHz.

With reference to FIG. 3, the distortion curve is shown at 18, and a typical distorted television signal is shown at 20. The video carrier is shown at 22, and the audio carrier is shown at 24.

FIG. 4 shows a comparison between a typical distorted television signal 26 and a restored signal 28 during the picture transmission part of the signal.

Referring again to FIG. 1, the gated jamming pulses of the invention will be described. The distortion-restoration system described with reference to FIGS. 2 through 4 provides adequate jamming of television signals for a large majority of the television receivers in use today. Some newer receivers, however, may be capable of producing a "viewable" picture from the distorted signal as shown by curve 26 of FIG. 4. Accordingly, applicants additionally provide two jamming signals between the audio and video carriers, the jamming signals having amplitudes such that they are each equal to the video carrier amplitude resulting at 50. These jamming signals are supplied only during the vertical and horizontal blanking periods, and the combination of the distortion and the gated jamming signals provides complete jamming for even state of the art receivers.

The gated jamming signals are provided by a first oscillator 30, which produces a signal spaced from the video carrier by about 1.4 MHz, and a second oscillator 32, which produces a signal spaced from the video carrier by about 2.258 MHz.

The video signal from the video source is supplied to a video loop 36, and the loop passes through a sync separator 38. The sync separator provides a series of pulses in accordance with the horizontal sync pulses, and the vertical sync pulses are derived from these. A composite blanking generator 40 generates a vertical signal 42 which controls a mixer 44 and a horizontal signal 46 which controls a mixer 48. The mixers are essentially gates controlled by the horizontal and vertical signals to allow the introduction of the signals from the oscillators 30 and 32 to a hybrid combiner 34 only during respective horizontal and vertical blanking intervals. The hybrid combiners themselves are known and provide low loss coupling of the signals from the input ports to the common output port.

The video signal which has been modulated by an intermediate frequency and which is supplied at 4 is combined with the gated jamming signals, and this combination is subjected to the buffer and distortion amplifiers 8, 10, and 12 as described above. The resulting signal at 50 is returned to the modulator for combination with the audio signal and transmission to the cable system.

While the gated jamming signals have been described as comprising carrier signals, they alternatively comprise noise. In a practical embodiment, the bandwidth of the noise was 3 MHz, but this may be larger or smaller. In accordance with this embodiment, the oscillators 30 and 32 are replaced by a noise generator which produces a noise signal for combination with the video signal in lieu of the jamming signals at single frequencies.

The gated jamming signals are inherently removed in large measure by the restoration filter 15 having the characteristics illustrated in FIG. 2. The restoration filter reduces the amplitude of the center of the signal between the audio and video carriers by about 30 dB with respect to the video carrier. Thus, the jamming signals are reduced in amplitude by about 97%. The residual 3% has been found to be small enough to permit the television receiver to read the information it is required to find in the blanking intervals, such as the horizontal sync signal, the color burst signal, and vertical interval signals. This remaining 3% can, however, reduce the quality of the picture if it is present during the interval when the signal carries picture information. Because these jamming signals are gated, however, they are not present when the picture information is transmitted and do not interfere with the production of a high quality picture by the receiver.

It will be appreciated that a unique technique for improving the quality of a television picture and for preventing unauthorized of television signals has been described. Modifications within the scope of the appended claims will be apparent to those of skill in the art.

I claim:

1. A television system comprising:

means for generating a television signal having frequency spaced video and audio carriers;

means for distorting said television signal in the region of said signal between said video and audio carriers by increasing the peak amplitude of [the signals] *said signal* in said region [by an amount such that said video carrier experiences carrier pinch off] *in accordance with a distortion curve*, wherein said means for distorting comprises means for increasing the amplitude of said signal in said region as a function of frequency.

2. A television system according to claim 1 wherein said means for distorting increases the amplitude of [the] *said* signal in said region with respect to frequency such that group delay of [the signals] *said signal* in said region is minimized.

3. A television system according to claim 2 wherein said means for distorting comprises means for increasing said amplitude in accordance with a Gaussian *distortion* curve.

4. A television system according to claim 3 wherein said means for distorting increases said peak amplitude by approximately 40 dB.

5. A television system according to claim 1 further comprising means for restoring said television signal by decreasing the magnitude of said [signals] *signal* in said region by [amounts] *an amount* substantially equal in magnitude but opposite in sign to the amount of increase provided by said means for distorting.

6. A television system according to claim 1 further comprising means for supplying a gated jamming signal in said region during one of a vertical or horizontal blanking portions of said signal.

7. A method for scrambling a television signal having a video carrier and an audio carrier comprising distorting said signal by increasing the amplitude of said signal between said video and audio carriers as a function of frequency by a characteristic curve having a maximum of about 30 dB with respect to the amplitude of said video carrier to produce a distorted signal.

8. A television system according to claim [7] *13* wherein said means for reducing comprises means for restoring said television signal by decreasing the magnitude of said signals in said region by amounts substantially equal in magnitude but opposite in sign to the amount of increase provided by said means for distorting.

9. A method for scrambling a television signal having a video carrier and an audio carrier comprising distorting said signal by increasing the amplitude of said signal between said video and audio carriers *as a function of frequency* by a characteristic curve having a maximum of about 30 dB with respect to the amplitude of said video carrier to produce a distorted signal.

10. A method according to claim 9 further comprising the step of increasing the amplitude of said video carrier by about 8 dB.

11. A method according to claim 10 further comprising the step of supplying jamming signals between said audio and video carriers during at least one of the horizontal or vertical blanking intervals.

12. A method according to claim 11 further comprising the step of restoring said television signal by decreasing the amplitude of said distorted signal by an amount equal to but opposite [is] *in* sign to said characteristic curve.

13. A television system according to claim 6 further comprising means for reducing the amplitude of said gated jamming signal to permit a receiver to detect synchronizing pulses and color burst signals.

14. A television signal enhancement and scrambling system, comprising:

an input, for receiving a video IF signal having a video carrier at an intermediate frequency and a video signal portion with horizontal and vertical blanking intervals; and

distortion means, coupled to said input, for distorting the video signal portion of said IF signal by increasing the amplitude of the video signal portion, as a function of frequency and in accordance with a distortion curve, to form a distorted IF signal.

15. A system as recited in claim 14, wherein the distortion curve of said distortion means has a maximum of at least 30 dB with respect to its level at the intermediate frequency of the video carrier.

16. A system as recited in claim 14, further comprising modulator means, coupled to said distortion means, for producing a television signal from said distorted IF signal, wherein said television signal includes video and audio carriers at respective radio frequencies, and the video signal portion of said distorted IF signal is relocated between the video and audio carriers of said television signal, whereby said television signal is distorted by the increase in amplitude of the video signal portion.

17. A system as recited in claim 14, further comprising means for supplying a jamming signal to the video signal portion of said IF signal during the horizontal blanking intervals of the video signal portion.

18. A system as recited in claim 14, further comprising means for supplying a jamming signal to the video signal portion of said IF signal during the vertical blanking intervals of the video signal portion.

19. A system as recited in claim 14, further comprising means for supplying a jamming signal to the video signal portion of said IF signal during both the horizontal and vertical blanking intervals of the video signal portion.

20. A system as recited in claim 15, wherein the distortion curve of said distortion means has a Gaussian shape.

21. A system as recited in claim 16, further comprising means for restoring said television signal by decreasing the amplitude of the video signal portion of said television signal in accordance with a restoring curve that is substantially the inverse of said distortion curve.

22. A system as recited in claim 17, further comprising means for supplying a second jamming signal to the video signal portion of said IF signal during the vertical blanking intervals of the video signal.

23. A system as recited in claim 19, wherein said jamming signal is a single frequency carrier signal.

24. A system as recited in claim 19, wherein said jamming signal is a noise signal.

25. A system as recited in claim 21, wherein said restoring means is a passive filter.

26. A system as recited in claim 21, wherein both the distortion curve and the restoring curve have Gaussian shapes.

27. An apparatus for distorting a television signal such that a television receiving said distorted signal is unable to produce an acceptable picture unless said signal is properly restored, said television signal having frequency spaced video and audio carriers and horizontal and vertical blanking intervals, said apparatus comprising

an encoder that effects an increase in the amplitude of said television signal, as a function of frequency, between said video carrier and said audio carrier, by such an amount that said television signal is distorted thereby.

28. An apparatus as recited in claim 27, wherein said encoder effects the increase in amplitude in accordance with a distortion curve.

29. An apparatus as recited in claim 27, wherein said television signal is produced from a video IF signal having a video carrier and a video signal portion, and wherein said encoder effects the increase in amplitude of said television signal by increasing the amplitude of the video signal portion of said IF signal, in accordance with a distortion curve.

30. An apparatus as recited in claim 27, further comprising means for supplying a jamming signal to said television signal, between said video and said audio carriers, during the horizontal blanking intervals of said signal.

31. An apparatus as recited in claim 27, further comprising means for supplying a jamming signal to said television signal, between said video and said audio carriers, during the vertical blanking intervals of said signal.

32. An apparatus as recited in claim 28, further comprising means for restoring said television signal by decreasing its amplitude, between the video and audio carriers, in accordance with a restoring curve that is substantially the inverse of said distortion curve.

33. An apparatus as recited in claim 32, wherein said distortion curve and said restoring curve have Gaussian shapes.

34. A method of distorting a television signal such that a television receiving said distorted signal is unable to produce an acceptable picture unless said signal is properly restored, said television signal having frequency spaced video and audio carriers and horizontal and vertical blanking intervals, the method comprising the step of

increasing the amplitude of said television signal, as a function of frequency, between said video carrier and said audio carrier, by such an amount that said television signal is distorted thereby.

35. A method as recited in claim 34, wherein said television signal is produced from a video IF signal having a video carrier and a video signal portion, and wherein said step of increasing the amplitude of said television signal is effected by increasing the amplitude of the video signal portion, in accordance with a distortion curve.

36. A method as recited in claim 34, wherein the amplitude of said television signal is increased in accordance with a distortion curve.

37. A method as recited in claim 34, wherein comprising the step of supplying a jamming signal to said television

signal, between said video and said audio carrier frequencies, during the horizonal blanking intervals of said signal.

38. A method as recited in claim 34, further comprising the step of supplying a jamming signal to said television signal, between said video and said audio carrier frequencies, during the vertical blanking intervals of said signal.

39. A method as recited in claim 36, further comprising the step of restoring said television signal by decreasing the amplitude of the scrambled signal between the video and audio carriers in accordance with a restoring curve that is substantially the inverse of said distortion curve.

40. A method as recited in claim 37, further comprising the step of supplying a second jamming signal to said television signal, between said video and said audio carrier frequencies, during the vertical blanking intervals of said signal.

41. A method as recited in claim 39, wherein the distortion curve and the restoring curve have Gaussian shapes.

42. An apparatus for restoring a television signal that has been distorted by an increase in its amplitude, between its video and audio carriers, in accordance with a distortion curve, said restoring apparatus comprising:

an input for accepting the distorted television signal; and

means, coupled to said input, for decreasing the amplitude of the distorted television signal, between the video and audio carriers, in accordance with a restoring curve that is substantially the inverse of said distortion curve.

43. An apparatus for restoring a television signal that has been distorted by an increase in its amplitude as a function of frequency and in accordance with a distortion curve, said restoring apparatus comprising:

a filter having a restoring curve that is substantially the inverse of said distortion curve, so that when the distorted television signal is passed through said filter, its amplitude is decreased in accordance with said restoring curve, to produce a restored television signal.

44. An apparatus as recited in claim 43, wherein said filter is a passive filter.

45. An apparatus as recited in claim 43, wherein the restoring curve of said filter has a Gaussian shape.

46. A method of restoring a television signal that has been distorted by an increase in its amplitude as a function of frequency and in accordance with a distortion curve, said method comprising the steps of:

receiving the distorted television signal; and

decreasing the amplitude of the distorted signal in accordance with a restoring curve that is substantially the inverse of said distortion curve.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : **Re. 34,720**

DATED : **September 6, 1994**

INVENTOR(S) : **Martin L. Zelenz**

It is certified that error appears in the above-indentified patent and that said Letters Patent is hereby corrected as shown below:

Column 3, line 1, "of the carrier" should read —of the video carrier—.

Column 6, claim 37, line 1, "wherein comprising" should read —further comprising—.

Signed and Sealed this

Twenty-first Day of March, 1995

Attest:

BRUCE LEHMAN

Attesting Officer

Commissioner of Patents and Trademarks