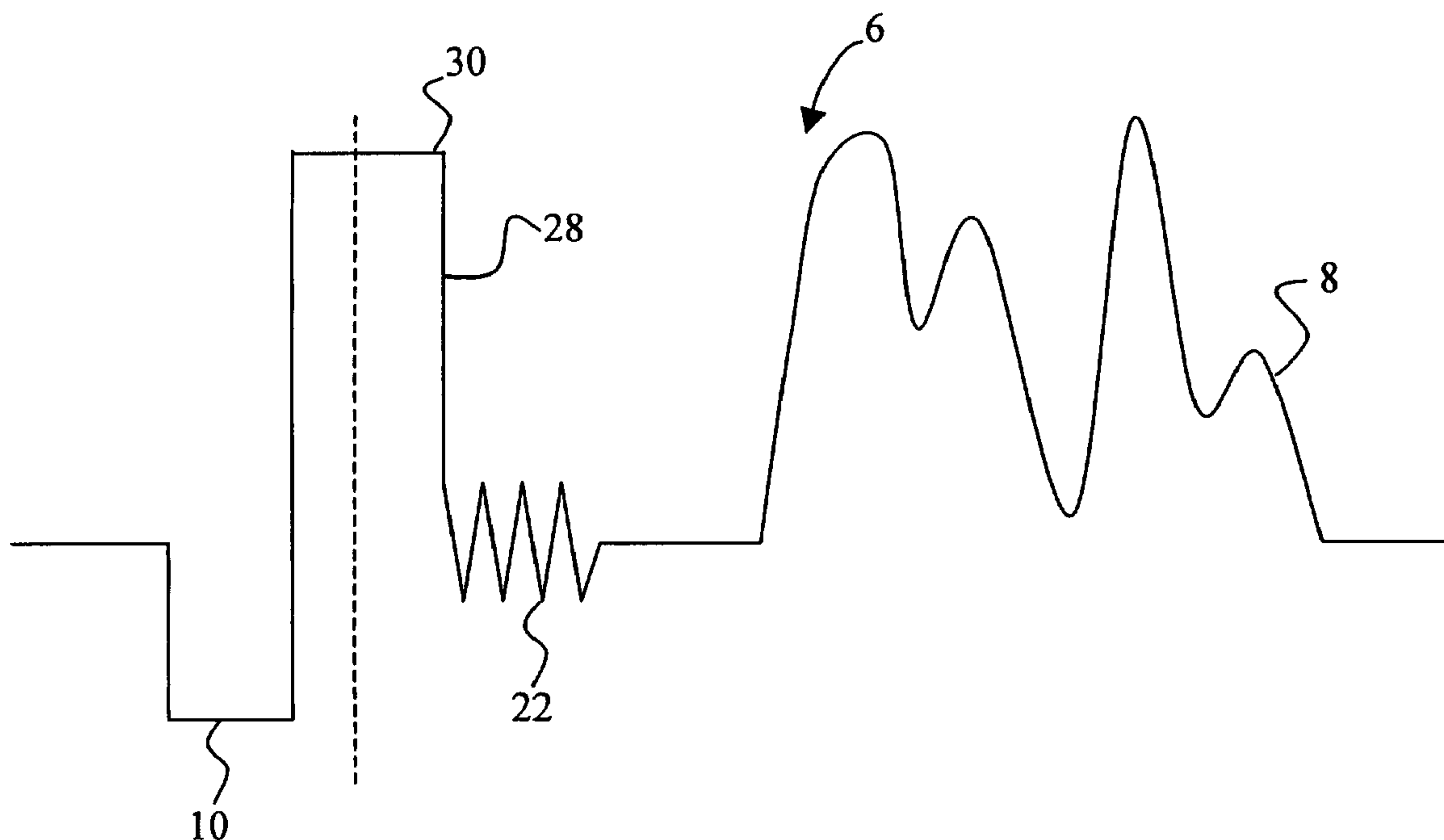




(86) Date de dépôt PCT/PCT Filing Date: 2003/06/30
(87) Date publication PCT/PCT Publication Date: 2004/01/08
(45) Date de délivrance/Issue Date: 2013/03/19
(85) Entrée phase nationale/National Entry: 2005/02/11
(86) N° demande PCT/PCT Application No.: GB 2003/002782
(87) N° publication PCT/PCT Publication No.: 2004/004346
(30) Priorité/Priority: 2002/06/28 (GB0215040.7)

(51) Cl.Int./Int.Cl. *H04N 7/169* (2011.01),
H04N 5/913 (2006.01)
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(54) Titre : PROCEDE ET APPAREIL AMELIORES POUR FOURNIR UN SIGNAL VIDEO PROTEGE CONTRE LA COPIE
(54) Title: AN IMPROVED METHOD AND APPARATUS FOR PROVIDING A COPY-PROTECTED VIDEO SIGNAL



(57) **Abrégé/Abstract:**

A anti-copy programme signal is provided. Copies of the anti-copy video pulses made on a video recorder experience reduced quality and interference in playback making them unpleasant to watch. The uncopied signal can be viewed without any material effect on picture quality. The signal comprises a pulse (28) added to each line (6) of the signal throughout both the visible picture region and throughout the vertical blanking region (12), as well as a first modulated wave-form (34) added to the vertical synchronisation pulses (16) of the signal and a second modulated wave-form (36) added to several lines (6) of the picture signal before the vertical blanking section (12). The presence of all three of these features together has been found to provide a surprising accumulative effectiveness in causing interference in the reproduction of the modified video signal during playback of the copied video signal, that is greater than the effectiveness provided by the different features taken separately.



(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
8 January 2004 (08.01.2004)

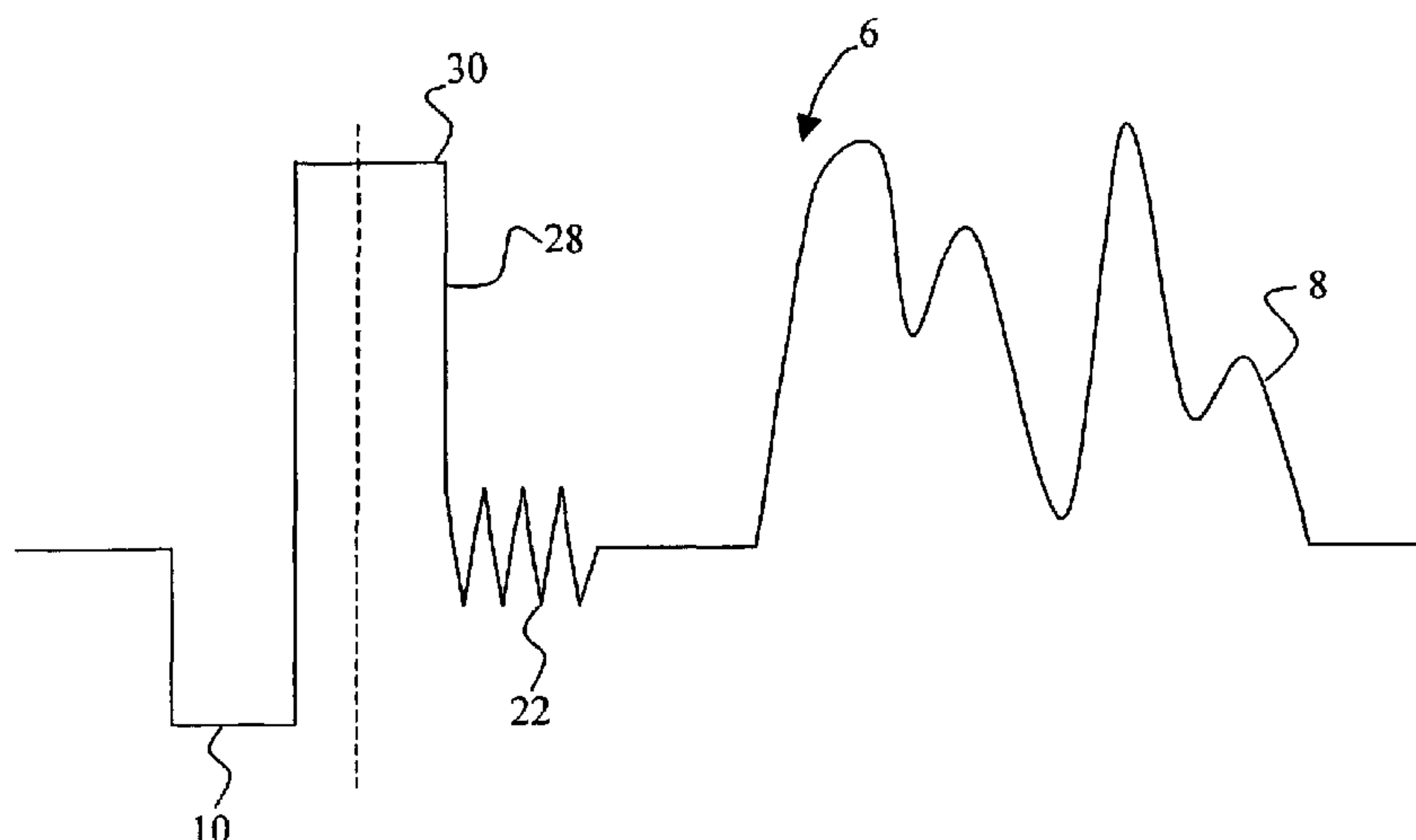
PCT

(10) International Publication Number
WO 2004/004346 A1

- (51) International Patent Classification⁷: **H04N 7/169**
- (74) Agent: ABNETT, Richard, Charles; Reddie & Grose, 16 Theobalds Road, London WC1X 8PL (GB).
- (21) International Application Number: PCT/GB2003/002782
- (81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.
- (22) International Filing Date: 30 June 2003 (30.06.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
0215040.7 28 June 2002 (28.06.2002) GB
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
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- Declaration under Rule 4.17:
— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES,*

[Continued on next page]

(54) Title: AN IMPROVED METHOD AND APPARATUS FOR PROVIDING A COPY-PROTECTED VIDEO SIGNAL



(57) Abstract: A anti-copy programme signal is provided. Copies of the anti-copy video pulses made on a video recorder experience reduced quality and interference in playback making them unpleasant to watch. The uncopied signal can be viewed without any material effect on picture quality. The signal comprises a pulse (28) added to each line (6) of the signal throughout both the visible picture region and throughout the vertical blanking region (12), as well as a first modulated wave-form (34) added to the vertical synchronisation pulses (16) of the signal and a second modulated wave-form (36) added to several lines (6) of the picture signal before the vertical blanking section (12). The presence of all three of these features together has been found to be provide a surprising accumulative effectiveness in causing interference in the reproduction of the modified video signal during playback of the copied video signal, that is greater than the effectiveness provided by the different features taken separately.

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WO 2004/004346 A1

FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

— with international search report

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AN IMPROVED METHOD AND APPARATUS FOR PROVIDING
A COPY-PROTECTED VIDEO SIGNAL

5 This invention relates to an improved method and apparatus for providing an anti-copy video signal, in particular a video signal that has application in the field of pay-per-view television.

10 It is desirable for producers of video programmes, whether recorded on video cassette or broadcast, to be able to provide a signal that when received by a television receiver or display device can be viewed, but which once copied, cannot be satisfactorily viewed on the television receiver or display device. Such a signal allows broadcasters and video content producers to
15 protect themselves against loss of revenue resulting from unauthorised copying of their signal. In the case of producers of pre-recorded video cassettes, unauthorised copying is video piracy, that is copying from one video cassette to another video cassette
20 illegally. Often video piracy is committed with a view to selling the illegally made copies of films to the public.

In the case of broadcasters however, in particular pay-per-view TV distributors, unauthorised copying may
25 simply be the recording of a video signal legitimately received at a digital set top box in the home onto a video cassette. Protection against this type of copying provides further advantages to the broadcasters than simply protecting against loss of revenue. By preventing
30 unauthorised copy in the home, the broadcaster can protect the interests of the producer of the video programmes while still allowing the programme to be

viewed in the home. Thus, a broadcaster may for example obtain a special agreement from a movie distributor to broadcast a movie before the movie's general video release date, allowing the broadcaster to enjoy increased rating figures, while protecting the revenue in subsequent video sales for the movie.

Various methods for modifying a video signal are known, such that when the modified signal is recorded by a video cassette recorder the recorded signal is unwatchable. However, the efficacy of such modified signals varies widely depending upon the television receiver and video recorder used to display and record the signal. We have appreciated therefore that it would be advantageous to provide an improved signal having an anti-copy effect on a wide range of television receivers and recording devices, such as video recorders.

SUMMARY OF THE INVENTION

Embodiments discussed herein are directed to systems and methods for providing an anti-copy programme signal. The anti-copy programme signal includes a pulse added to each line of the signal throughout both the visible picture region and throughout the vertical blanking region, as well as a first modulated wave-form added to the vertical synchronisation pulses of the signal and a second modulated wave-form added to several lines of the picture signal before the vertical blanking section. Copies of video having the anti-copy programme signal made on a video recorder experience reduced quality and interference in playback making them unpleasant to watch. Uncopied video having the anti-copy programme signal can be viewed without any material effect on picture quality.

One embodiment is directed to a method of generating or modifying a programme signal to provide protection

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against copying on a programme recording device, the method comprising the steps of: receiving a programme signal or information for generating a programme signal divided into lines of information, the signal having horizontal synchronisation pulses and vertical synchronisation pulses for synchronising the programme on the screen of a receiver; adding a pulse into the programme signal during the horizontal blanking interval of lines that contain picture information and into lines in the vertical blanking region; adding a first modulation signal to vertical synchronisation pulses of the programme signal; adding a second modulation signal to lines of picture information in the vicinity of the vertical blanking region at the bottom of a frame of the programme signal; wherein the pulse, and the first and second modulation signals added to the programme signal are sufficient such that when the signal is copied by the recording device, interference is produced in the reproduction of the copied signal that is not visible in the reproduction of an uncopied programme signal.

Another embodiment is directed to a method of generating or modifying a programme signal to provide protection against copying on a recording device, the method comprising: receiving a programme signal or information for generating a programme signal divided into lines of information, the signal having horizontal synchronisation pulses and vertical synchronisation pulses for synchronising the programme on the screen of a receiver; and performing two of following three steps: adding a pulse into the programme signal during the horizontal blanking interval of lines that contain picture information and into lines in the vertical blanking region; adding a first modulation signal to vertical synchronisation pulses of the programme signal;

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adding a second modulation signal to lines of picture information in the vicinity of the vertical blanking region at the bottom of a frame of the programme signal; wherein two of either the pulse, and the first and second modulation signals added to the programme signal are sufficient such that when the signal is copied by a recording device, interference is produced in the reproduction of the copied signal that is not visible in the reproduction of an uncopied programme signal.

A further embodiment is directed to an apparatus for modifying a programme signal to provide protection against copying on a recording device, the apparatus comprising: an input for receiving a programme signal divided into lines of information, the signal having horizontal synchronisation pulses and vertical synchronisation pulses for synchronising the programme on the screen of a receiver; a first adder for adding a pulse into the programme signal during the horizontal blanking interval of lines that contain picture information and into lines in the vertical blanking region; a second adder for adding a first modulation signal to vertical synchronisation pulses of the programme signal; a third adder for adding a second modulation signal to lines of picture information in the vicinity of the vertical blanking region at the bottom of a frame of the programme signal; and an output for outputting a modified programme signal; wherein the pulse, and the first and second modulation signals added to the programme signal are sufficient such that when the modified programme signal is copied by a recording device, interference is produced in the reproduction of the copied signal that is not visible in the reproduction of an uncopied programme signal.

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Another embodiment is directed an apparatus for modifying a programme signal to provide protection against copying on a recording device, the apparatus comprising: an input for receiving a programme signal divided into lines of information, the signal having horizontal synchronisation pulses and vertical synchronisation pulses for synchronising the programme on the screen of a receiver; an output for outputting a modified programme signal; and any two of the following: a first adder for adding a pulse into the programme signal during the horizontal blanking interval of lines that contain picture information and into lines in the vertical blanking region; a second adder for adding a first modulation signal to vertical synchronisation pulses of the programme signal; a third adder for adding a second modulation signal to lines of picture information in the vicinity of the vertical blanking region at the bottom of a frame of the programme signal; and wherein the two of the pulse, and the first and second modulation signals added to the programme signal are sufficient such that when the modified programme signal is copied by a recording device, interference is produced in the reproduction of the copied signal that is not visible in the reproduction of an uncopied programme signal.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail by way of example and with reference to the drawings in which:

Figure 1 illustrates a part of a known television picture signal;

Figure 2 illustrates a line of the video picture signal shown in Figure 1;

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Figure 3 illustrates a line of the video picture signal, according to the preferred embodiment of the invention;

Figure 4 illustrates the addition of pulses to the modified video picture signal shown in Figure 2, and throughout the vertical blanking section of the picture signal, as well as the addition of a modulated wave-form into the vertical synchronisation pulses, according to the preferred embodiment of the invention;

Figure 5 illustrates the addition of a modulation signal prior to the vertical blanking section of the video picture signal shown in Figure 1, according to the preferred embodiment of the invention;

Figure 6 is a schematic illustration of apparatus for generating the modified wave form according to the preferred embodiment of the invention; and

Figure 7 is a block diagram of a circumvention apparatus to remove the anticopy signal.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 shows a region of a known video picture signal 1, such as a phase-alternating-line (PAL) signal. The signal comprises synchronisation information 2 for initialising the circuits of a television receiver and picture information 4. The information is arranged into 625 lines 6 which correspond to one full screen of a picture called a frame. There are 625 lines in a PAL signal making up a single frame, and each line of the signal has a length of $64\mu\text{s}$. The following discussion uses timing periods and other parameters based on the 625 line PAL standard. It will be appreciated that the timings and other parameters may need to be adjusted to

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accommodate the different television standards. It will also be appreciated that, where specific times or other parameters are referred to in the text below, the standards prescribe tolerances for such times and other parameters, and accordingly some variation is permitted from the precise values.

The picture information is displayed on a screen of a television receiver using an electron gun to sweep an electron beam across the screen from the left to the right in a single line. The electron beam also sweeps from the top of the screen to the bottom of the screen to display the lines of the picture signal, and does this twice for a PAL signal. In the first sweep, the odd numbered lines are displayed, after which the electron beam returns to the top to display the even numbered lines. Each pattern of lines displayed on the screen is called a raster and there are therefore two rasters in one frame of a PAL signal.

The picture information 4 comprises a positive going wave-form 8, the height of which above the zero-level of the video signal represents the colour to be displayed at a corresponding point on a line of the screen of the television receiver. The zero-level of the signal is called the blanking level and corresponds to the colour black displayed on the screen. Once a line of picture information has been projected on to the television screen, the electron beam must be reset to the left of the screen before the next line can be displayed. This is achieved by negative-going line synchronisation pulses 10, each of width $4.7\mu\text{s}$. A line synchronisation pulse 10 is positioned at the end of each line, after any picture information 8.

The video picture signal contains more lines than are usually displayed on the screen of a television

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receiver; not all lines of the signal are used to display picture information. In particular, two regions of blank lines are provided in the PAL signal in order to control the fly-back of the electron beam from the bottom of the screen to the top, after all of the odd or even numbered lines have been displayed. These regions are called vertical blanking regions 12 and each contains a number of synchronisation pulses which are used to reset the television receiver so that it is ready to display the next frame of picture information. The vertical blanking region contains a series of pre-equalisation pulses 14, vertical synchronisation pulses 16 and post-equalisation pulses 18. The vertical synchronisation pulses 16 can be detected in the television receiver by an arrangement of capacitors that build up charge as each vertical synchronisation pulse is received. The spacing of the vertical synchronisation pulses, and the width of the pulses is such that the charge on the capacitors increases until a threshold level is reached, triggering fly-back of the electron beam from the bottom of the television screen to the top. The pre-equalisation pulses 14, and post-equalisation pulses 18 however are spaced such that the charge on the arrangement of capacitors is reset before and after the vertical synchronisation pulses are received. This ensures reliable detection of the vertical synchronisation pulses and reliable fly-back of the electron beam to start a new raster. Only one vertical blanking region is shown in Figure 1.

30 A modified picture signal according to the preferred embodiment of the invention will now be described. The modified signal comprises an additional positive going pulse added to each line of the signal throughout both the visible picture region and

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throughout the vertical blanking region 12 or to a substantial number of such lines. Furthermore, the modified signal comprises a first modulated wave-form added to the vertical synchronisation pulses and a
5 second modulated wave-form added to several lines of the picture signal before the vertical blanking section. The second modulated wave-form substantially attenuates or preferably replaces the picture information 8 of those lines. The presence of all three of these features
10 together has been found to be provide a surprising accumulative effectiveness in causing interference in the reproduction of the modified video signal during playback of the copied video signal, that is greater than the effectiveness provided by the different
15 features taken separately. Indeed the presence of just one of the features alone may not be sufficient to result in interference in the reproduction of the copied modified video signal when it is played back. The presence of one of the features therefore increases the
20 effectiveness of the other features, resulting in enhanced overall effect.

As well as an unexpected increased effectiveness, the modified video signal provides increased protection against any measures that might prevent the modified
25 video signal from having an effect. Even if a television receiver is not susceptible to one of the anti-copy features, the presence of the other two are still likely to have a disruptive effect. For this reason, it is preferred if the features are added to the video signal
30 such that the presence of two of them is enough to cause interference during playback of the copied signal.

Furthermore, if any apparatus is developed to deliberately overcome the protection provided by the preferred anti-copy video signal, it must compensate for

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three anti-copy features in the modified video signal not just one. If the dimensions of the features are varied from line to line or frame to frame, as described later, the three anti-copy features are even more
5 difficult to negate.

Furthermore, the modulated picture signal according to the preferred embodiment of the invention comprises picture information 8 that has been amplified in comparison to the unmodified signal shown in figure 1.

10 Each of the features of the modified video signal will now be described in more detail with reference to Figures 2 to 6. Figure 2 shows a single line 6 in the picture region of the picture signal 1 shown in Figure 1. The line is $64\mu\text{s}$ in length and comprises positive-
15 going wave form 8 defining picture information and horizontal blanking section 20. The picture information of the line is known as the active line and is $52\mu\text{s}$ in length. The horizontal blanking section is therefore $12\mu\text{s}$ in length. It does not contain picture information
20 and is not displayed on the screen of the television receiver, but does include synchronisation information and other information for regulating the response of the television receiver circuits. In particular, the horizontal blanking section 20 includes a horizontal or
25 line synchronisation pulse 10 for controlling the line flyback circuits of the television receiver, and colour burst portion 22 for initialising the colour response of the television receiver to the picture signal. The horizontal line pulse is $4.7\mu\text{s}$ in width and extends to -
30 300mV below the blanking level.

The region of the horizontal blanking section 20 to the left in the diagram of the horizontal line pulse 10 is called the front porch 24, while the region extending to the right of the horizontal line synchronisation

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pulse is called the back porch 26. The back porch extends to the start of the picture information 8.

Figure 3 shows the corresponding region of the modified video picture signal according to the preferred embodiment of the invention for providing an anti-copy effect. The modified signal comprises a positive-going pulse 28 added to the horizontal blanking section at the beginning of the back porch 26. Preferably the height of the additional pulse 28 is 1V above the blanking level, but any height in the range 0.5V to 1.5V has been found to be acceptable preferably in the range 0.7V to 1.2V. The maximum height of the picture information wave-form 8 is about 0.7V. The pulse is added to each line 6 of the modified video signal. While the pulse is preferably added to each line, or a substantial number of the lines, addition to selected lines may achieve a sufficient result.

The additional pulse 28 preferably has a width of $1.2\mu\text{s}$ and is situated such that it extends $0.8\mu\text{s}$ into the horizontal line synchronisation pulse 10. Thus, the effective width of the line synchronisation pulse is reduced from $4.7\mu\text{s}$ to $3.9\mu\text{s}$. The original position of the rising edge of the horizontal synchronisation pulse 10 is shown in Figures 2 and 3 by the dotted line 30.

The width of the additional pulse and the position in the blanking signal at which it is positioned may however be varied. As particular television receivers may be less susceptible to the effect of the additional pulses if the pulse is maintained at a particular height and at a particular position, it is preferred if the position, and height and width of the pulse are varied throughout the picture signal and indeed even from line to line. This ensures that the effect of the additional pulse 28 is likely to be encountered on a range of

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different television receivers despite their different responses to the recorded video signal.

The additional pulse has been found to produce satisfactory results providing it has a width in the
5 range $0.2\mu\text{s}$ and $4\mu\text{s}$, preferably 0.5 to $1.5\mu\text{s}$. It has also been found that the position of the pulse can be varied such that the width of the horizontal line pulse is reduced by up to $2\mu\text{s}$ from line 30, preferably in the range 0.5 to $1.5\mu\text{s}$.

10 The effect of the pulse inserted into the horizontal blanking region is to interfere with the operation of the Automatic Gain Control (AGC) circuits of a video recorder. The AGC circuits of the video recorder typically detect the height of the
15 synchronisation pulses in the received signal and amplify the signal so that it is at a suitable level to be recorded. The AGC circuits therefore compensate for any attenuation in the video picture signal when it is received at the video recorder.

20 The pulse 28 is to present a rising or falling edge of greater amplitude than the synchronisation pulse in the region where the AGC circuits sample the signal to detect the synchronisation pulse. The automatic gain control circuits are caused therefore to underestimate
25 the amount by which the signal needs to be amplified in order to ensure that the picture quality is at a suitable level for recording. The synchronisation pulses are not therefore amplified sufficiently to achieve reliable synchronisation on a television receiver when
30 the signal is viewed and as a result the playback quality is reduced. Apparatus and systems that work in this way are well known in the art and shall not be described further here. Further, such pulses may also be inserted after a negative going pulse, for example,

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in the vertical blanking interval, where the negative going pulse is misinterpreted by the video recorder as a further horizontal synchronisation pulse, and in some embodiments it may be possible to add further negative going pulses in, for example, the vertical blanking interval, which fool the video recorder in this way, followed by a pulse in accordance with the invention. In this case the pulse may be required on fewer of the lines in the modified video signal.

However, the pulse that is added in the preferred embodiment, has the additional effect of reducing the width of the horizontal line synchronisation pulse. Before recording, the reduction in width of the horizontal line synchronisation pulses 10 is not sufficient to affect the display of the picture information. However, after recording of the signal has taken place on a video cassette recorder, the reduction in width is combined with the reduction in height of the horizontal synchronisation pulse that results from insufficient amplification by the AGC circuits. This causes the line synchronisation pulses to be even less likely to be reliably detected by the television receiver.

Reference shall now be made to Figure 4, the upper half of which shows a number of lines in the vertical blanking region 12 of the picture signal shown in Figure 1. The five vertical synchronisation pulses 16 can be seen to extend negatively from the blanking level 32.

The modified video signal according to the preferred embodiment of the invention, is shown in the bottom half of the figure. It comprises a modulated wave-form 34 that is added into at least part of, and preferably the full width of the vertical synchronisation pulses. The modulated wave-form is preferably a square wave of

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frequency 400kHz, which extends from the peak minimum level of the vertical synchronisation pulses to a height of about 315mV above the blanking level 32. Heights of the first modulated waveform 34 in the range of 150mV to 400mV
5 have been found to work well. Preferably the height of the modulated waveform is in the range 250 to 350mV.

Other wave-forms, such as a sine-wave or a saw-tooth wave for example, could also be used. Furthermore, it has been found that the frequency of the modulated wave-from
10 can be varied from 100kHz to 6.5MHz. Preferably the frequency is in the range 200kHz to 1MHz, more preferably 300kHz to 600kHz. Preferably the signal is added to at least 80% of the width of the vertical synchronisation pulse, preferably to the full width of each pulse.

15 The effect of the modulated wave-from is to partially cancel out the vertical synchronisation pulses 16 making them harder to detect in the television receiver. Before the modified video signal is recorded, the height of the modulation is not sufficient to have an effect on the
20 display of the modified signal. During recording however, the video signal is amplified according to an amount determined by the AGC circuits of the video recorder. The maximum amplitude of the negative-going synchronisation pulses is clamped at a value of approximately -300mv
25 relative to the blanking level to ensure that the synchronisation pulses of the recorded signal are suitable for detection by a television receiver. As a result of the clamping in the negative region of the signal, the positive region of the signal is amplified with respect to
30 the negative region. This amplification of the positive part of the signal during recording has the effect of amplifying the positive part of the modulated wave-form, thereby cancelling more of the vertical synchronisation pulse.

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This can also be understood from a consideration of the average voltage level of the vertical synchronisation pulse. After recording the average voltage level of the vertical synchronisation pulses 16 comprising the modulation is higher than the average voltage level before recording, owing to the recording-induced-increase in the maximum positive amplitude of the modulation.

As a result, the capacitor arrangement in the television receiver which detects the vertical synchronisation pulse may not be able to charge beyond the threshold level as quickly as before, or even at all before the last vertical synchronisation pulse is received. The television receiver is more likely therefore to experience difficulty in synchronising fly-back between frames. This will cause the picture displayed on the screen of the television receiver to jump and jitter making it unpleasant to watch. The effect of these pulses, may be realised after a single recording, or after several recordings depending upon the amount of amplification. Even if a first unauthorised recording of the modified video signal is successfully made, in which the height of the pulses is insufficient to have an effect, subsequent recordings will raise the height of the pulses to a level at which it is likely to have an effect.

It can be seen from this figure that the additional pulse 28 is inserted not just in the picture region but at every line of the video picture signal including those in the vertical blanking region. The additional pulses 28 inserted into the vertical blanking region add to the effect of the modulation 34 by further partially cancelling the vertical synchronisation pulses. The effect of these additional pulses is also increased by recording of the signal.

Figure 5 to which reference should now be made shows in more detail another feature of the modified video

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picture signal in a preferred embodiment. Lines of picture information 8 prior to the vertical blanking section 12 of the picture signal are removed and replaced by a modulated wave form 36. Though these lines contain picture

5 information, they are not normally within the visible region displayed on the screen and can therefore be manipulated without any material loss in picture quality.

An unmodified video signal is shown in the bottom half of Figure 5 by way of comparison.

10 The modulated wave form 36 is preferably centred about the DC level and has an amplitude in the range 40 to 150 mV (that is a peak-to-peak amplitude of 80mV to 300mV), more preferably 60 to 100mV. A preferred amplitude has been found to be about 80mV, in particular 84mV. The

15 frequency of the modulated wave is preferably in the range 10kHz to 2 MHz, more preferably 50kHz to 1MHz, especially 100kHz to 400kHz. A frequency of 220kHz and particularly 200kHz has been found to be favourable in practice. The pulse 28 which is added to the lines of the picture signal

20 is not shown in Figure 5 for the sake of clarity.

Although a square wave form is shown in Figure 5, it will be appreciated that alternative wave forms such as a sine wave or saw-tooth waves may also be used. Preferably, the modulated wave-form is added to 12 lines of picture

25 information at the bottom of the picture signal before the vertical blanking region. In practice it has been found that the wave-form may be added to just 5 lines or up to 15 lines. If more than 15 lines are modified in this way, it is possible that the modulation may become visible on

30 the television screen of the television receiver.

The effect of inserting the modulated wave-form into the lines of picture information is to cause the voltage level in the recorded video signal in the region of modulated wave-form to fall off with time. As a result,

35 the signal may drop to a level where it is mistaken for a

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synchronisation pulse, causing the television receiver to experience difficulty in synchronising the recorded signal on playback.

As described earlier, the modified video picture
5 signal according to the preferred embodiment of the
invention, comprises amplified video picture information
8, in comparison to the unmodified video picture signal
shown in Figure 1. It has been found advantageous to
amplify the picture information because of the increase in
10 the dc level of the modified video signal caused by the
additional pulses 22. As a result of this increase, the
amplitude of the video picture information appears smaller
in comparison. The AGC circuits of the television receiver
do not therefore amplify the signal by a sufficient
15 amount and as a result the modified picture video signal
appears dark when viewed on a television receiver even if
it has not been recorded.

The picture information in the preferred embodiment
is therefore amplified, preferably after the additional
20 pulses, and the first and second modulated wave-form have
been added to a signal to produce a modified signal.
Preferably, the amplification is achieved by adding 100mV
to the picture information signal across its entire width.
The term amplify is used in this specification to include
25 such level shifting. Preferably the level shifting is in
the range 50mV to 150mV. The amplification causes the
amplitude of the picture signal to increase from a maximum
value, corresponding to the peak white level, of 700mV to
800mV. Alternatively, the picture information 8 may be
30 multiplied by a scaling factor to provide the
amplification. Preferably the scaling factor will result
in the peak amplitude being increased by the equivalent
amount as the level shifting discussed above. Level
shifting and scaling may be used together.

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Only the part of the signal containing picture information, that is the active line, is amplified. The horizontal blanking interval 30, is not amplified as this may contain the additional pulse 28.

5 The amplification applied to the signal is chosen such that the signal appears on the screen of a television receiver at an improved brightness for viewing. The change in brightness caused by the amplification will vary from television receiver to television receiver depending on
10 its construction. Preferably, if the type of television receiver on which the modified picture signal is to be viewed is known, the amplification applied to the picture information can be provided at a level suitable for that television receiver. In the case of pay-per-view
15 television, information about the television receiver may be collected from subscribers when they first subscribe to the service. Although, it is not necessary that they provide information about their television receiver, doing so will allow them to receive a modified video signal
20 adjusted to be viewable at the optimum brightness for their receiver. The invention also encompasses the use of such information, as in the case of a person seeking to reduce the impact of the modifications proposed in accordance with this invention, to reduce the impact of
25 such modifications, for example by programming the system with information for a television other than that used, with the object of making the impact of the modification less.

Figure 6 is a schematic diagram of an apparatus for
30 generating a modified video picture signal in accordance with the preferred embodiment of the invention from an ordinary video picture signal.

Unmodified video picture signal is first received at
input 40. The signal is then passed to Anti-Copy Signal
35 Generator 42 and to Brightness Separator 44.

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The Anti-copy Signals Generator generates the additional pulses 28, as well as the first and second modulated wave-forms 34 and 36 for insertion into the vertical synchronisation pulses and the lines before the vertical blanking region, and inserts the pulses and
5 modulated wave-forms into the signal as described.

The Brightness Separator 44 extracts the brightness information from the received video signal, and passes this in the form of a brightness signal to Brightness
10 Algorithm 46 which also receives input from TV Receiver Model 48. The Brightness Algorithm determines from the TV Receiver Model the desired amount of amplification that is required for the picture information of the signal. The picture information may be amplified by the addition of a
15 constant signal, such as 100mV as in the preferred embodiment, or by multiplying the picture information by a scaling factor.

The TV Receiver Model 48 comprises information specifying the amount of amplification required for
20 different respective television receivers. The information may be calculated empirically, and may be stored in a look-up table for example. If the information describing the type of television receiver has been provided by a Pay-Per-View television subscriber, then the look-up table
25 can be referred to obtain the amplification necessary to give the optimum increase in brightness of the signal following modification for that receiver. A generic television type may be provided in the look-up table to be used when no information about the destination television
30 receiver of the subscriber is known, or when the destination television receiver happens not to be included in the table.

The TV Receiver Model 48 is also coupled to Anti-copy signals generator 42. As explained before the dimensions
35 of the additional pulse 28 and first and second modulated

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wave-forms, such as height, width, frequency and position for example, can be altered. Different values for these figures have different effects on different television receivers. If the type of the destination television receiver on which the modified video signal is to be viewed is known, it is therefore possible to add the pulses, and modulation effects with parameters that produce the optimum effect when viewed on that television receiver. In this way the effect of the modified video signal can be tailored to suit a particular receiver. The Anti-copy signals generator therefore consults the look-up table before adding the pulses and modulations to obtain the optimum values. A generic response which comprises a range of figures for the dimensions and positions of the pulses and the dimensions of the modulated wave-forms are provided if the television receiver type is not known, or is not included in the table. The Anti-copy signals generator can then vary the dimensions and position of the pulses, and the dimensions of the modulated wave-forms within the range in order to ensure the effect of the anti-copy signals are visible on a wide range of receivers.

The amplification specified by the TV Receiver Model is applied by the Brightness Algorithm 46 to the brightness signal supplied by the Brightness separator 44. The amplified brightness signal is then passed to adder 50, which also receives the modified signal from the Anti-copy signal generator. Adder 50 adds the amplified brightness signal into the modified video signal replacing the original brightness information in the modified video signal, to form a final modified signal which is supplied to an output 52.

It will be appreciated that the apparatus shown in Figure 6 may be implemented in software on a computer or as hardware, such as a processor. It will further be

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appreciated that different elements of the modified signal, for example the pulse, and first and second modifications, may be added together prior to modifying the unmodified signal, and these elements then added to
5 the unmodified signal all at once, or such elements may be added sequentially to the unmodified signal, or a combination of these may be adopted. Moreover, where for example the process is applied in apparatus which also converts a digital signal to an analog signal, the
10 different elements of the signal may be generated separately and added together. In such case there may not be a pre-existing unmodified signal.

Although, the invention has been described with reference to a video cassette recorder, the invention has
15 equal application to DVD recorders, digital video recorders and video recorders using video capture cards.

There is also provided a process (a circumvention process) for making acceptable copies of a video signal which has been modified or generated in accordance with
20 the invention, comprising removing the added components or at least some, especially at least two of them, or reducing the effects of the added components or some of them, especially at least two of them, to an acceptable level. For example such a process may comprise inserting
25 a signal which cancels or reduces one or more of the added components, or by replacing the section of the video signal which has been modified by the inclusion of the added components by a section which is acceptable to the video recorder system or television, or by inserting a
30 signal which is interpreted by video recorder system in a manner which cancels the effect of the disruption component. In this context acceptable does not necessarily mean that the copy is free from any artefacts that have been introduced by the copy protection; rather
35 than the effect of such copy protection has been reduced

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to such an extent that the picture is viewable. In the most attractive embodiments of course the removal of the effects will result in a copy free from or substantially free from the effects of the copy protection signal.

5 Where the circumvention process comprises the addition of a further signal which cancels signal of the added component, this will depend on the nature of the signal of the added component. For example, if in the relevant disruption component, there is added a pulse
10 after the horizontal sync pulse, the effect of this may be counteracted by replacing all or a substantial proportion of such pulse by a back porch level immediately following the horizontal sync pulse by a level close to the normal blanking level, or alternatively by replacing the back
15 porch region immediately after the horizontal sync pulse by a level below the blanking level, in at least some cases. It will be appreciated that this may involve also cancelling some, but not necessarily all of the existing pulses where it is decided to lower the level of the back
20 porch to below the blanking level at a location where there is one of the added pulses.

 In relation to the first modulated wave form, the vertical sync pulses may be recreated. Alternatively, the tops of the added signal (the parts above blanking level)
25 could be clipped or further reduced in amplitude either before or after a recording is made. An example of a process for achieving this is an apparatus which determines the position of the vertical sync pulses and switches in a shunt which shunts all signal levels above a
30 predetermined level, for example blanking level or above, either exactly where the vertical synchronisation pulses occur or in that region.

 An apparatus for carrying out the circumvention process will typically include at means for circumventing
35 at least two of the added components.

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The second modulated waveform may be counteracted by the addition to it, or replacement of it, by a zero level signal or a signal which is more similar to an active video signal in at least some of active video lines at the beginning of the vertical overscan portion of the signal,
5 for example by stepped waveform which rises from zero to full white level, or a waveform which rises from zero to full white and descends back to zero again.

Figure 7 show a block diagram of an apparatus for
10 circumventing the anti copy signal. In figure 7, the H & V sync separator separates the timing signals, horizontal and vertical synchronization pulses of the copy-protected video signal. To remove the AGC pulses, the switcher control will connect to the output (which is set up to the
15 blanking level) of the adjustable resistor A during the AGC pulses. The switcher control is controlled by the delayed horizontal synchronization pulses. The H-line counter produces the starting and ending control signals for controlling the switcher connecting to the blanking
20 level or 0V level to remove the 200 kHz and the 400 kHz signals, respectively.

1. A method of generating or modifying a programme signal to provide protection against copying on a programme recording device, the method comprising:

receiving a programme signal or information for generating a programme signal divided into lines of information, the signal having horizontal synchronisation pulses and vertical synchronisation pulses for synchronising the programme on the screen of a receiver;

adding a pulse into the programme signal during the horizontal blanking interval of lines that contain picture information and into lines in the vertical blanking region, wherein the height of the pulse is in the range 0.5V to 1.5V above the blanking level and the width of the pulse is in the range 0.2 μ s to 4 μ s;

adding a first modulation signal to vertical synchronisation pulses of the programme signal;

adding a second modulation signal to lines of picture information in the vicinity of the vertical blanking region at the bottom of a frame of the programme signal;

wherein the pulse, and the first and second modulation signals added to the programme signal are sufficient such that when the signal is copied by the recording device, interference is produced in the reproduction of the copied signal that is not visible in the reproduction of an uncopied programme signal.

2. A method according to claim 1 comprising amplifying the picture information in lines of the programme signal to increase the brightness of the signal such that the darkening effect of adding the pulse, and the first and second modulated signals is reduced.

3. A method according to claim 1 or 2 wherein the pulse is added to the horizontal blanking interval adjacent the horizontal synchronisation pulse.
4. A method according to claim 1 to 3 wherein the pulse is added to the horizontal blanking interval such that the width of the horizontal synchronisation pulse is reduced.
5. A method according to any one of claims 1 to 4 in which the height of the pulse is 1V.
6. A method according to any one of claims 1 to 5 in which the width of the pulse is 1.2 μ s.
7. A method according to any one of claims 1 to 6 wherein the pulse is positioned such that the width of the horizontal synchronisation pulse is reduced by 0 μ s to 2 μ s.
8. A method according to any one of claims 1 to 7 wherein the pulse is positioned such that the width of the horizontal synchronisation pulse is reduced by 0.8 μ s.
9. A method according to any one of claims 1 to 8 comprising adding the pulse to the horizontal blanking interval such that one or more of the height, the width, and the position of the pulse varies across the lines of the programme signal.
10. A method according to any one of claims 1 to 9 wherein the first modulation signal has a frequency in the range 100kHz to 6500kHz.
11. A method according to any one of claims 1 to 10 wherein the first modulation signal has a frequency of 400kHz.
12. A method according to any one of claims 1 to 11 wherein the height above the blanking level to which the first modulation signal extends is 250mV.

13. A method according to any one of claims 1 to 12 wherein the to first modulation signal is a square wave.

14. A method according to any one of claims 1 to 12 wherein the first modulation signal is a sine wave.

15. A method according to any one of claims 1 to 12 wherein the first modulation signal is a saw tooth function.

16. A method according to any one of claims 1 to 15 wherein the frequency of the first modulation signal is varied between different vertical synchronisation pulses.

17. A method according to any one of claims 1 to 16 wherein the second modulation signal has a frequency in the range 10kHz to 2MHz.

18. A method according to any one of claims 1 to 17 wherein the second modulation signal has a frequency of 220kHz.

19. A method according to any one of claims 1 to 18 wherein the second modulation signal has an amplitude in the range 40mV to 150mV.

20. A method according to any one of claims 1 to 19 wherein the second modulation signal has an amplitude of 70mV.

21. A method according to any one of claims 1 to 20 wherein the second modulation signal is a square wave.

22. A method according to any one of claims 1 to 20 wherein the second modulation signal is a sine wave.

23. A method according to any one of claims 1 to 20 wherein the second modulation signal is a saw tooth function.

24. A method according to any one of claims 1 to 23 wherein the to second modulation signal is added to between 5 and 15

lines of picture information prior to the vertical blanking section.

25. A method according to any one of claims 1 to 24 wherein the second modulation signal is added to 12 lines of picture information prior to the vertical blanking section.

26. A method according to any one of claims 1 to 25 wherein at least one of the number of lines to which the second modulation signal is added, the amplitude of the modulation signal, and the frequency of the modulation signal is varied from frame to frame of the programme signal.

27. A method according to any one of claims 1 to 26 wherein the pulse, and first and second modulation signals are added to the programme signal in dependence on information relating to the type of receiver on which the programme signal is to be viewed.

28. A method according to any of claims 2 to 27 wherein the picture information is amplified by adding 100mV to the region of the signal comprising the picture information.

29. A method according to any of claims 2 to 27 wherein the picture information is amplified by multiplying the region of the signal comprising the picture information by a scaling factor.

30. A method according to any of claims 2 to 27 wherein the picture information is amplified by multiplying the region of the signal comprising the picture information by an amount that varies in dependence on information relating to the type of receiver on which the programme signal is to be viewed.

31. A method of generating or modifying a programme signal to provide protection against copying on a recording device, the method comprising:

receiving a programme signal or information for generating a programme signal divided into lines of information, the signal having horizontal synchronization pulses and vertical synchronisation pulses for synchronising the programme on the screen of a receiver; and performing two of following three steps:

adding a pulse into the programme signal during the horizontal blanking interval of lines that contain picture information and into lines in the vertical blanking region, wherein the height of the pulse is in the range 0.5V to 1.5V above the blanking level and the width of the pulse is in the range 0.2 μ s to 4 μ s;

adding a first modulation signal to vertical synchronisation pulses of the programme signal;

adding a second modulation signal to lines of picture information in the vicinity of the vertical blanking region at the bottom of a frame of the programme signal;

wherein two of either the pulse, and the first and second modulation signals added to the programme signal are sufficient such that when the signal is copied by a recording device, interference is produced in the reproduction of the copied signal that is not visible in the reproduction of an uncopied programme signal.

32. Apparatus for modifying a programme signal to provide protection against copying on a recording device, the apparatus comprising:

an input for receiving a programme signal divided into lines of information, the signal having horizontal synchronisation pulses and vertical synchronisation pulses for synchronising the programme on the screen of a receiver;

a first adder for adding a pulse into the programme signal during the horizontal blanking interval of lines that contain picture information and into lines in the vertical blanking region, wherein the height of the pulse is in the range 0.5V to 1.5V above the blanking level and the width of the pulse is in the range 0.2 μ s to 4 μ s;

a second adder for adding a first modulation signal to vertical synchronisation pulses of the programme signal;

a third adder for adding a second modulation signal to lines of picture information in the vicinity of the vertical blanking region at the bottom of a frame of the programme signal; and

an output for outputting a modified programme signal;

wherein the pulse, and the first and second modulation signals added to the programme signal are sufficient such that when the modified programme signal is copied by a recording device, interference is produced in the reproduction of the copied signal that is not visible in the reproduction of an uncopied programme signal.

33. An apparatus according to claim 32 comprising an amplifier for amplifying the picture information in lines of the programme signal to increase the brightness of the signal such that the darkening effect of adding the pulse, and the first and second modulated signals is reduced.

34. An apparatus according to claim 33 wherein the amplifier comprises:

a brightness separator for extracting a brightness signal from the received programme signal;

an analyser for analysing the brightness information and determining, in conjunction with information describing the receiver on which the modified programme signal is to be viewed, an amplification amount by which the brightness signal is amplified in the amplifier;

a forth adder, coupled to the first to third adders, for receiving the modified programme signal and adding to it the amplified brightness signal.

35. An apparatus according to claims 32 to 34 wherein the first adder is operable to add the pulse to the horizontal blanking interval adjacent the horizontal synchronization pulse.

36. An apparatus according to claims 32 to 35 wherein the first adder is operable to add the pulse to the horizontal blanking interval such that the width of the horizontal synchronisation pulse is reduced.

37. An apparatus according to claims 32 to 36 wherein the first adder is operable to add the pulse with a height of 1V.

38. An apparatus according to claims 32 to 37 wherein the first adder is operable to add the pulse with a width of 1.2 μ s.

39. An apparatus according to claims 32 to 38 wherein the first adder is operable to position the pulse such that the width of the horizontal synchronisation pulse is reduced by 0 μ s to 2 μ s.

40. An apparatus according to claims 32 to 39 wherein the first adder is operable to position the pulse such that the width of the horizontal synchronisation pulse is reduced by 0.8 μ s.

41. An apparatus according to claims 32 to 40 wherein the first adder is operable to add the pulse to the horizontal blanking interval such that one or more of the height, the width, and the position of the pulse varies across the lines of the programme signal.

42. An apparatus according to claims 32 to 41 wherein the second adder is operable to add the first modulation signal having a frequency in the range 100kHz to 6500kHz.

43. An apparatus according to claims 32 to 42 wherein the second adder is operable to add the first modulation signal having a frequency of 400kHz.

44. An apparatus according to claims 32 to 43 wherein the second adder is operable to add the first modulation signal having a height that extends to 250mV above the blanking level.

45. An apparatus according to claims 32 to 44 wherein the second adder is operable to add a square wave as the first modulation signal.

46. An apparatus according to claims 32 to 44 wherein the second adder is operable to add a sine wave as the first modulation signal.

47. An apparatus according to claims 32 to 44 wherein the second adder is operable to add a saw tooth function as the first modulation signal.

48. An apparatus according to claims 32 to 47 wherein the second adder is operable to vary the frequency of the first modulation signal between different vertical synchronisation pulses.

49. An apparatus according to claims 32 to 48 wherein the third adder is operable to add the second modulation signal having a frequency in the range 10kHz to 2MHz.

50. An apparatus according to claims 32 to 49 wherein the third adder is operable to add the second modulation signal having a frequency of 220kHz.

51. An apparatus according to claims 32 to 50 wherein the third adder is operable to add the second modulation signal having an amplitude in the range 40mV to 150mV.

52. An apparatus according to claims 32 to 51 wherein the third adder is operable to add the second modulation signal having an amplitude of 70mV.

53. An apparatus according to claims 32 to 52 wherein the second modulation signal is a square wave.

54. An apparatus according to claims 32 to 52 wherein the third adder is operable to add a sine wave as the second modulation signal.

55. An apparatus according to claims 32 to 52 wherein the third adder is operable to add a saw tooth function as the second modulation signal.

56. An apparatus according to claims 32 to 55 wherein the third adder is operable to add the second modulation signal to between 5 and 15 lines of picture information prior to the vertical blanking section.

57. An apparatus according to claims 32 to 56 wherein the third adder is operable to add the second modulation signal to 12 lines of picture information prior to the vertical blanking section.

58. An apparatus according to claims 32 to 57 wherein the third adder is operable to add the second modulation signal such that at least one of the number of lines to which the second modulation signal is added, the amplitude of the modulation signal, and the frequency of the modulation signal is varied from frame to frame of the programme signal.

59. An apparatus according to claims 32 to 58 wherein one or more of the first to third adders add the pulse, and the first and second modulation signals to the programme signal in dependence on information relating to the type of receiver on which the programme signal is to be viewed.

60. An apparatus according to any of claims 33 to 59 wherein the amplifier is operable to add 100mV to the region of the signal comprising the picture information.

61. An apparatus according to any of claims 33 to 59 wherein the amplifier is operable to amplify the picture information by multiplying the region of the signal to comprising the picture information by a scaling factor.

62. An apparatus according to any of claims 33 to 59 wherein the amplifier is operable to amplify the picture information by multiplying the region of the signal comprising the picture information by an amount that varies in dependence on information relating to the type of receiver on which the programme signal is to be viewed.

63. Apparatus for modifying a programme signal to provide protection against copying on a recording device, the apparatus comprising:

- an input for receiving a programme signal divided into lines of information, the signal having horizontal synchronisation pulses and vertical synchronisation pulses for synchronising the programme on the screen of a receiver;

- an output for outputting the modified programme signal;
- and any two of the following:

- a first adder for adding a pulse into the programme signal during the horizontal blanking interval of lines that contain picture information and into lines in the vertical blanking region, wherein the height of the pulse is in the range 0.5V to 1.5V

above the blanking level and the width of the pulse is in the range 0.2 μ s to 4 μ s;

a second adder for adding a first modulation signal to vertical synchronisation pulses of the programme signal;

a third adder for adding a second modulation signal to lines of picture information in the vicinity of the vertical blanking region at the bottom of a frame of the programme signal; and

wherein the presence of just one of the pulse, and the first and second modulation signals is not sufficient, but the presence of two of either the pulse, and the first and second modulation signals together is sufficient such that when the signal is copied by the recording device, interference is produced in the reproduction of the copied signal that is not visible in the reproduction of an uncopied programme signal.

64. A process for making an acceptable copy, or acceptable viewing of a copy of a video signal which has been modified or generated in accordance with any one of claims 1 to 63, comprising removing or counteracting the effect of at least some of the added components so that an acceptable copy of the signal can be made on a recording device or can be viewed.

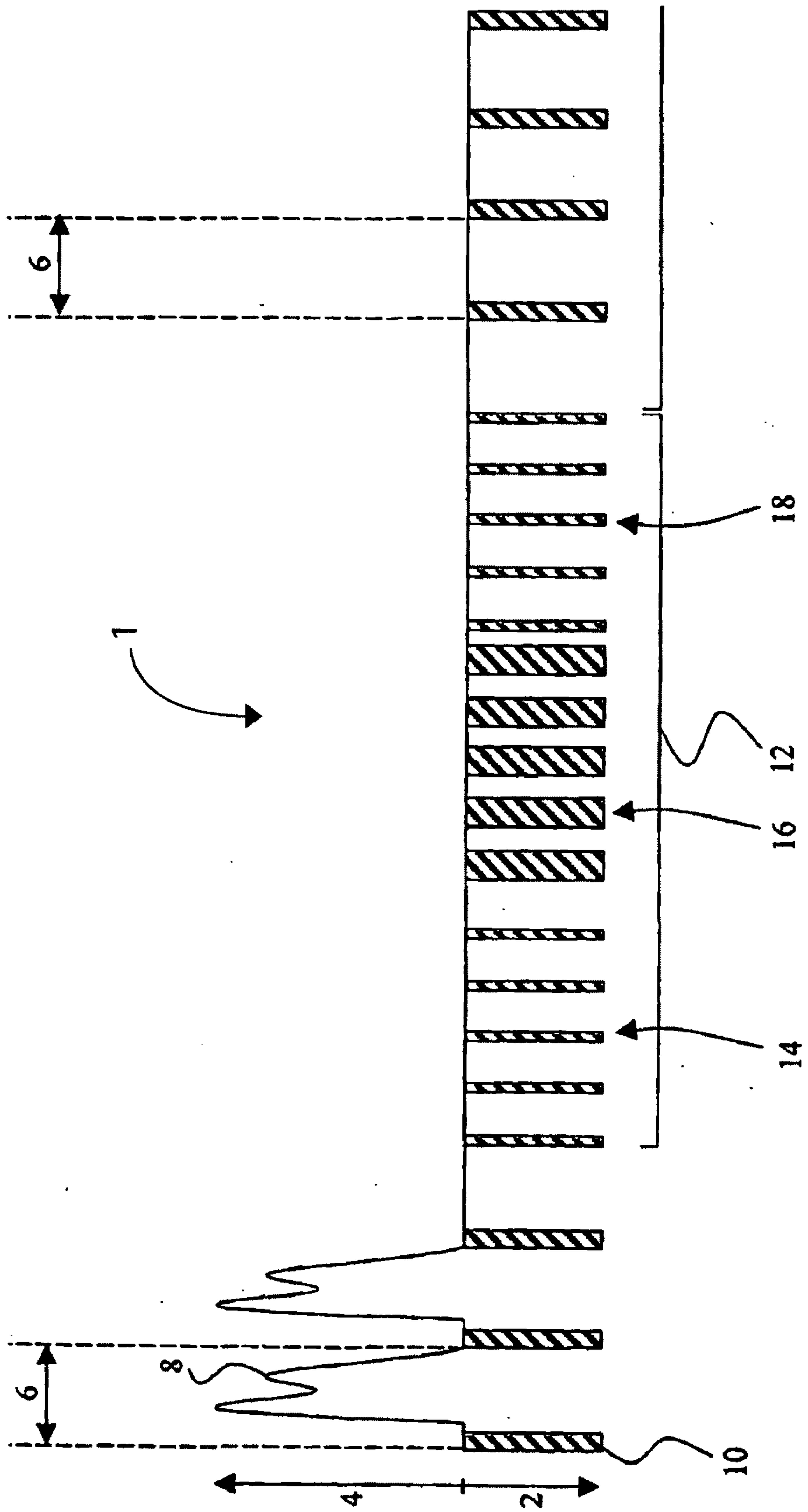
65. A process according to any one of claims 1 to 63, in which a synchronisation pulse is detected in the modified signal, and at a predetermined time following detection of the synchronisation pulse, means are activated for at least partially blanking one or more of the components added.

66. An apparatus for converting a signal which has been modified or generated in accordance with any one of claims 1 to 63, so as to generate a signal of which acceptable copies can be made or which can be acceptably viewed after copying, comprising:

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a sync pulse separator, and
means, associated with the sync pulse separator, for
cancelling or reducing one or more components of the signal
added in accordance with any one of claims 1 to 63.

Figure 1



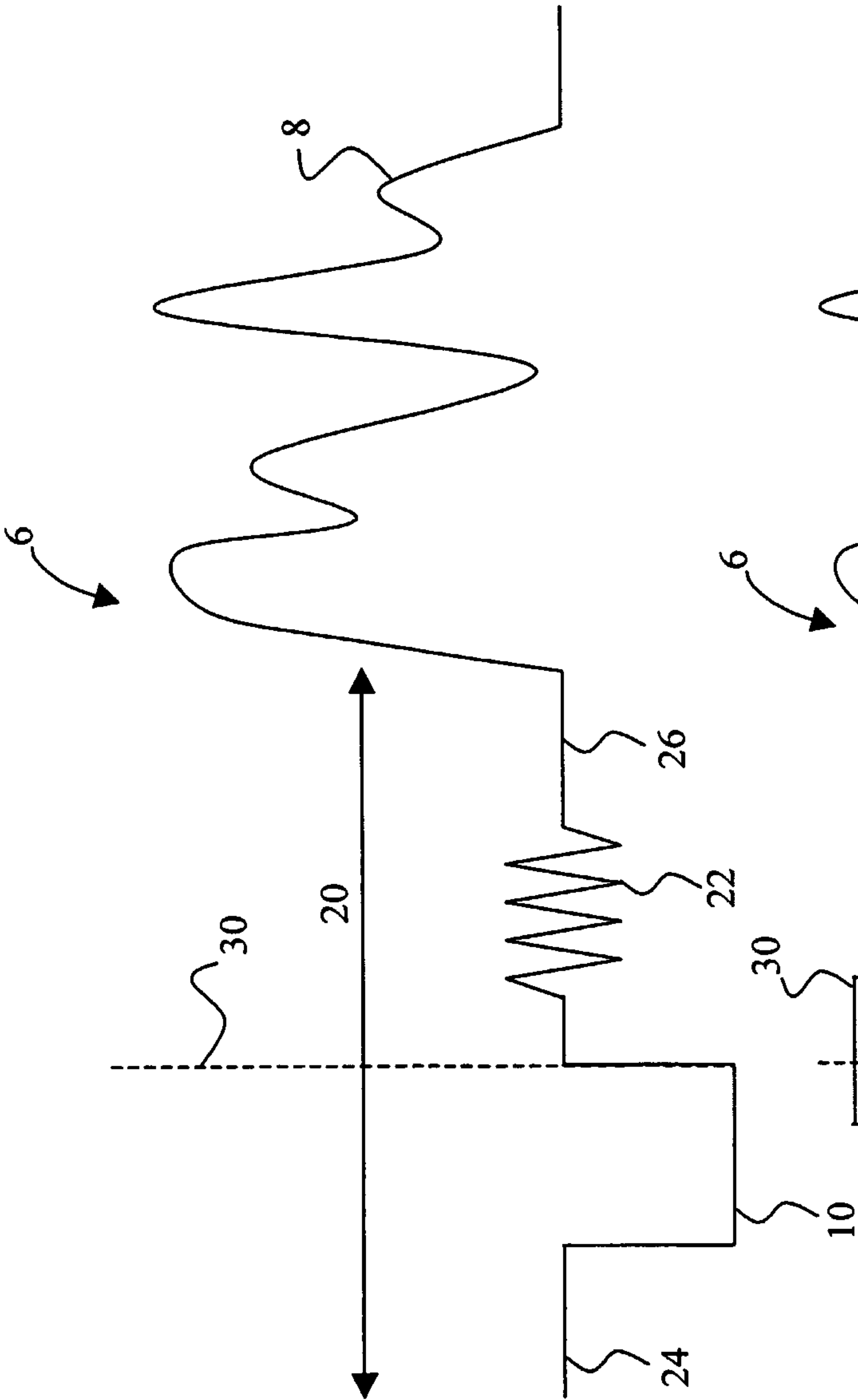


Figure 2

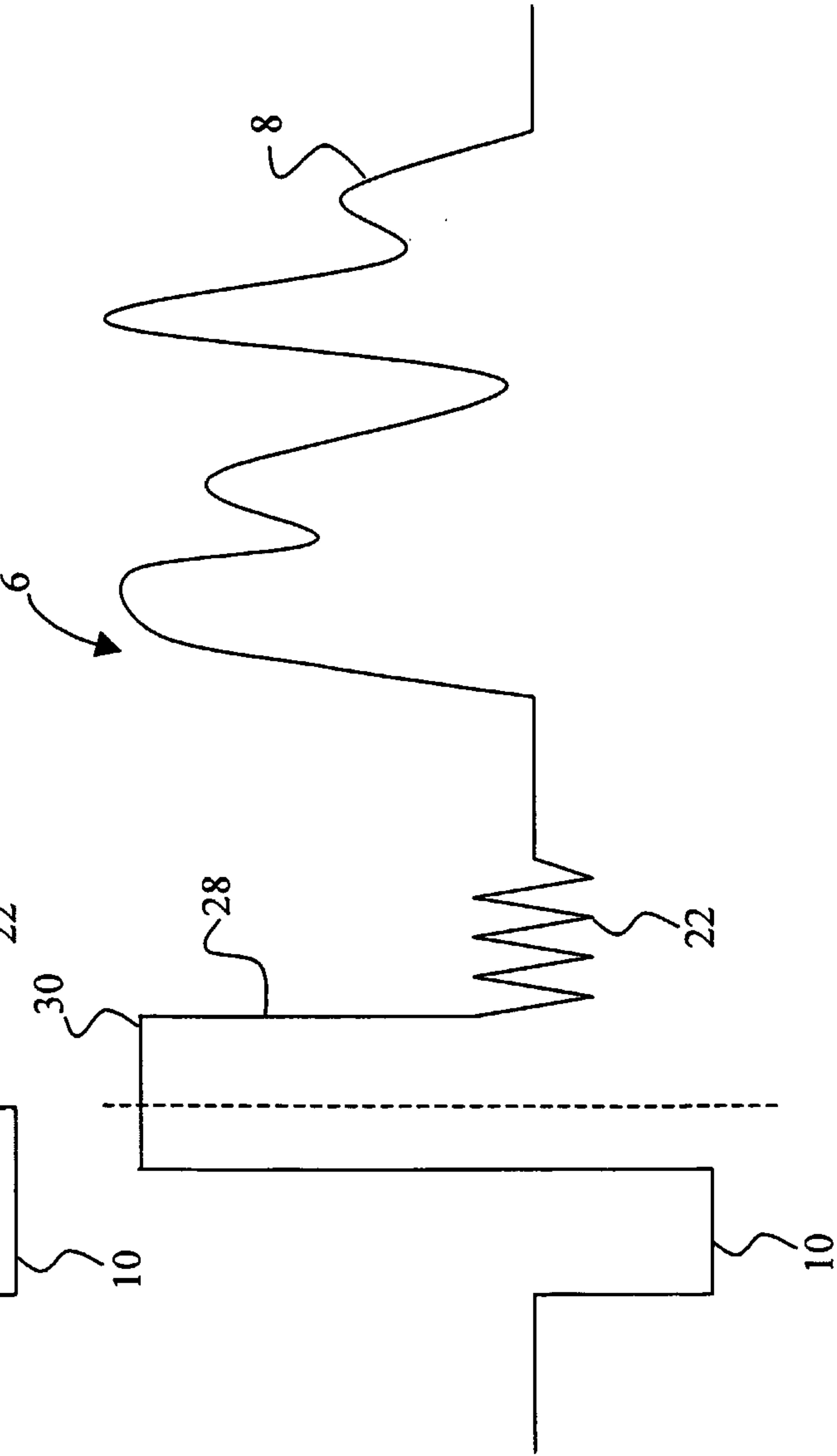


Figure 3

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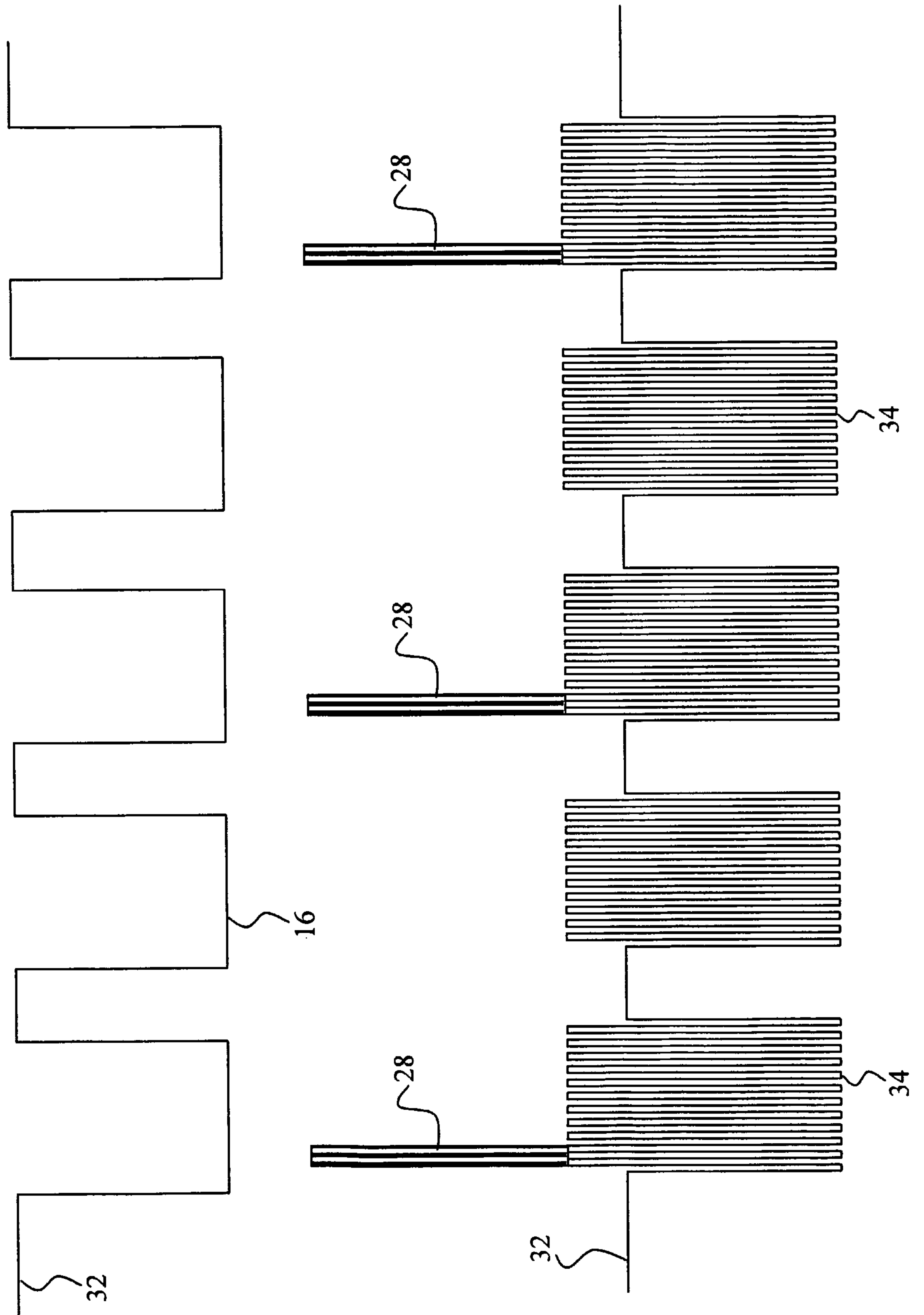
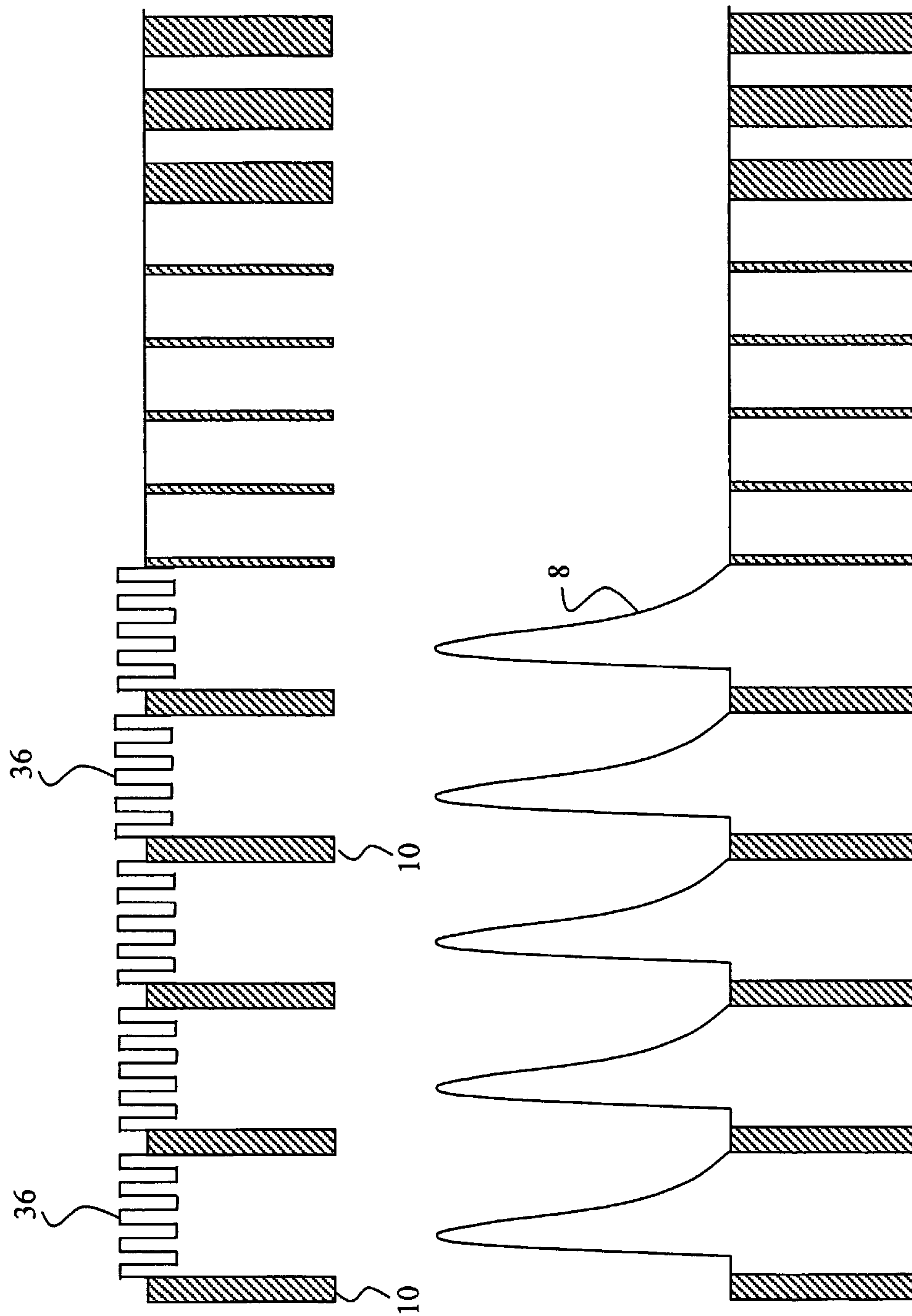
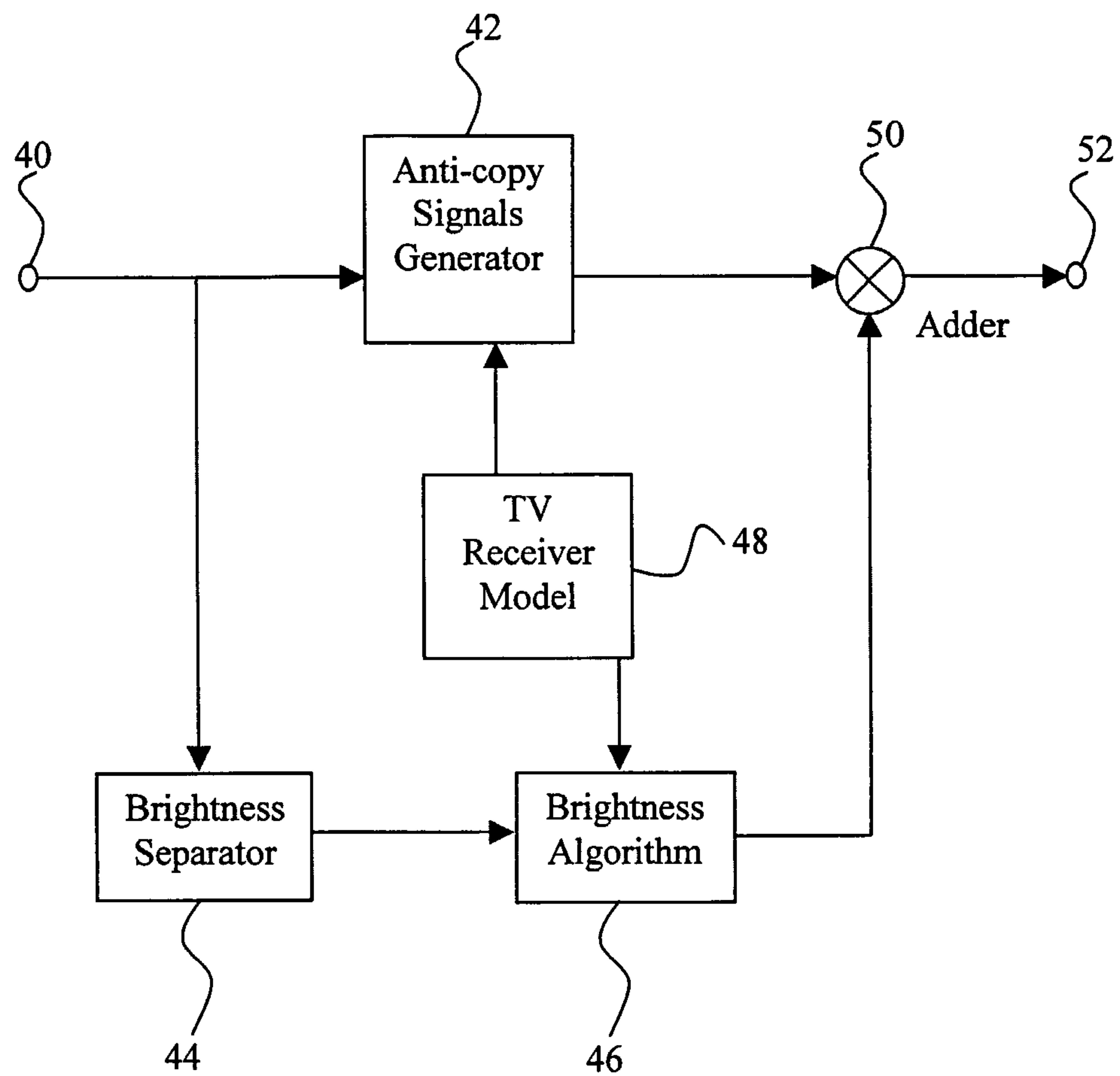
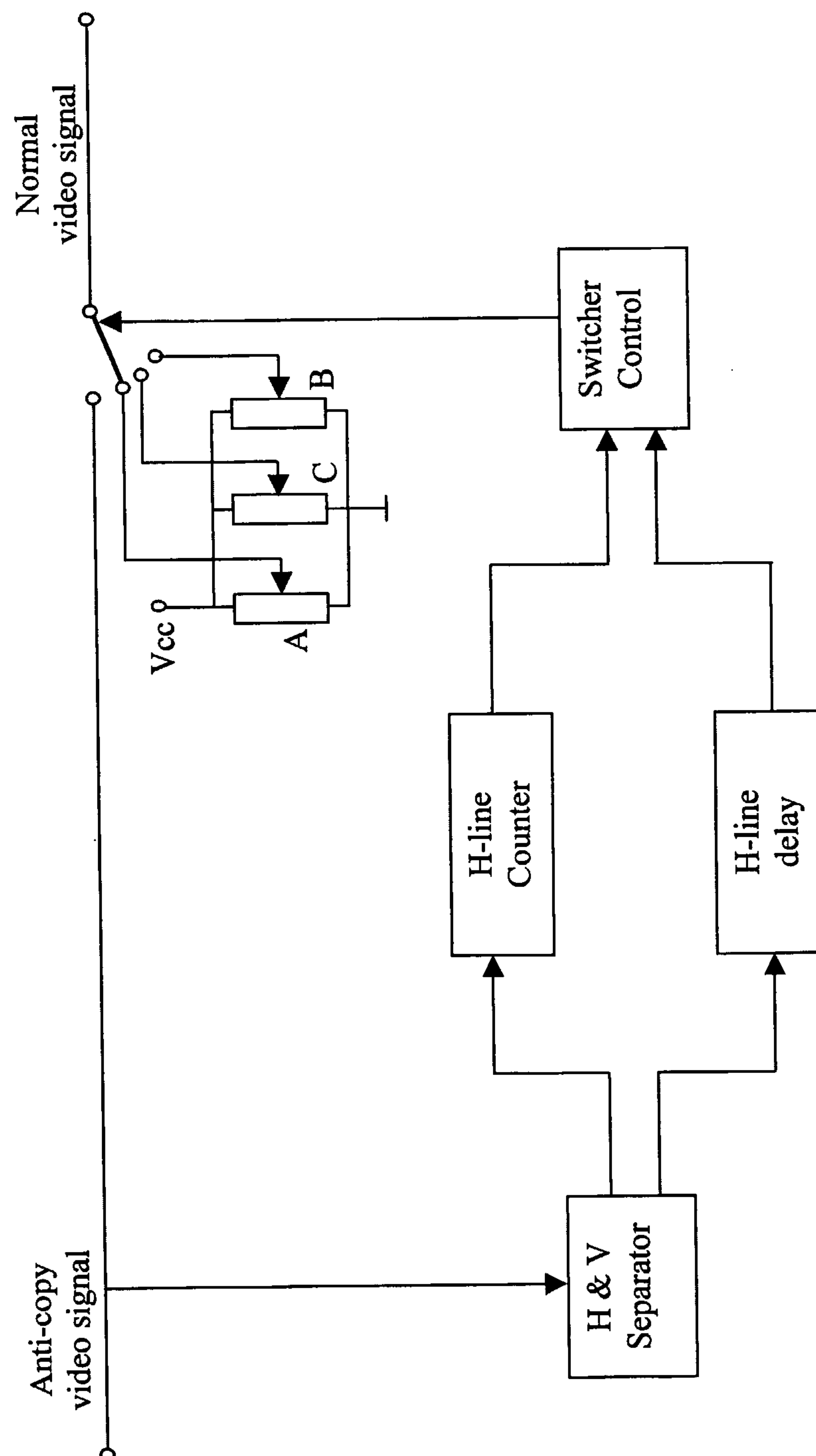
Figure 4

Figure 5

**Figure 6**

**Figure 7**

