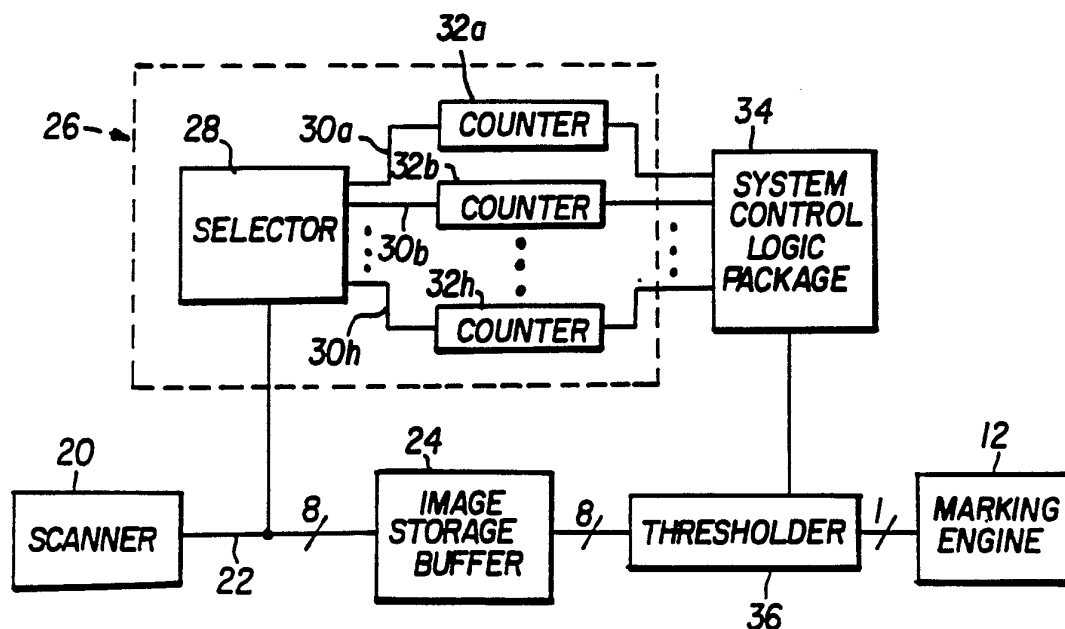




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(21) International Application Number: PCT/US90/06785 (22) International Filing Date: 26 November 1990 (26.11.90) (30) Priority data: 443,543 30 November 1989 (30.11.89) US (71) Applicant: EASTMAN KODAK COMPANY [US/US]; 343 State Street, Rochester, NY 14650-2201 (US). (72) Inventor: TELLE, Lawrence, Bruce ; 14 Parkside Lane, Ro- chester, NY 14612 (US). (74) Agent: SALES, Milton, S.; 343 State Street, Rochester, NY 14650-2201 (US).		(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent). Published <i>With international search report.</i>

(54) Title: COPIER AND PROCESS FOR COPYING**(57) Abstract**

An electronic copier (10) includes a marking engine (12) for forming a copy based on a supplied series of electrical signals, and a data monitor (26) for selecting a threshold reflectance from the background reflectance of the original document. The image is processed (36) according to the threshold reflectance selected by the data monitor, and the processed signal is applied to the marking engine. A scanner (20) generates, during a single scan of a document, a series of electrical signals representative of the image content of the documents and applies the scanned signals to the data monitor (26) and a full page image storage buffer (24).

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Copier and process for copying

BACKGROUND OF THE INVENTION

Technical Field

5 This invention relates generally to electronic copiers, and more particularly to such copiers capable of image processing such as for example by object isolation by referencing the background of an image being copied.

Background Art

10 Object isolation of images being electronically copied often employs image segmentation by a thresholding technique wherein the image is partitioned into a finite number of disjoint (non-overlapping) picture elements, called pixels,
15 each of which is represented as a pure binary quantity, i.e., object or background. Thresholding is particularly useful for images containing solid area objects resting upon a contrasting background. When using a threshold rule for image segmentation of
20 positive images, one assigns all pixels at or above the threshold reflectance to the background. All pixels with reflectance below threshold fall inside the object.

25 It is desirable that the threshold reflectance be determined by an examination of the background level of the entire original document. So called "background referencing" techniques, wherein estimates of the background level are periodically updated so that the threshold reflectance is
30 constantly being updated, are generally not suitable for document copiers because of the high incidents of artifacts produced.

35 Accordingly, it is generally desirable to select one threshold reflectance for the entire, or a substantial portion of the entire, original

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document. This of course requires that the reflectance levels over the whole document be considered before the image signal can be processed.

5 In the prior art, this is accomplished by pre-scanning the document to gather sufficient data regarding the various reflectances across the image so that a threshold reflectance can be determined. During a subsequent scan, the image signal is processed according to the threshold reflectance
10 determined using the data collected during the first scan.

A copier's life is in part limited by the physical number of times the image is scanned, and the inconvenience of the operators is measured in
15 part by the time duration they must wait to remove the original after pressing the start button. A copier which requires only a single scan to determine the threshold reflectance and to effect image processing according to the threshold reflectance
20 would be very preferable to a copier which requires two or more scans for the same functions.

Another drawback to copiers which require a pre-scan to determine the threshold reflectance and a second scan to process the image as the image signal
25 comes from the scanner is that there is no provision for producing a test print of the image as processed, and for then changing the threshold reflectance before a final print without rescanning the original document.

30 Disclosure of Invention

It is an object of the present invention to provide a copier with the capability to determine characteristics of the original document for purposes of image processing, to set image processing
35 parameters, and to process the image signal according

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to the set parameters in but a single scan of the original document.

It is another object of the present invention to provide a copier with the capability to
5 determine the overall background level of the original document, to select a threshold reflectance, and to process the image signal according to the selected threshold reflectance in but a single scan of the original document.

10 It is yet another object of the present invention to provide a copier with the capability to select a threshold reflectance according to the overall background level of the original document, to process the image signal according to the selected
15 threshold reflectance for a test print, and to reprocess the image signal according to a modified threshold reflectance for a final print, all in but a single scan of the original document.

According to these and other objects, the
20 present invention provides an electronic copier for reproducing original documents from electrical signals representative of the image content of the documents. The copier includes image forming means for forming a copy based on a supplied series of
25 electrical signals. Data monitoring means determine a characteristic of the original document from a series of electrical signals representative of the image content of the documents. Image processing means are provided for processing electrical signals
30 representative of the image content of the documents on the basis of the characteristic of the original document determined by the data monitoring means to improve the quality of the reproduction, and for applying the processed electrical signals to the
35 image forming means. Memory means store a series of

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electrical signals representative of the image content of a document, and apply the stored electrical signals to the image processing means. Scanning means generate, during a single scan of a document, a series of electrical signals representative of the image content of the documents and apply the scanned signals to the data monitoring means and the memory means. Means retrieve the stored series of data signals from the memory means and apply them to the image processing means.

In a preferred embodiment of the present invention, the memory means is adapted to store electrical signals representative of the unmodified image content of the documents. The data monitoring means is adapted to select a threshold reflectance from the overall background reflectance level of the original document, and the image processing means is adapted to process the electrical signals according to the selected threshold reflectance in but a single scan of the original document. The image may be re-processed according to a modified threshold reflectance for a final print, all in but a single scan of the original document.

The invention, and its objects and advantages, will become more apparent in the detailed description of the preferred embodiments presented below.

Brief Description of the Drawings

In the detailed description of the preferred embodiments of the invention presented below, reference is made to the accompanying drawings, in which:

Figure 1 is a perspective view of a copier according to one embodiment of the present invention;
Figure 2 is a schematic block diagram of the

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image data path of the copier of Figure 1; and

Figure 3 is bimodal histogram of gray levels.

Best Mode for Carrying Out the Invention

The present description will be directed in particular to elements forming part of, or cooperating more directly with, apparatus in accordance with the present invention. It is to be understood that elements not specifically shown or described may take various forms well known to those skilled in the art.

According to Figure 1, a copier 10 includes a marking engine 12 and a document scanner 14. The document scanner produces a series of electrical signals representative of the image content of originals. Scanner 14 consists of an automatic document handler 16 for stream feeding multiple hard copy original pages past an optical system enclosed in an optics housing 18 to be automatically read by a scanning device 20 such as a linear array of solid-state charge-coupled devices (see Figure 2). The scanning device scans the originals pages, converting their images to an image data stream of electrical signals. Preferably, scanning device 20 comprises a linear array of CCD's.

Image signals pass over a bus 22 unmodified for storage in a full page image buffer 24. By "unmodified" it is meant in a form in which the image content of the original can be retrieved. Image buffer 24 can retain the un-modified image until a test print has been run and accepted by the operator. In that way, image processing adjustments (as explained below) can be inspected and, if unacceptable, redone from the original image data.

As an original document is scanned into image buffer 24, the image signal passes pixel by

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pixel along bus 22 into a data monitor unit 26. The data monitor unit provides means for determining a characteristic of the original document for purposes of setting image process parameters. In the preferred embodiment, the parameters provide a threshold reflectance according to the image content of the area of interest, which area is usually a page of the original, but may be a portion of a page or several pages. According to the illustrated embodiment, data monitor 26 includes a selector unit 28 which receives the multiple bit data signal and outputs a signal over one of a plurality of paths 30a-30h according to the reflectance value of the signal.

For example, assume that each pixel of the original image is represented on bus 22 by a eight-bit binary word representing one of 256 reflectance levels (0-255). Assume also that there are eight paths 30a-30h from selector unit 28. Now, the path 30a-30h selected for a particular pixel will be determined by its reflectance level "R" as follows:

	R between	0 and	31	= path 30a
	R between	31 and	63	= path 30b
	R between	64 and	95	= path 30c
	R between	96 and	127	= path 30d
25	R between	128 and	159	= path 30e
	R between	160 and	191	= path 30f
	R between	192 and	223	= path 30g
	R between	223 and	255	= path 30h

Each of paths 30a-30h provides an input to one of eight counters 32a-32h, respectively. The counters accumulate the number of pixels of the image having a reflectance falling within their respective ranges. Thus, by comparing the counters, a system control logic package 34 can form a histogram of the reflectance levels of the pixels of the image. This function summarizes the gray level content of an

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image, and is, for each gray level, the number of pixels in the image that have that gray level.

Suppose an image contains a dark object on a light background. Figure 3 illustrates the appearance of the histogram of such an image. The dark pixels inside the object produce the rightmost peak in the histogram. The leftmost peak is due to the large number of light gray pixels in the background. The relatively few mid-gray pixels around the edge of the object produce the dip between the two peaks. A threshold gray level chosen in the area of the dip will produce a reasonable boundary for the object. Generally the gray level corresponding to the minimum between the two peaks is optimal for defining the boundary. Histograms and thresholding are discussed in Digital Image Processing; Kenneth R. Castleman; Prentice-Hall, Inc.; 1979; page 76. Once a threshold reflectance has been selected, its value is inputted to a thresholder 36.

Now, and without rescanning the original document, the image data can be read from image buffer 24 and sent a pixel at a time to marking engine 12 through thresholder 36. The reflectance value of the pixel is compared to the threshold reflectance stored in the thresholder. All pixels at or above the threshold reflectance are assigned to the object. All pixels with gray level below threshold fall outside the object. The resultant single bit value of the pixel is sent to the marking engine and the next pixel value is read from image buffer 24.

The first print of a page by the marking engine may be considered to be a test print. The operator, upon viewing the test print may decide that

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the threshold reflectance is too dark or too light in that excessive background may exist or image content may be lost, respectively. The operator may, with suitable controls, adjust the threshold reflectance up or down. A second test print, or a production print, may now be produced without rescanning the original document since the full image content remains in image buffer 24 until the next original document is scanned into the buffer.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention. For example, this specification has referred to object isolation by referencing object and background reflectances. It will be understood that referencing can equally be effected by means of transmittances or densities.

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What is claimed is:

1. An electronic copier (10) for reproducing original documents from electrical signals representative of the image content of the documents; said copier comprising:
 - image forming means (12) for forming a copy based on a supplied series of electrical signals;
 - data monitoring means (26) for determining a characteristic of the original document from a series of electrical signals representative of the image content of the documents;
 - image processing means (36) for processing electrical signals representative of the image content of the documents on the basis of the characteristic of the original document determined by said data monitoring means to improve the quality of the reproduction, and for applying the processed electrical signals to said image forming means;
 - memory means (24) for storing a series of electrical signals representative of the image content of a document, and for applying the stored electrical signals to said image processing means;
 - scanning means (20) for generating, during a single scan of a document, a series of electrical signals representative of the image content of the documents and for applying the scanned signals to said data monitoring means and said memory means; and
 - means for retrieving the stored series of data signals from said memory means and for applying them to said image processing means.
2. An electronic copier (10) as defined in Claim 1 wherein said memory means (24) is adapted to store electrical signals representative of the unmodified image content of the documents.
3. An electronic copier (10) as

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defined in Claim 1 wherein:

said data monitoring means (26) is adapted to select a threshold reflectance from the overall background reflectance level of the original

5 document; and

said image processing means (36) is adapted to process the electrical signals according to the selected threshold reflectance in but a single scan of the original document.

10 4. An electronic copier (10) as defined in Claim 1 wherein:

said data monitoring means (26) is adapted to select a threshold reflectance from the overall background reflectance level of the original

15 document; and

said image processing means (36) is adapted to (1) process the electrical signals according to the selected threshold reflectance for production of a test print, and (2) re-process the image signal according to a modified threshold reflectance for a final print, all in but a single scan of the original document.

5. An electronic copier (10) for reproducing original documents from electrical
25 signals representative of the image content of the documents; said copier comprising:

scanning means (20) for generating, during a single scan of a document, a series of electrical signals representative of the image content of the
30 documents;

memory means (24) for storing the series of electrical signals generated during said single scan of a document;

35 means (22) for applying the scanned signals to said storing means;

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data monitoring means (26) for determining a characteristic of the original document from the series of electrical signals generated during said single scan of a document;

5 means for applying the scanned signals to said data monitoring means

image processing means (36) for processing stored electrical signals on the basis of the characteristic of the original document determined by
10 said data monitoring means to improve the quality of the reproduction;

image forming means (12) for forming a copy based on a supplied series of processed electrical signals from said image processing means; and

15 means for retrieving the stored series of electrical signals from said memory means and for applying them to said image processing means.

6. A process for reproducing original documents from electrical signals representative of
20 the image content of the documents; said process comprising:

scanning a document to generate a series of electrical signals representative of the image content of the documents;

25 storing the series of electrical signals generated during a single scan of the document;

determining a characteristic of the original document from the series of electrical signals generated during said single scan of the document;

30 retrieving the stored series of electrical signals;

processing the retrieved electrical signals on the basis of the determined characteristic of the original document to improve the quality of the
35 reproduction; and

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forming an image with the processed electrical signals.

7. A process for reproducing original documents from electrical signals representative of the image content of the documents as defined in Claim 6 wherein:

said determining step includes selecting a threshold reflectance from the overall background reflectance level of the original document; and
said processing step includes processing the electrical signals according to the selected threshold reflectance in but a single scan of the original document.

8. A process for reproducing original documents from electrical signals representative of the image content of the documents as defined in Claim 5 wherein:

said determining step includes selecting a threshold reflectance from the overall background reflectance level of the original document; and
said processing step includes (1) processing the electrical signals according to the selected threshold reflectance in but a single scan of the original document, and (2) re-processing the image signal according to a modified threshold reflectance for a final print, all in but a single scan of the original document.

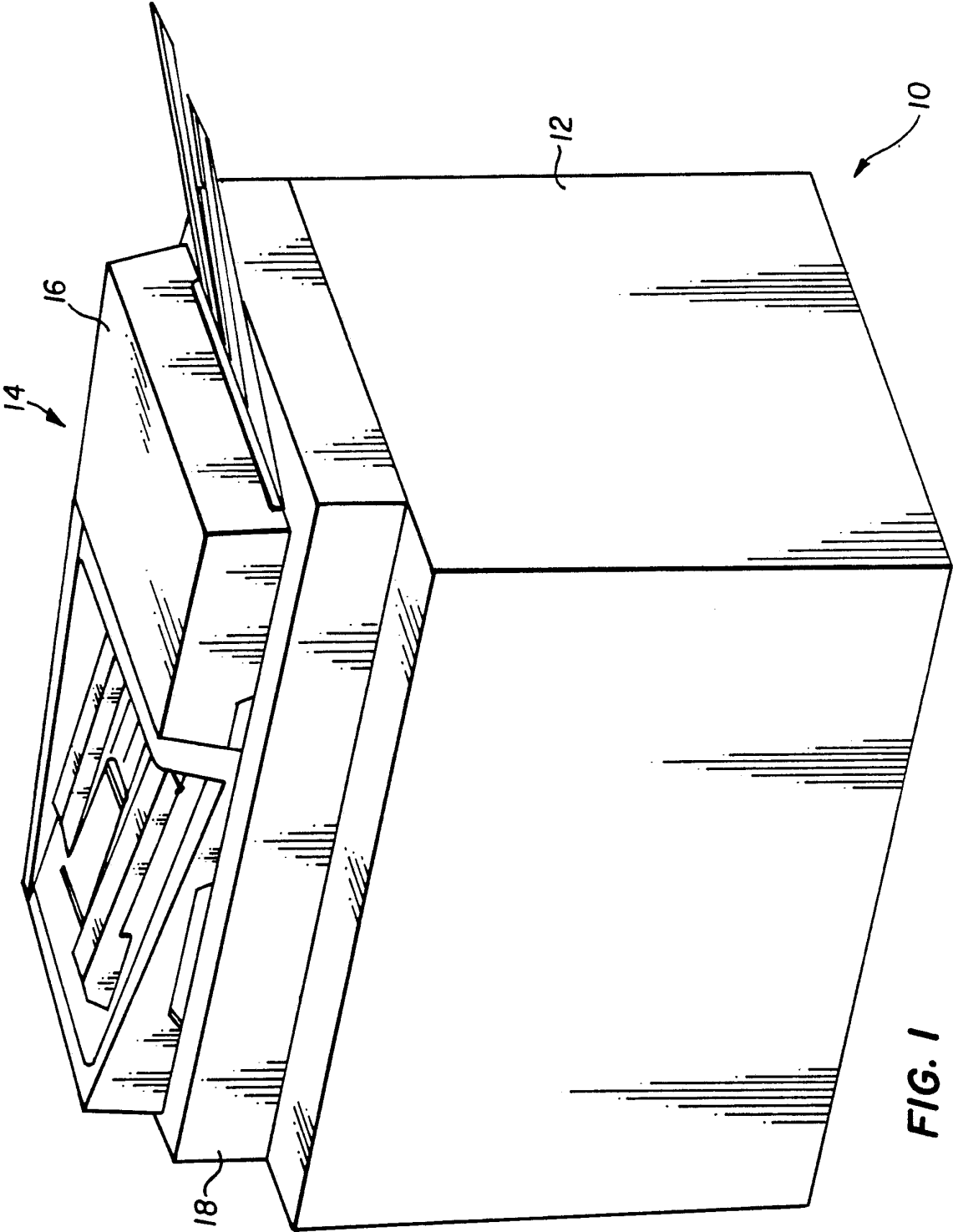


FIG. 1

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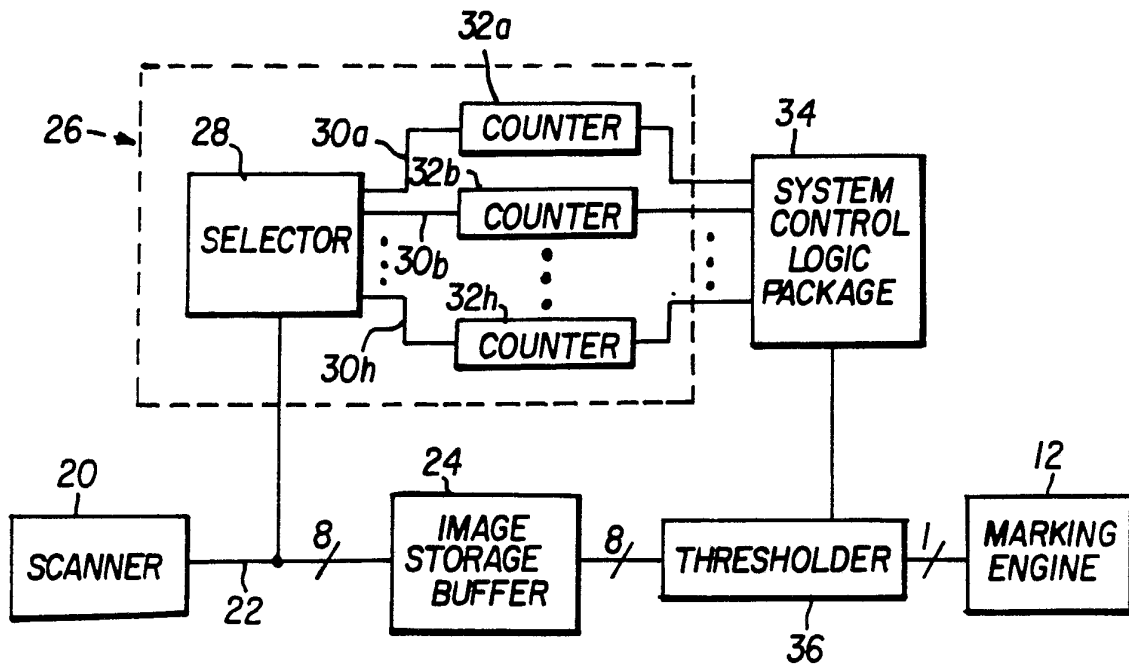


FIG. 2

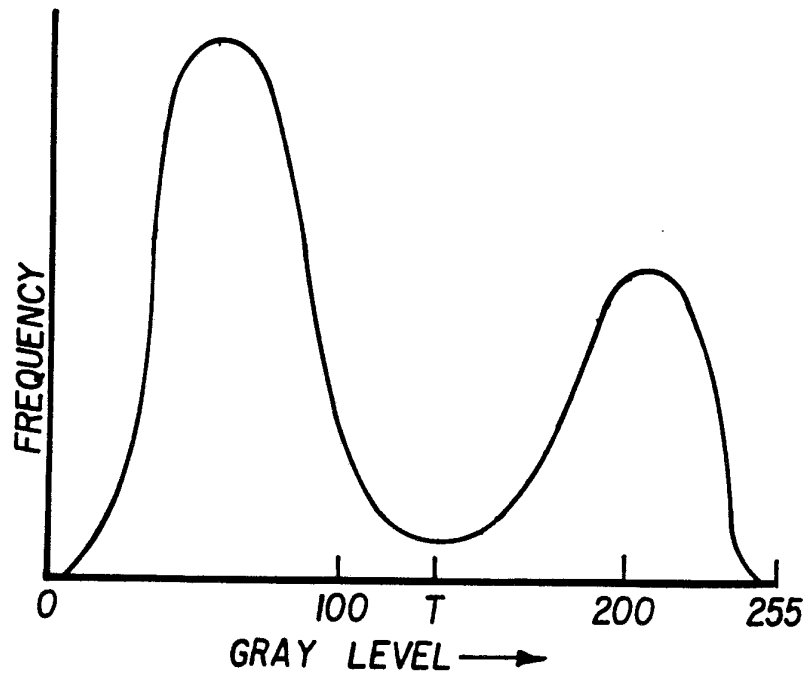


FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 90/06785

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC IPC5: H 04 N 1/40														
II. FIELDS SEARCHED Minimum Documentation Searched⁷ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 25%; border: 1px solid black; padding: 2px;">Classification System</th> <th style="border: 1px solid black; padding: 2px;">Classification Symbols</th> </tr> <tr> <td style="border: 1px solid black; padding: 10px; vertical-align: top;">IPC5</td> <td style="border: 1px solid black; padding: 10px; vertical-align: top;">H 04 N</td> </tr> </table> Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched⁸			Classification System	Classification Symbols	IPC5	H 04 N								
Classification System	Classification Symbols													
IPC5	H 04 N													
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%; border: 1px solid black; padding: 2px;">Category *</th> <th style="border: 1px solid black; padding: 2px;">Citation of Document,¹¹ with indication, where appropriate, of the relevant passages¹²</th> <th style="width: 15%; border: 1px solid black; padding: 2px;">Relevant to Claim No.¹³</th> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top;">X</td> <td style="border: 1px solid black; padding: 5px;">US, A, 4710822 (MATSUNAWA) 1 December 1987, see abstract; figure 10 -- </td> <td style="border: 1px solid black; text-align: center; vertical-align: top;">1-8</td> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top;">X</td> <td style="border: 1px solid black; padding: 5px;">EP, A2, 0113016 (IBM) 11 July 1984, see abstract; figure 2 -- </td> <td style="border: 1px solid black; text-align: center; vertical-align: top;">1-8</td> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top;">A</td> <td style="border: 1px solid black; padding: 5px;">GB, A, 2104449 (CANON) 9 March 1983, see abstract; figure 1 -- ----- </td> <td style="border: 1px solid black; text-align: center; vertical-align: top;">1-8</td> </tr> </table>			Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	X	US, A, 4710822 (MATSUNAWA) 1 December 1987, see abstract; figure 10 --	1-8	X	EP, A2, 0113016 (IBM) 11 July 1984, see abstract; figure 2 --	1-8	A	GB, A, 2104449 (CANON) 9 March 1983, see abstract; figure 1 -- -----	1-8
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X	US, A, 4710822 (MATSUNAWA) 1 December 1987, see abstract; figure 10 --	1-8												
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* Special categories of cited documents:¹⁰ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family														
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border: 1px solid black; padding: 5px;"> Date of the Actual Completion of the International Search 4th March 1991 </td> <td style="width: 50%; border: 1px solid black; padding: 5px;"> Date of Mailing of this International Search Report 22 MAR 1991 </td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;"> International Searching Authority EUROPEAN PATENT OFFICE </td> <td style="border: 1px solid black; padding: 5px;"> Signature of Authorized Officer Mme N. KUIPER </td> </tr> </table>			Date of the Actual Completion of the International Search 4th March 1991	Date of Mailing of this International Search Report 22 MAR 1991	International Searching Authority EUROPEAN PATENT OFFICE	Signature of Authorized Officer Mme N. KUIPER								
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**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. PCT/US 90/06785**

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4710822	01/12/87	DE-A- 3334171 GB-A-B- 2127647 JP-A- 59054376	22/03/84 11/04/84 29/03/84
EP-A2- 0113016	11/07/84	JP-A- 59125176 US-A- 4695884	19/07/84 22/09/87
GB-A- 2104449	09/03/83	DE-A-C- 3225209 GB-A-B- 2153301 JP-B- 1029111 JP-A- 58007971 US-A- 4499500	27/01/83 21/08/85 07/06/89 17/01/83 12/02/85

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