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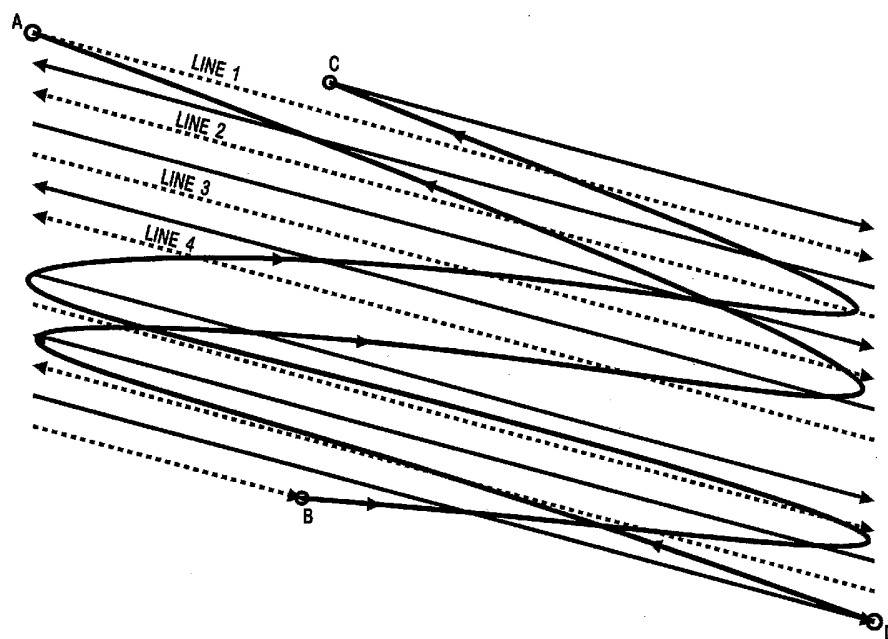
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(54) Title: INTERLACED BI-DIRECTIONAL SCANNED CRT



(57) Abstract: The present invention provides a display system that forms images by providing a temporal sequence of frames, each frame comprising at least two interlaced, bi-directional fields of parallel lines of image pixels.

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INTERLACED BI-DIRECTIONAL SCANNED CRT

Field of the Invention

The invention is directed to a cathode ray tube (CRT), and more particularly to a CRT
5 with interlaced bidirectional scan fields.

Background of the Invention

Until recently television signals were transmitted in analog formats and television receivers displayed the analog TV signals in a line-by-line synchronous manner.

10 Line-by-line synchronism meant that when a transmitter sent 525 line NTSC signals, for example, in the receiver the CRT was scanned from left to right at the rate that was determined line by line by the timing signals provided with the TV signal. In the selected NTSC example the 525 line signals were transmitted at 30 frames per second organized in such a manner that alternate lines were sent in separate fields and in the receiver on the

15 display screen these alternate fields were interlaced. Figure 1 shows schematically the generalized scan pattern for standard scan interlaced signals. On Figure 1 line 1 starts at Point A, is scanned from left to right, and then it is rapidly retraced to begin line 2, which then again proceeds left to right. Lines 1, 2, 3,... "n" proceed from top to bottom. After line "n" the scanning beam is retraced during a vertical blanking period. During the vertical retrace an

20 integer number of horizontal scans take place in such a manner that the blanking period that started on line "n" at Point B ends with the beam located at Point C. Point C begins the first line in the second field denoted in Figure 1 as line $n + r + 1$. Here "n" denotes a number of active lines per field, and "r" denotes the number of scan lines during which vertical retrace takes place. At the end of line $n + r + 1$ the beam is rapidly retraced to begin line $n + r + 2$, etc.

25 As shown in Figure 1 the scan lines from fields 1 and 2 are continuously interlaced, and they

together provide a complete frame. Field 2 ends at the end of line $2n + r$ at Point D from where the beam is retraced to the beginning of line 1 at Point A.

A well-known improvement on the foregoing interlace system was introduced by progressive scan. Progressive scan is schematically shown on Figure 2. The scanning starts at line 1, is retraced, and the next line drawn is the next line displayed. There is no interlacing of two fields. Each frame comprises a single field, and at the end of the frame at Point E the beam is directly retraced to the beginning of line 1 at Point S. Again the vertical retrace is accomplished in an integer number of horizontal scan lines. To accomplish a progressive scan display as outlined in Figure 2 a significant degree of decoupling between standard interlaced transmission and progressive scan display has to be implemented. Such decoupling necessitated the use of frame memory and also the development of motion-adaptive and motion-compensating algorithms. The required bandwidth of the video drivers of pro-scan receivers is twice that of equivalent interlaced implementations. Even with this double bandwidth for an NTSC system, for example, the required bandwidth is less than 10 MHz. The deflection signals required for a progressive scan format are also operating at twice the rate of their equivalent interlaced counterparts. The overall benefit to the viewer is a perceptibly better image produced in the progressive scan mode than in the interlaced scan mode.

Summary of the Invention

The present invention provides a display system that forms images by providing a temporal sequence of frames, each frame comprising at least two interlaced, bi-directional fields of parallel lines of image pixels. In an exemplary embodiment the display system comprises: a universal front end unit having a universal front end processor that converts a signal from any one of a plurality of input sources into a single progressive scan format

signal, and a dedicated back end unit having a display module and a dedicated back end processor. The dedicated back end processor is digitally interfaced with the universal front end processor to receive the single progressive scan format signal and process the single progressive scan format signal for display by the display module.

5

Brief Description of the Drawings

The invention will be described with reference to the drawing, in which:

Fig. 1 shows the generalized scan pattern for standard scan interlaced signals;

Fig. 2 shows the generalized scan pattern for a progressive scan signal;

10 Fig. 3 shows the generalized scan pattern for a bi-directional progressive scan signal;

Fig. 4 shows the generalized scan pattern for interlaced bidirectional scan fields according to an exemplary embodiment of the invention;

Fig. 5 shows a block diagram of a TV architecture according to an exemplary embodiment of the invention; and

15 Fig. 6 shows the generalized scan pattern for a three-field, interlaced, bidirectional scan according to an exemplary embodiment of the invention.

Detailed Description of the Invention

With digital high definition signals the most common modes of display are 720
20 progressive lines or 1080 interlaced lines, both at a field rate of 60 Hz. Numerous viewer studies show that there is no significant perceived difference between these two signals when viewed on typical high performance CRTs having diagonal dimensions less than about 35".

In general, CRT displays utilizing more than 720 lines and simultaneously scanned at rates faster than 2H, where H refers to the NTSC scan rate of about 15 KHz, provide

essentially equivalent images to the viewers whether they are scanned in the interlaced or progressive scan mode. At the same time the penalty for progressive scan can be substantial with such high definition (HD) signals both in terms of video bandwidth and in terms of deflection system implementation.

5 With the advent of digital HD transmissions and the availability of cost effective digital image processing techniques the synchronism between transmission and image display is no longer a requirement. As a matter of fact, the pixel-by-pixel and line-by-line synchronism discussed above for NTSC receivers is not even applicable to digital processed signals that are displayed on alternate technology displays such as LCD's. Thus, the receiver and transmitter no longer track in a pixel-by-pixel and line-by-line fashion. In modern receivers the display can be optimized to operate in a manner most appropriate to the physical characteristics of the given display and the required signal structure is provided by an appropriate front end decoder, as shown in Figure 5. In receivers following the architecture shown in Figure 5, for example, various input signals, such as HDTV (through an ATSC tuner 10 101), DVD, DBS, and others are received in a Universal Front End Unit (UFEU) 100 having a Universal Front End Processor (UFEP) 120 serving as the front end decoder. The UFEP 120 converts any of the various signals into an appropriate format, for example to single field per frame progressive scan format. For example, a NTSC 525 line interlaced signal could be converted to an appropriate high performance digital signal by the UFEP 120, then provided 15 to dedicated back end unit (DBEU) 200 through a digital interface 300. The DBEU 200 would then reformat the digital signal to a display format best suited for the particular display module (DM) 220 being used. The digital signal from the UFEP 120 is reformatted by a Dedicated Back End Processor (DBEP) 210. 20

A convenient display format for 16:9 CRT could be 1280 interlaced visible lines per

frame drawn vertically while each line would have 720 active pixels, and each frame would last 1/30 of a second with each frame composed of two interlaced fields, each lasting 1/60 of a second. The resulting fast vertical scan requirement would be, for example, about 40 KHz, and the video pixel rate would be about 37 MHz.

5 A display designer may desire to increase the number of lines over and above the previous example, or alternatively, one may wish to retain the image content but reduce the deflection power requirements.

It has been recognized by the prior art that, in progressive scan systems, deflection power savings could be achieved by modifying the scan system such that, instead of all
10 lines drawn from left to right, subsequent lines would be drawn alternately left to right and then right to left. This is known as bi-directional or zigzag scan and is outlined on Figure 3. To draw about 40,000 lines per second in the bi-directional mode in the above example, the fast vertical scan frequency requirement is reduced to about 20 KHz.

As discussed above, with high definition signals having many more scan lines than
15 the standard definition NTSC, the benefit of progressive versus interlaced scan with image sizes having diagonal dimensions less than about 35 in. is insignificant, but one would like to select the number of scan lines as the maximum number manageable for deflection power and video bandwidth. The solution to this problem is provided by interlaced, bi-directional scan as shown in Figure 4. As shown here, the entire image (or frame) comprises two fields
20 (A-B and C-D) that are interlaced and drawn in the bi-directional manner. The significant advantage of this arrangement is that it combines the benefits of the deflection advantage of bi-directional scanning and the video bandwidth advantage of interlaced scanning.

In the example shown on Figure 4 standard two-field interlacing is indicated. With digital techniques one may consider more complex interlace patterns. Note for example that in

Figure 4 with two-field interlacing alternate pairs of lines in the image are scanned in the same direction followed by a pair-wise scan direction inversion. It may be advantageous to avoid such pairings and interlaced bi-directional scanning could deliver the desired alteration of scan direction between adjacent lines through three-field interlacing, as shown in Fig. 6. In
5 three-field interlacing, for example, a 1500 active line scan pattern could be created from the combination of three fields, each of 500 active lines, and each of these fields would be bi-directionally scanned in such a manner that alternate lines in the final image would have an alternating scan direction. As such, fields could be scanned in 1/90 of a second resulting in 90 Hz field rates and 30 Hz frame rates.

10 Bi-directional interlaced scanning is equally applicable to standard X (horizontal) fast scan and to rotated Y (vertical) fast scan.

The foregoing illustrates some of the possibilities for practicing the invention. Many other embodiments are possible within the scope and spirit of the invention. It is, therefore, intended that the foregoing description be regarded as illustrative rather than limiting, and that
15 the scope of the invention is given by the appended claims together with their full range of equivalents.

What is Claimed is:

1. A display system that forms images by providing a temporal sequence of frames, each frame comprising at least two interlaced, bi-directional fields of parallel lines of image pixels.

5 2. The display system of claim 1 wherein each frame comprises exactly three interlaced, bi-directional fields of parallel lines of image pixels.

3. The display system of claim 1 wherein the ratio of horizontal to vertical pixels is 16:9.

4. The display system of claim 3, wherein each frame comprises 1280 interlaced
10 visible lines drawn vertically with each line having 720 active pixels.

5. The display system of claim 4, wherein each frame lasts 1/30 of a second and includes two interlaced fields, each lasting 1/60 of a second.

6. The display system of claim 5, wherein the vertical scan rate is about 20 KHz, or about 40,000 lines/sec, and the video pixel rate is about 37 MHz.

15 7. A display system, comprising:
a universal front end unit having a universal front end processor that converts a signal from any one of a plurality of input sources into a single progressive scan format signal; and

a dedicated back end unit having a display module and a dedicated back end
20 processor; the dedicated back end processor being digitally interfaced with the universal front end processor to receive the single progressive scan format signal and process the single progressive scan format signal for display by the display module.

8. The display system of claim 7, wherein the dedicated back end processor provides a temporal sequence of frames, each frame comprising at least two interlaced, bi-
25 directional fields of parallel lines of image pixels.

9. The display system of claim 8 wherein each frame comprises exactly three interlaced, bi-directional fields of parallel lines of image pixels.

10. The display system of claim 8 wherein the ratio of horizontal to vertical pixels is 16:9.

5 11. The display system of claim 10, wherein each frame comprises 1280 interlaced visible lines drawn vertically with each line having 720 active pixels.

12. The display system of claim 11, wherein each frame lasts 1/30 of a second and includes two interlaced fields, each lasting 1/60 of a second.

10 13. The display system of claim 12, wherein the vertical scan rate is about 20 KHz or 40,000 lines/sec, and the video pixel rate is about 37 MHz.

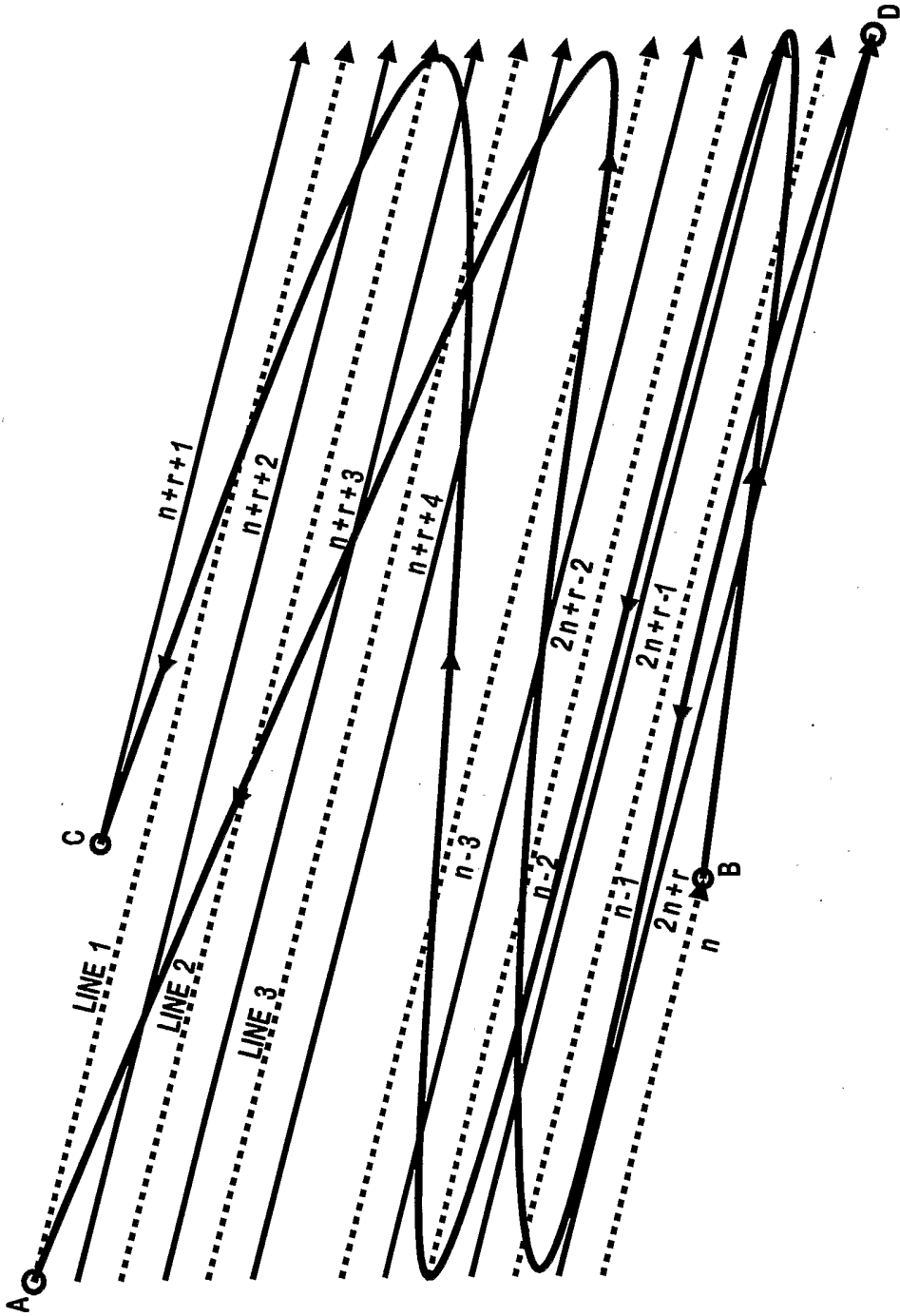


FIG. 1
(PRIOR ART)

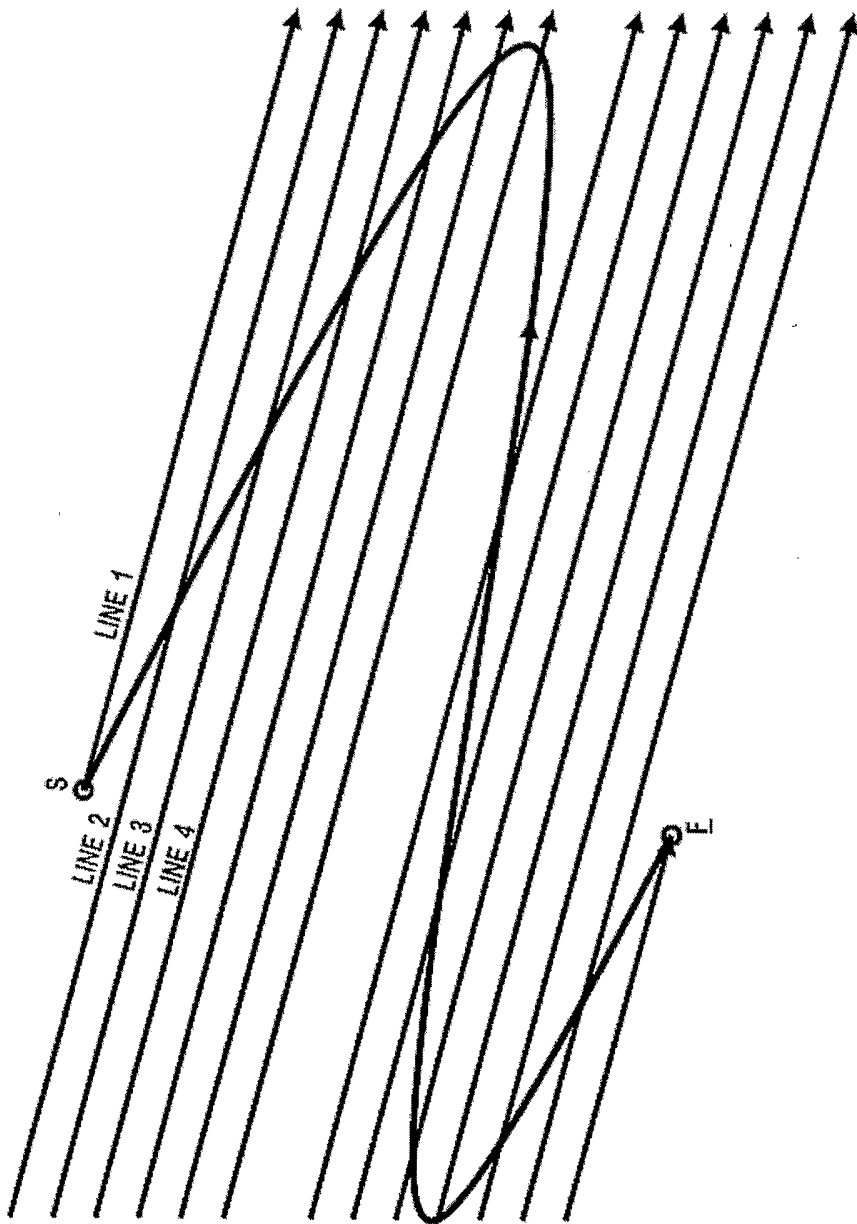


FIG. 2
(PRIOR ART)

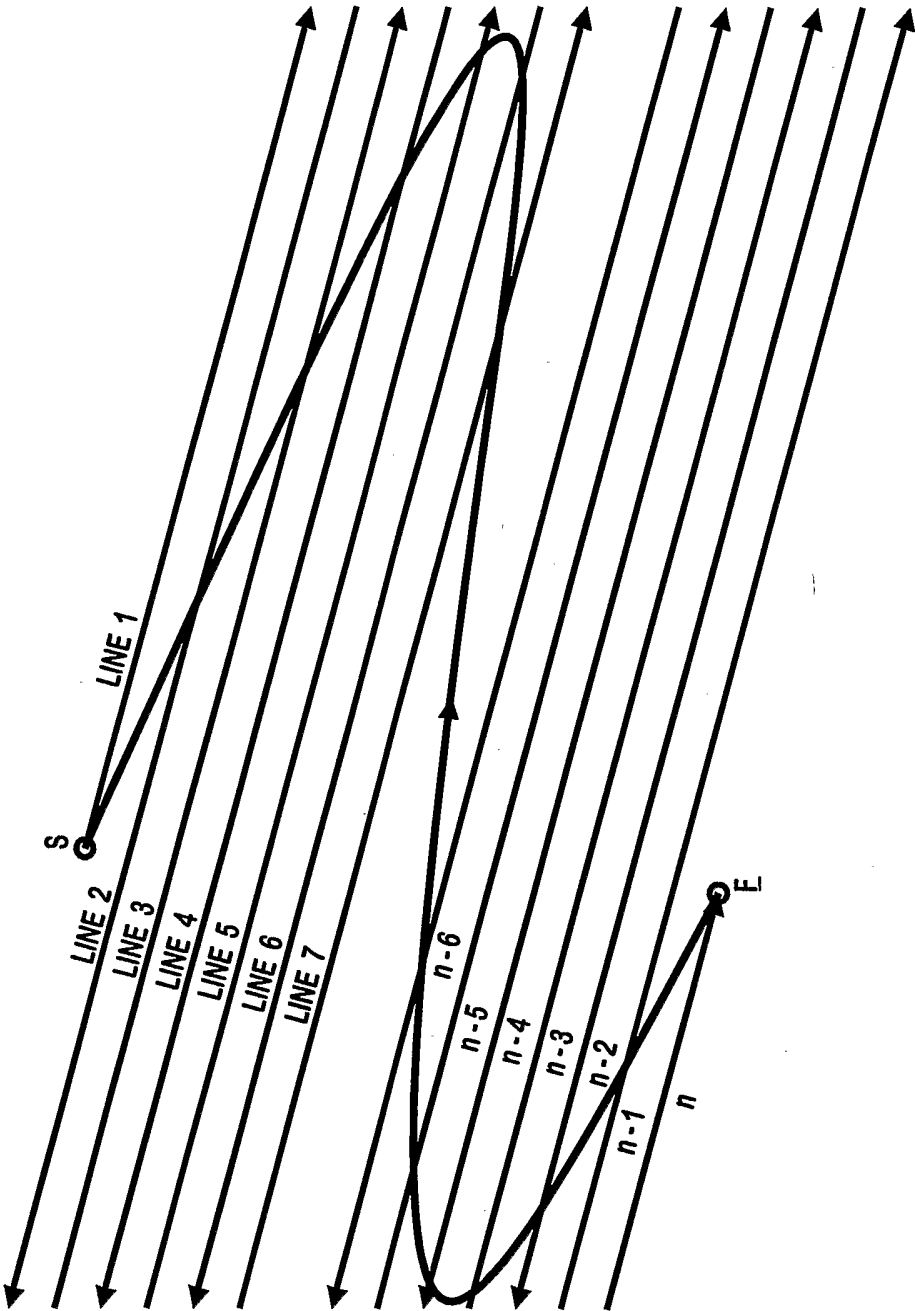


FIG. 3
(PRIOR ART)

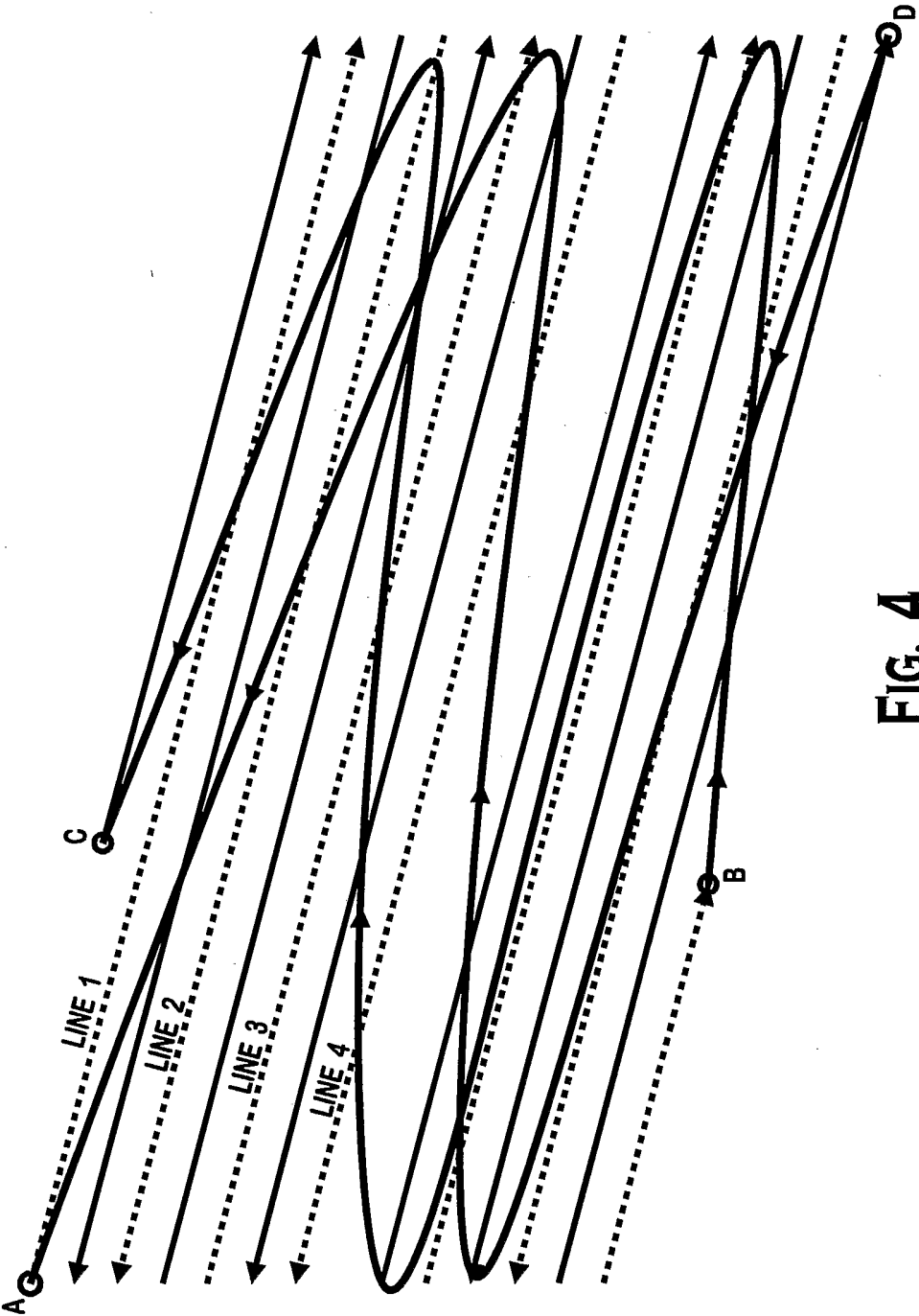
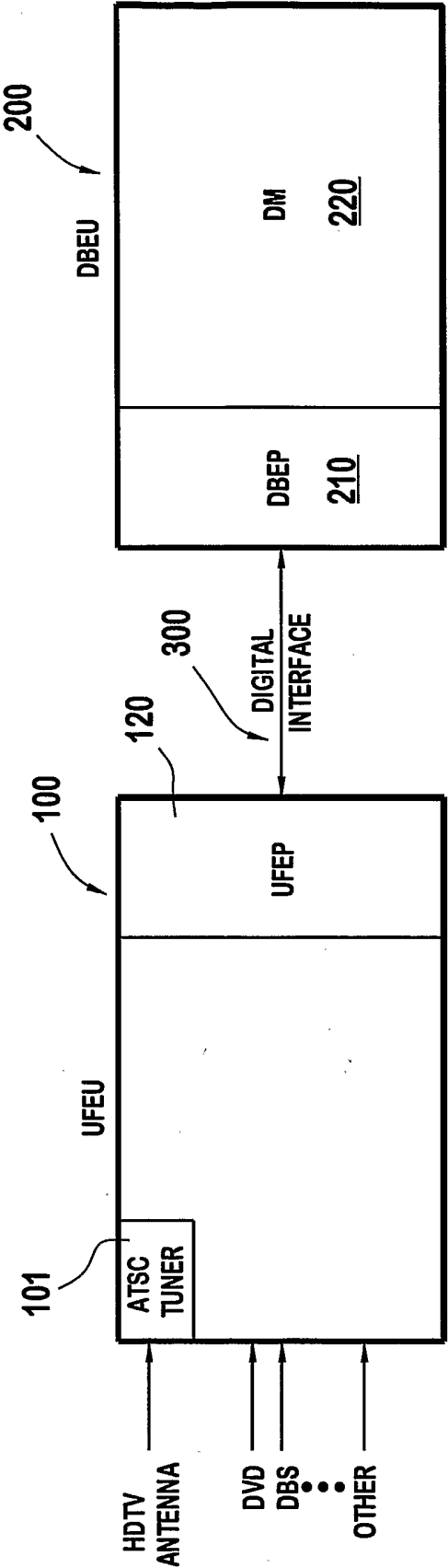


FIG. 4

FIG. 5



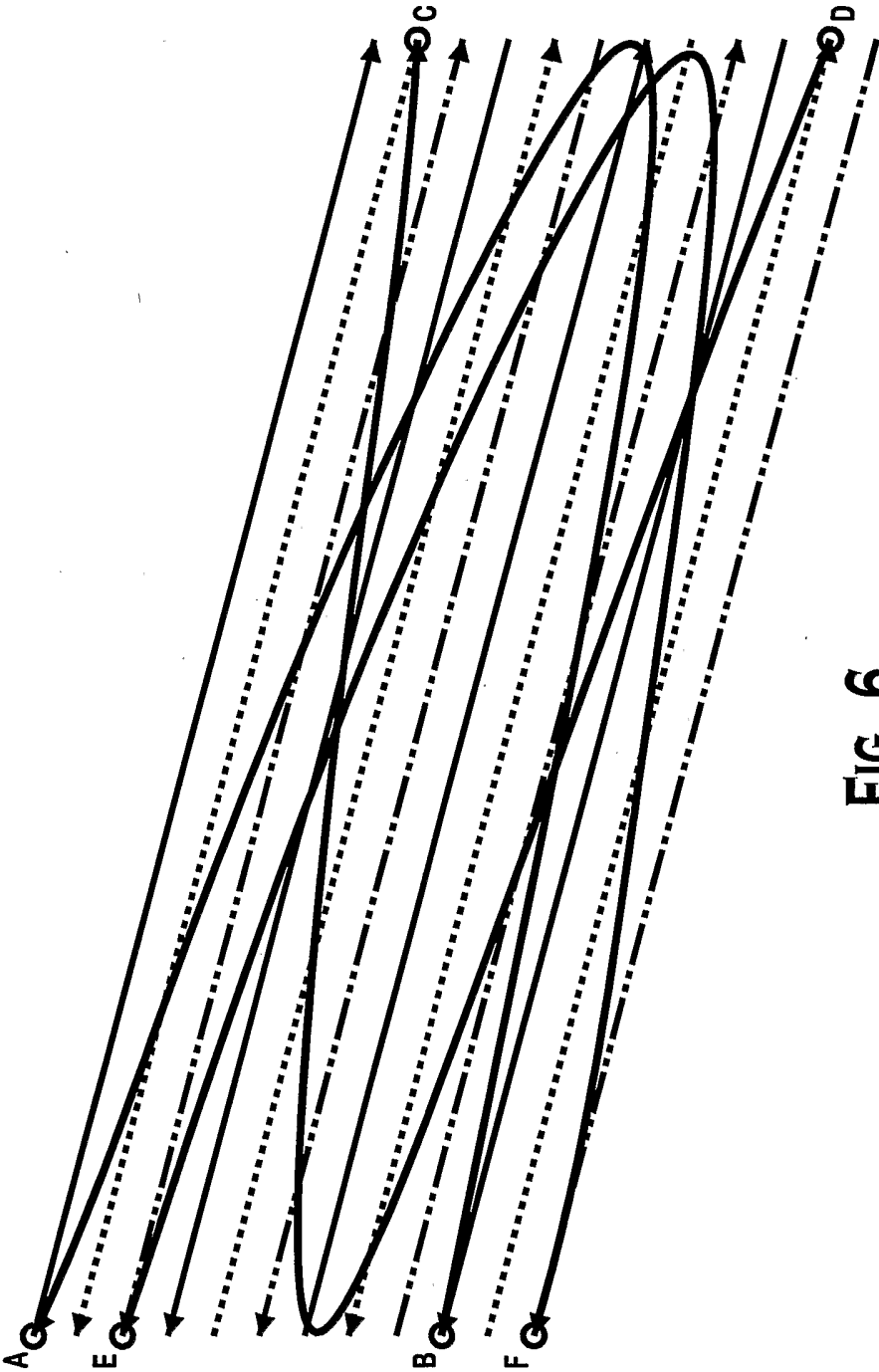


FIG. 6

INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04N3/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 429 899 B1 (NIO YUTAKA ET AL) 6 August 2002 (2002-08-06) column 8, line 16 - line 29; figures 2a, 2b -----	1-13
X	GB 2 253 978 A (BEVERLEY HUGH * PARDOE; LEONARD * UNSWORTH) 23 September 1992 (1992-09-23) page 2, line 24 - line 27; figure 1 -----	1, 7



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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Date of the actual completion of the international search

15 April 2005

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Information on patent family members

International Application No
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