PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 :		(11) International Publication Number: WO 89/ 00741
G06K 3/00	A1	(43) International Publication Date: 26 January 1989 (26.01.89)

(21) International Application Number: PCT/US88/02503

(22) International Filing Date: 22 July 1988 (22.07.88)

(31) Priority Application Number: 076,490

(32) Priority Date: 22 July 1987 (22.07.87)

(33) Priority Country: US

(71) Applicant: ETC. [US/US]; 129 Canfield Drive, Stamford, CT 06902 (US).

(71)(72) Applicants and Inventors: HUXLEY, William, F. [US/US]; 54 Azel Road, Braintree, MA 02184 (US). CORREA, John, C. [US/WS]; United Nations Development Program, Private Mail Bag, Apia (WS).

(72) Inventors: GREENFIELD, Gary, R. ; 129 Canfield Drive, Stamford, CT 06902 (US). COSSETTE, Joseph, P. ; 74 Ojibwa Road, Shelton, CT 06484 (US).

(74) Agent: FEIGENBAUM, David, L.; Fish & Richardson, One Financial Center, Suite 2500, Boston, MA 02111-2658 (US).

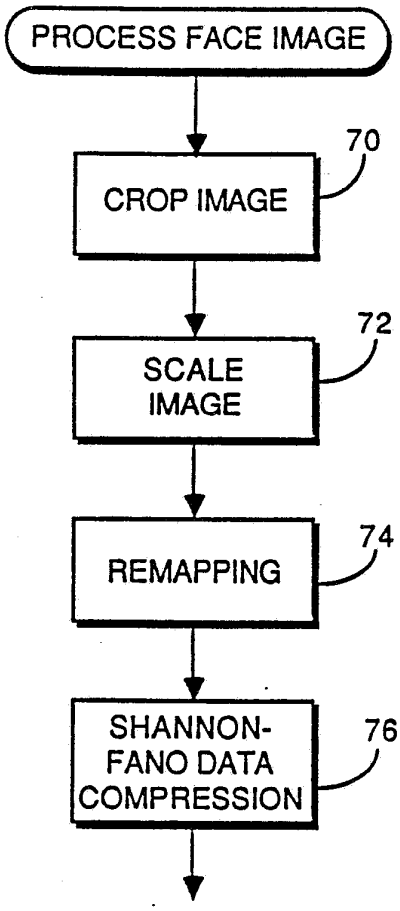
(81) Designated States: AT (European patent), AU, BB, BE (European patent), BG, BR, CH (European patent), DE (European patent), DK, FI, FR (European patent), GB (European patent), HU, IT (European patent), JP, KP, KR, LK, LU (European patent), MC, MG, MW, NL (European patent), NO, RO, SD, SE (European patent), SU.

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: IDENTIFICATION INFORMATION STORAGE AND RETRIEVAL

(57) Abstract

A method for compressing a face image (62) into a digital bit stream; the method includes the steps of converting the image (62) to an array of raw pixel values; reducing the image (62) to generate a smaller array of pixel values (72); reducing the gray scale range of the pixel values in the smaller array (74); deriving data words indicative of the pixel values (74); and encoding the data words of the bit stream in accordance with the code of the type in which more frequently occurring data words are encoded as shorter sets of bits (76).



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	**FR**	France	**ML**	Mali
AU	Australia	**GA**	Gabon	**MR**	Mauritania
BB	Barbados	**GB**	United Kingdom	**MW**	Malawi
BE	Belgium	**HU**	Hungary	**NL**	Netherlands
BG	Bulgaria	**IT**	Italy	**NO**	Norway
BJ	Benin	**JP**	Japan	**RO**	Romania
BR	Brazil	**KP**	Democratic People's Republic of Korea	**SD**	Sudan
CF	Central African Republic			**SE**	Sweden
CG	Congo	**KR**	Republic of Korea	**SN**	Senegal
CH	Switzerland	**LI**	Liechtenstein	**SU**	Soviet Union
CM	Cameroon	**LK**	Sri Lanka	**TD**	Chad
DE	Germany, Federal Republic of	**LU**	Luxembourg	**TG**	Togo
DK	Denmark	**MC**	Monaco	**US**	United States of America
FI	Finland	**MG**	Madagascar		

Identification Information Storage and Retrieval

Background of the Invention

This invention relates to digitally storing and retrieving information identifying individuals, e.g., images of their faces and signatures.

Such information may be used, for example, when a purchaser gives a credit card to a merchant to buy something. Conventionally, the merchant may check the purchaser's signature against the signature on the back of the card and may try to confirm the purchaser's identity by comparing his face with the picture on his driver's license.

One digital technique for confirming a person's identity, proposed in United States Patent 4,636,622, issued January 13, 1987, involves first digitally storing the person's fingerprint in a central location. When an identification needs to be made, the person's fingerprint is again taken on a machine capable of converting the fingerprint to digital data. The data is sent to the central station where it is compared to the stored fingerprint. A signal is sent back to the remote station if the fingerprints match.

Summary of the Invention

A general feature of the invention provides a method for compressing a face image into a digital bit stream; the method includes the steps of converting the image to an array of raw pixel values; reducing the image to generate a smaller array of pixel values; reducing the gray scale range of the pixel values in the smaller array; deriving data words indicative of the pixel values; and encoding the data words of the bit stream in accordance with the code of the type in which more frequently occuring data words are encoded as

shorter sets of bits.

Preferred embodiments include the following features.

The method may be adapted for confirming, at multiple locations, the identities of a predetermined group of individuals; the method would then further include the steps of capturing information about the face image that identifies each individual for compressing into the digital bit stream; recording the compressed bit stream on a pocket-size recording medium to be provided to each individual; and providing apparatus at each location for recovering the image from the recorded bit stream, for confirming the identities of the individuals.

The recording medium may be a magnetic strip, or a printed strip, in either case part of a plastic card. The image may include a signature image. In the case of central storage of the bit streams, each individual may be provided with a key to the storage address at which the compressed bit stream for the individual is recorded at the central location, and the bit stream is delivered to the local apparatus on the basis of the key information. The key is stored as bits on a pocket-size recording medium to be provided to the invidual.

The bit stream is no longer than 5,000 bits. The image is reduced to the smaller array to a degree specified by a user based on viewing the image. Each data word, prior to encoding, is the difference between two of the reduced gray-scale pixel values. The method also includes remapping the pixel values to a coarser range of pixel values. The remapping is more sensitive to tones in the middle of the scale than at the extremes of the scale.

As a result, individuals can be rapidly and accurately identified based on their face images and signature images. The face and signature images are stored on a card that can be easily carried by the individual and yet be difficult to counterfeit. Alternatively access by the individual to the face and signature images can be restricted by storing all of the images centrally. The total amount of bits required to store the face and signature images is small, reducing the amount of time needed to transmit them and the amount of space needed to store them.

Other advantages and features will become apparent from the following description of the preferred embodiment, and from the claims.

Description of the Preferred Embodiment

We first briefly describe the drawings.

Fig. 1 is a block diagram of an identification system.

Fig. 2 is a block diagram of a capture terminal or unit.

Fig. 3 is a diagram of a captured frame illustrating cropping.

Fig. 4 is a flow chart of the routine for processing a face image.

Fig. 5 is a diagram of the scaling process.

Fig. 6 is a flow chart of the routine for processing a signature.

Fig. 7 shows the make-up of an identification packet.

Fig. 8 is a block diagram of a display terminal or unit.

Figs. 9, 10 are flow charts respectively of the routines for displaying a face image and a signature.

Fig. 11 is a diagram of the bilinear interpolation process.

Fig. 12 is a diagram of a credit card.

Structure

Referring to Fig. 1, in a system 10 for digitally storing and retrieving identification information (e.g., face images and signatures of individuals) the images and signatures are captured by so-called capture terminals, e.g., the terminal labeled 12. To identify an individual whose image and signature have been captured, a display terminal, e.g., terminal 14, displays a previously stored image and signature which purportedly correspond to the individual who is to be identified.

Capture terminal 12 is connected by a dedicated telephone line 16 to a central station 18. Line 16 carries digital data representing a captured image and signature to be held in conventional storage 20 in central station 18. Central station 18 includes conventional communication apparatus 22 for receiving and sending the digital data and a conventional data processing device 24 for supervising the communication apparatus and processing the stored data, among other things.

Display terminal 14 also is connected to central station 18 by a conventional dial-up telephone line 26 for receiving data representing stored images and signatures for use in identifying individuals.

A combined capture terminal and display terminal 28, capable of performing both the capture and display functions, is connected to central station 18 via a dial-up line 30. Another display terminal 32 is connected via a satellite link 34 to central station 18.

Free-standing capture and display units 36, 38 may also be provided. Capture unit 36 is not connected to central station 18 and instead stores the image and signature information, e.g., on the magnetic stripe of a conventional credit card. Display unit 38 similarly is not connected to central station 18 and displays a signature and image directly from the credit card stripe.

A wide variety of combinations of terminals and units (beyond the exemplary combination shown in Fig. 1) may be provided, including large numbers of capture terminals, display terminals, capture units, and display units, with communication to the central station being over any combination of available communication links.

Such a system has a broad range of applications. One example is a system for identifying credit card users. In such a system, the image and signature of each authorized credit card holder would be captured either on the credit card itself or in the central station storage device. Each time an individual presents a credit card for use, the merchant would display the purported image and signature of the individual to verify his identity. The display could be generated either directly from the credit card stripe or from data delivered from the central station. For this purpose other information stored on the credit card may also be useful. For example, an identifying number stored on the card may be used at the central station to point to the stored image and signature that are to be returned to the display terminal.

Referring to Fig. 2, in a capture terminal 12 or a capture unit 36, a conventional monochrome video camera 40 (e. g., model number .....supplied by .....) is positioned to capture a face image of an individual 42 with the aid of approriate lighting (not

shown). A second monochrome video camera 44 (model.....) is positioned to capture an image of the signature 46 of individual 42. Signature 46 may be written on a piece of paper and then held in position by a carrier (not shown).

The output of each camera 40, 44 is a conventional raster scanned analog composite NTSC video signal. The NTSC video signals are delivered to a conventional frame grabber 48. A microprocessor controls the operation of cameras 40, 44, and frame grabber 48 (under the direction of a user working at an interactive terminal 52 connected to the microprocessor) so that the face image and the signature image are delivered to frame grabber 48 at the proper times. Interactive terminal 52 may be a personal computer monitor and keyboard which is menu driven.

Frame grabber 48 samples and digitizes the NTSC signals and for each image delivers to a data storage 54, a stream of 307,200 raw pixel values in 480 rows of 640 columns each. Each raw pixel value is eight bits long and the values are generated by the frame grabber so that the set of pixel values for the image are reasonably well distributed among all 256 possible eight-bit pixel values.

The arrays of raw pixel values representing both the face image and the signature are processed to generate a compressed bit stream that captures both the image and the signature in a relatively small number of bits, small enough to be stored on the magnetic stripe of a conventional credit card or to be sent over a communication line in a very short time period. The processing of the raw pixel values is done by microprocessor 50 under control of a program stored in

conventional program storage, based on input from the user.

Referring to Fig. 3, the raw pixel values generated by camera 40 include information about both the face of the individual and the background surrounding the face. Thus the frame 60 of raw pixel values may be larger than a cropped frame 62 which is still large enough to include all of the information of interest.

Referring to Fig. 4, the first step in processing the face image is to crop (70) the frame to include only those pixel values within cropped frame 62. The height and width of cropped frame 62 are indicated by the user via interactive terminal 52 in a conventional manner. For example the boundary lines of cropped frame 62 can be adjusted using conventional cursor controls until the proper boundary lines are reached. Thus the user can dictate both the aspect ratio of the cropped frame (ratio of height to width) and the total number of pixels remaining in the cropped frame (determined by the absolute magnitudes of the height and width). The primary effect of cropping is to eliminate from the raw pixels those which are irrelevant to the face image so that no effort will be wasted on subsequently processing the irrelevant pixels.

The next step is to scale the image (72), that is reduce the number of pixels in each dimension by a scaling factor. The user selects the scaling factor via the interactive terminal 52 and the same scaling factor is applied to both dimensions. The scaling is accomplished by a simple averaging process. Referring to Fig. 5, for example, for a scaling factor of 4, each region 80 containing 4 x 4 = 16 pixels 81 in the cropped frame 82 is mapped into a single pixel 84 in the scaled

image 86 by averaging the sixteen pixel values of the pixels in region 80.

Referring again to Fig. 4, the pixel values of the scaled image are then remapped (74) from 8 bits to 4 bits. The remapping is done by assigning tones in the 8-bit pixel value range to tones in the remapped 4-bit pixel range as follows. The remapping is center biased, i.e., more sensitive to tones in the middle of the scale than at the extremes of the scale. The remapping table is as follows:

8-Bit Pixel value range	Remapped 4-Bit Pixel Value
0 - 43	0
44 - 55	1
56 - 67	2
68 - 79	3
80 - 91	4
92 - 103	5
104 - 115	6
116 - 127	7
128 - 139	8
140 - 151	9
8-Bit Pixel value range	Remapped 4-Bit Pixel Value
152 - 163	10
164 - 175	11
176 - 187	12
188 - 199	13
200 - 211	14
212 - 255	15

Next, the cropped, scaled, remapped pixel values are subjected to data compression (76) in accordance with a Shannon-Fano code of the following form. (An example of Shannon-Fano Coding is set forth

on p. 741 of Pratt, Digital Image Processing, Wiley, New York, 1978). First the difference between each pixel value and the preceding pixel value (where the pixel values are taken one after another, row by row) is calculated. The output of the coding process is a stream of bits that represent code words in the code based on the magnitude of the calculated difference in the pixel values. If the difference is zero (the most likely situation) the code word is a single "1" bit. If the diffe.ence is +1, -1, or +2, the code word is one of three different 3-bit codewords (respectively 001, 010, and 011). If the difference is any other value, the code word is a particular 3-bit code word (000) followed by a 4-bit value equal to the magnitude of the actual difference.

The result of the coding process is a relatively short stream of bits, e.g., less than 5,000 bits. The actual number of bits depends on each stage of the processing, including the cropping, scaling factor, remapping technique, and coding. There is a tradeoff between image quality and the number of bits in the final stream. For example, the number of bits can be reduced by more sharply scaling the image, but the image quality is reduced. In most cases, it should be possible to obtain recognition quality face images with a final bit stream that is short enough to be recorded on the magnetic stripe of a conventional credit card.

Referring to Fig. 6, in processing the signature image, the image is first cropped (90) in the same way as for the face image. The next step (unlike the face image processing) is to threshold the cropped image (92), that is to map each 8-bit pixel value is converted to a 1-bit black or white value. The threshold value for choosing between black or white is

selectable by the operator using the interactive terminal 52 (Fig. 1).

Next, the thresholded image is scaled (94) in a manner similar to the face image except that microprocessor 50 automatically determines the scaling factor in order to compress the total number of pixel values to a target number.

The scaled pixel values are then subjected to a two-stage data compression. The first stage is two dimensional run length encoding (96) by the so-called run length predictive differential quantizing technique (described in Huang et al. eds., Picture Bandwidth Compression, Gordon J. Beach, NY, 1972). The purpose is to identify two-dimensional regions that are to be black. First, a line is run length encoded in a conventional manner. Then the difference between the run length codes for that line and the run-length codes for the next line are determined. The line-to-line difference values obtained in that process are then Shannon-Fano coded (98) using the same code as for the face image, except that the entry which follows a 000 code is either a position difference value or a run length difference value. The length for each entry is calculated during signature compression, so the lengths may be distinct for a given signature and each length may vary from one signature to the next. The result is a coded bit stream representing the signature. The bit stream may be as short as, e.g., 1400 bits, but the actual number may vary depending on the cropping, thresholding, scaling, and coding. Similar tradeoffs of image quality and bit stream length (as for the face image) exist.

Referring to Fig. 7, after the compressed signature and image bit streams are generated, an

identification packet 90 is assembled. The packet includes a header (which among other things may contain a packet identifier, an issuer identifier, a description of the contents and size of the packet, and an identification of the coding technique used); the signature bit steam; the face image bit stream; a compressed version of textual information entered by the user (e.g., a credit limit for the credit card holder); and a check sum for the entire packet for use in later checking the integrity of the packet.

Referring again to Figs. 1, 2, in the case of a stand alone capture unit, the identification packet is then delivered from data storage 54 (where it was stored by microprocessor 50) to a magnetic stripe recorder which records the packet on the magnetic stripe 57 of plastic card 59.

Alternatively, in the case of a capture terminal that is connected to a central station, the identification packet is passed from data storage 54 to a conventional communication unit 61 capable of communication with the communication device 22 in the central station. At the central station the packet is stored in storage 20 at a location where it can be later retrieved on the basis of the identifier included in the header. That same identifier may also be recorded as bits on a credit card in some manner so that it can later be retrieved.

Referring to Fig. 8, in a display terminal or unit 14, 38, the display packet is loaded into a data storage unit 100 either from magnetic stripe 59 via a magnetic stripe reader 102 (in the case of a standalone display unit 38) or from the central office via a communication unit 104 (in the case of a display terminal 14). In each case the loading of the packet is

controlled by a microprocessor 106 (based on a program stored in program storage 108) and under direction of a user acting through a keyboard 110. Microprocessor 106, using generally the reverse procedures of those used in the capture terminal or unit, regenerates the cropped face image and cropped signature pixel arrays and from them generates a combined display pixel array for loading into a conventional frame buffer 112. A conventional video monitor 114 (including driver) uses the array in the frame buffer to produce a display of the face image and signature of the individual whose identity is being checked. Alternatively, the user may instruct the microprocessor to display the textual information from the packet.

Referring to Fig. 9, in regenerating the face image, microprocessor 106 first Shannon-Fano decodes (120) the face image bit stream to recover an array of 4-bit pixel values. Next the 4-bit pixel values are mapped back to 8-bit pixel values according to the following table.

4-Bit Pixel Value	Mapped 8-Bit Pixel Value
0	8
1	24
2	40
3	56
4	72
5	88
6	104
7	120
8	136
9	152
10	168
11	184
12	200
13	216
14	232
15	248

The image is then magnified by adding more pixel values between the existing pixel values using bilinear interpolation (122).

Referring to Fig. 11, in bilinear interpolation each new pixel 130 in the magnified pixel array 132 is calculated as a weighted average of the four adjacent pixel values 134, 136, 138, 140 in the original pixel array 142, the weighting being based on the distance of the new pixel 130 from each of the original pixels as placed in the magnified array 132. Bilinear interpolation is discussed in Castleman, Digital Image Processing, Prentice-Hall, 1979.

Following magnification, the pixels are subjected to contrast enhancement (123), e.g., using a convolutional filtering technique of the kind described in the Pratt reference at page 322.

Referring to Fig. 10, to regenerate the signature image from the compressed signature bitstream, microprocessor 106 first Shannon-Fano docodes (140) the bit stream and then run length decodes it (142) to recover the thresholded scaled pixel array. The array is similarly magnified using bilinear interpolation (144).

Referring to Fig. 11, in one technique for recording the identification packet on a conventional credit card 150, the usual 1/4" wide magnetic stripe 152 is treated as having four tracks three of which comply with ANSI standards, with tracks 1 and 2 (recorded at 210 bits per inch (bpi)) and track 3 used for conventional puroses. Track 0 is then split into two half-tracks 154, 156 and recorded at 2600 bits per inch with flux changes recording zero-valued bits on one half-track and one-valued bits on the other half-track. Alternatively all four tracks may be recorded outside the ANSI standards at a higher bit rate in order to include all of the conventionally recorded information plus identification packet.

Operation

In the example of a system used for identifying credit card holders, each individual to whom a card is issued would be required to have his "picture" and an image of his signature captured and stored using a capture terminal. The compressed identification packet would either be stored directly on the issued credit card or be stored in the central station, or both, with the key to retrieving the stored packet also being recorded on the credit card (perhaps on another track).

When an individual presents the card to buy something, the merchant would run the stripe through the stripe reader in the display terminal. The person's

picture and signature would be displayed to the merchant as well as information such as the person's credit limit. The identification packet would either be read directly from the credit card, or would be retrieved over a telepone line from the central station based on the storage location read from the card and sent to the central station.

Other embodiments are within the following claims.

For example, the system may be used in a wide variety of applications other than the credit card example described. And other types of identification information may be captured and retrieved, including fingerprint information.

The cropping process could be done by providing a zoom lens on the video camera and having the user adjust the lens so that the face image fills the entire screen. Then the original raw pixel values would not include any unnecessary background pixels.

The identification information could be stored in other ways than on the magnetic stripe of a credit card, e.g. in a hologam on the card, or on an optically readable stripe.

Other data compression techniques could be used, with the particular technique being indicated in the identification packet header, so that the display process can be performed in the appropriate way.

The information which identifies the identification packet may be stored independently of the packet itself, e.g., elsewhere on the card, so that the packet and the information identifying it act as lock and key to prevent use of the card in a manner which does not involve detecting both the lock and key.

Other techniques may be used to process the

signature image for redisplays. Following the run-length decoding step, the threshold scaled pixel array may be scaled up (without interpolation) or scaled up and edge-smoothed.

Claims

1. A method for compressing a face image into a digital bit stream including the steps of

converting the image to an array of raw pixel values, reducing the image to generate a smaller array of pixel values,

reducing the gray-scale range of the pixel values in the smaller array,

deriving data words indicative of said pixel values, and

encoding said data words as said bit stream in accordance with a code of the type in which more frequently occurring data words are encoded as shorter sets of bits.

2. The method of claim 1 wherein said bit stream is no longer than 5000 bits.

3. The method of claim 1 wherein said image is reduced to said smaller array to a degree specified by a user based on viewing said image.

4. The method of claim 1 wherein each said data word comprises the difference between two of the reduced gray-scale pixel values.

5. The method of claim 1 further comprising remapping said pixel values to a coarser range of pixel values.

6. The method of claim 5 wherein said remapping is more sensitive to tones in the middle of the scale than at the extremes of the scale.

7. The method of claim 1 adapted for use in confirming, at multiple locations, the identities of a predetermined group of individuals, further comprising

capturing information about said face image that identifies each individual for compressing into said digital bit stream,

recording said digital bit stream on a pocket-size recording medium to be provided to each said individual, and

providing apparatus at each said location for recovering said image from said recorded bit stream for confirming the identity of said individual.

8. The method of claim 7 wherein said recording medium comprises a magnetic strip.

9. The method of claim 7 wherein said recording medium comprises a printed strip.

10. The method of claim 7 wherein said strip is part of a plastic card.

11. The method of claim 7 wherein said face image further comprises a signature image.

12. The method of claim 1 adapted for use in confirming, at multiple locations, the identities of a predetermined group of individuals, further comprising

capturing information about said face image that identifies each individual for compressing into said digital bit stream,

capturing information about a signature image that identifies each individual and converting said signature information for inclusion in said digital bit stream,

recording said digital bit streams for said individuals at a central location, and

providing local apparatus at each said location for receiving a said bit stream for a selected said individual from said central location and recovering said face and signature images from said bit stream to confirm the identity of said individual.

13. The method of claim 12 further comprising providing each said individual with a key to the storage address at which said digital bit stream for said

individual is recorded at said central location, and

delivering said bit stream to said local apparatus on the basis of said key information.

14. The method of claim 13 wherein said key is stored as bits on a pocket-size recording medium to be provided to said individual.

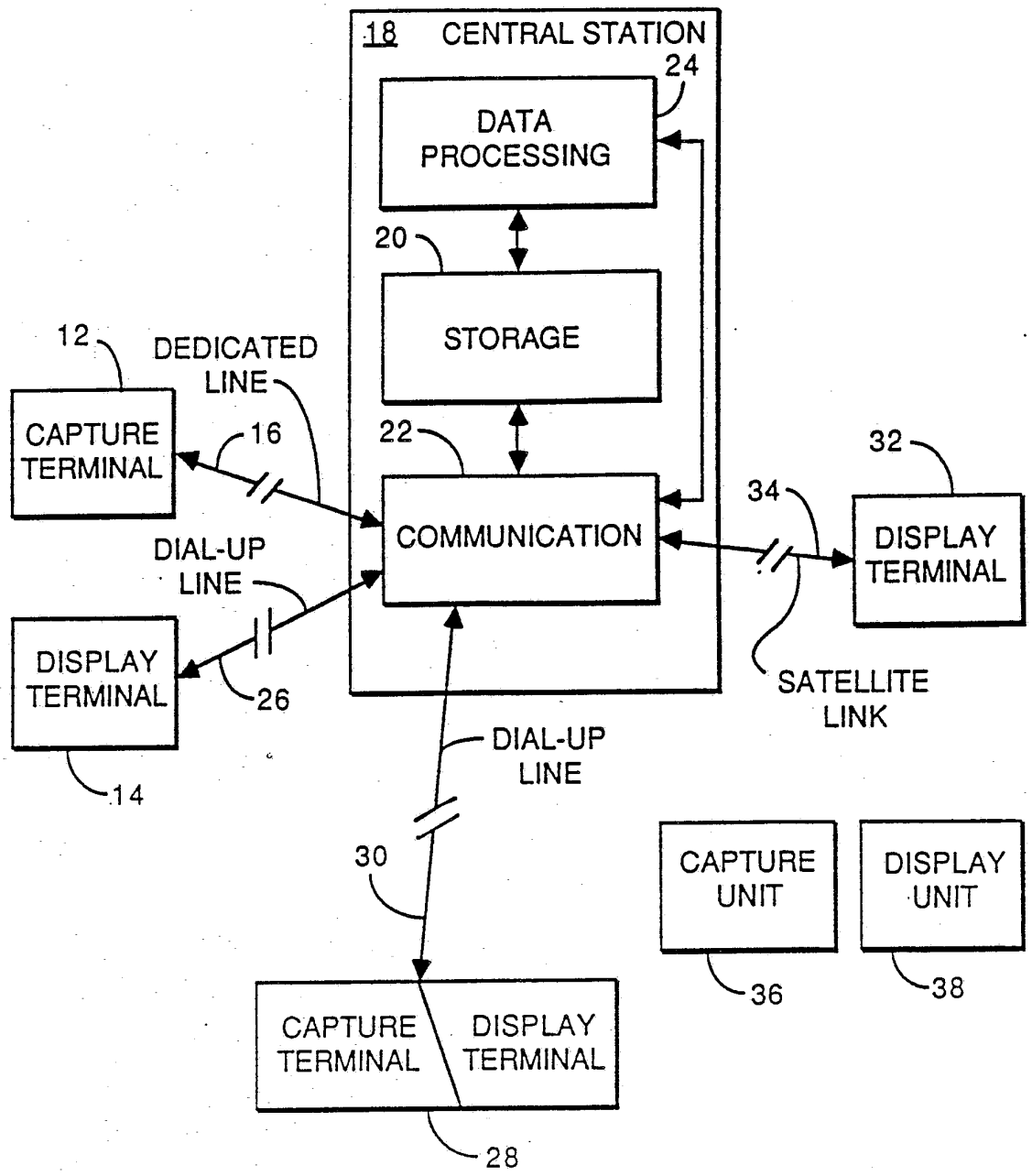
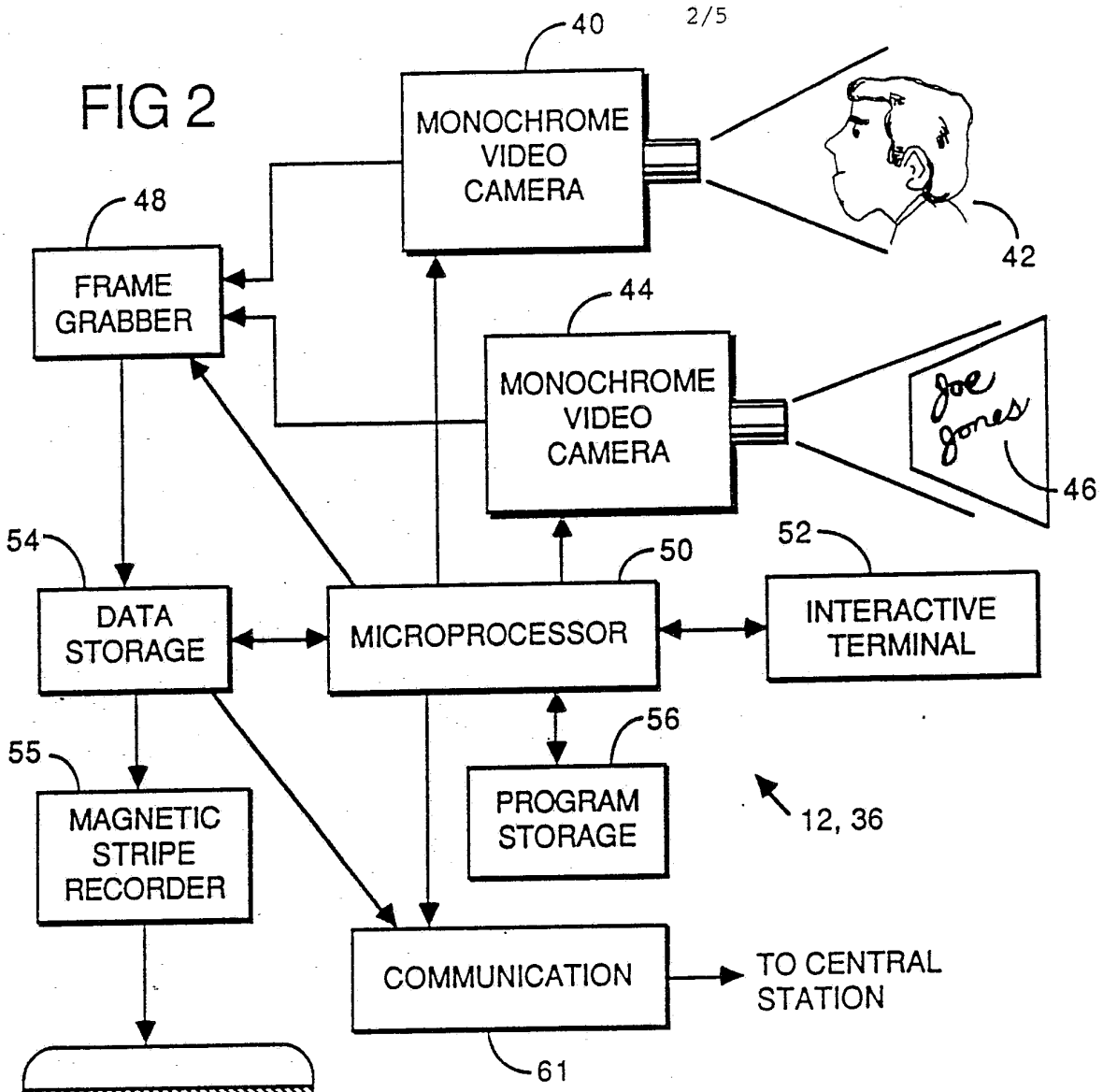

18 CENTRAL STATION
24
DATA PROCESSING
20
STORAGE
22
COMMUNICATION
12
DEDICATED LINE
16
CAPTURE TERMINAL
DIAL-UP LINE
26
DISPLAY TERMINAL
14
32
34
DISPLAY TERMINAL
SATELLITE LINK
DIAL-UP LINE
30
CAPTURE UNIT
DISPLAY UNIT
36
38
CAPTURE TERMINAL
DISPLAY TERMINAL
28

FIG 1

FIG 2


40
MONOCHROME VIDEO CAMERA
42
48
FRAME GRABBER
44
MONOCHROME VIDEO CAMERA
Joe Jones
46
54
DATA STORAGE
50
MICROPROCESSOR
52
INTERACTIVE TERMINAL
56
55
MAGNETIC STRIPE RECORDER
PROGRAM STORAGE
12, 36
COMMUNICATION
TO CENTRAL STATION
61
57
59

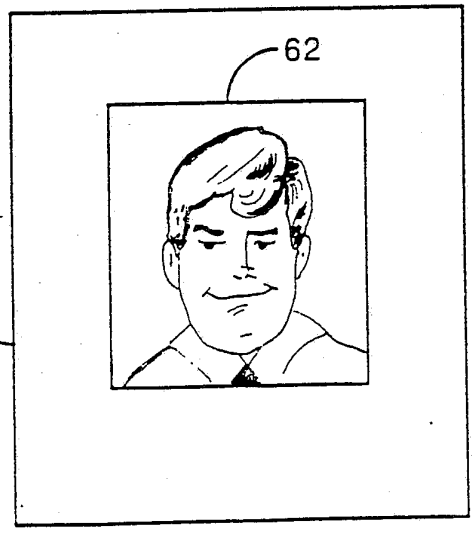

62
60

FIG 3

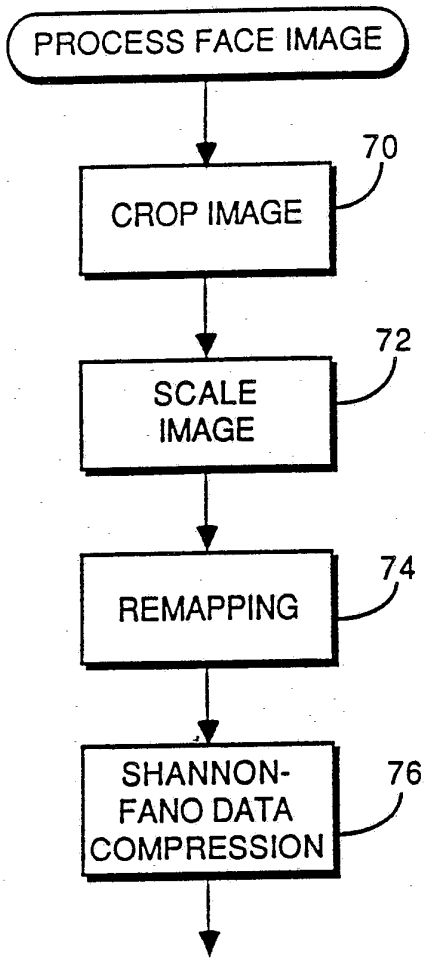


FIG 4

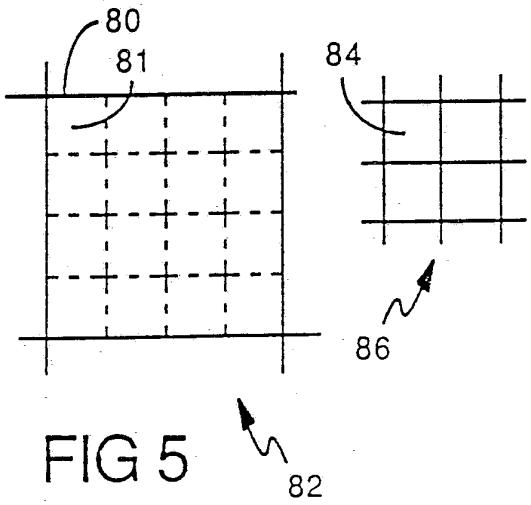


FIG 5

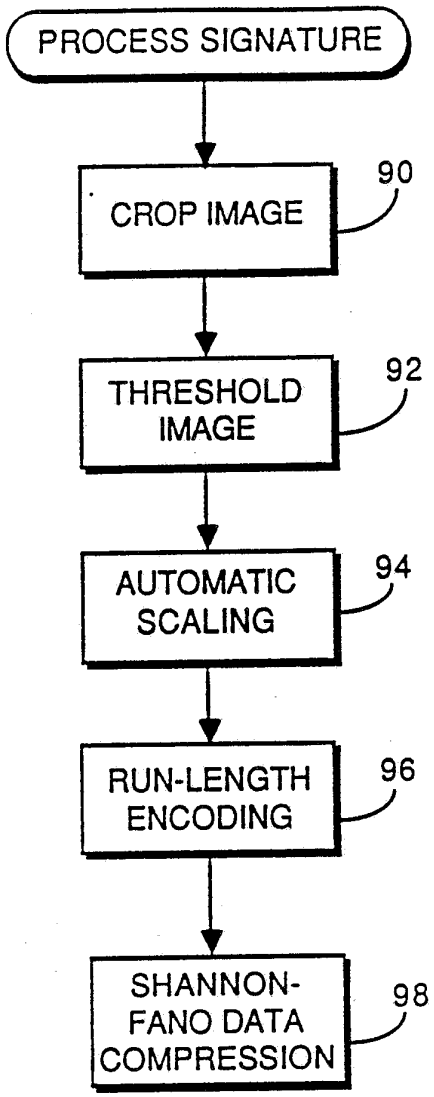


FIG 6

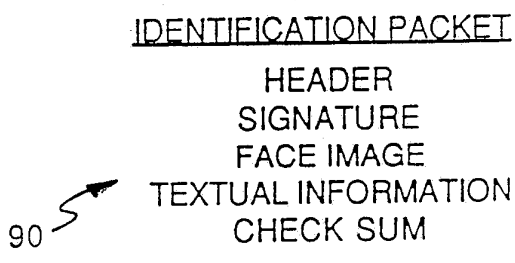


FIG 7

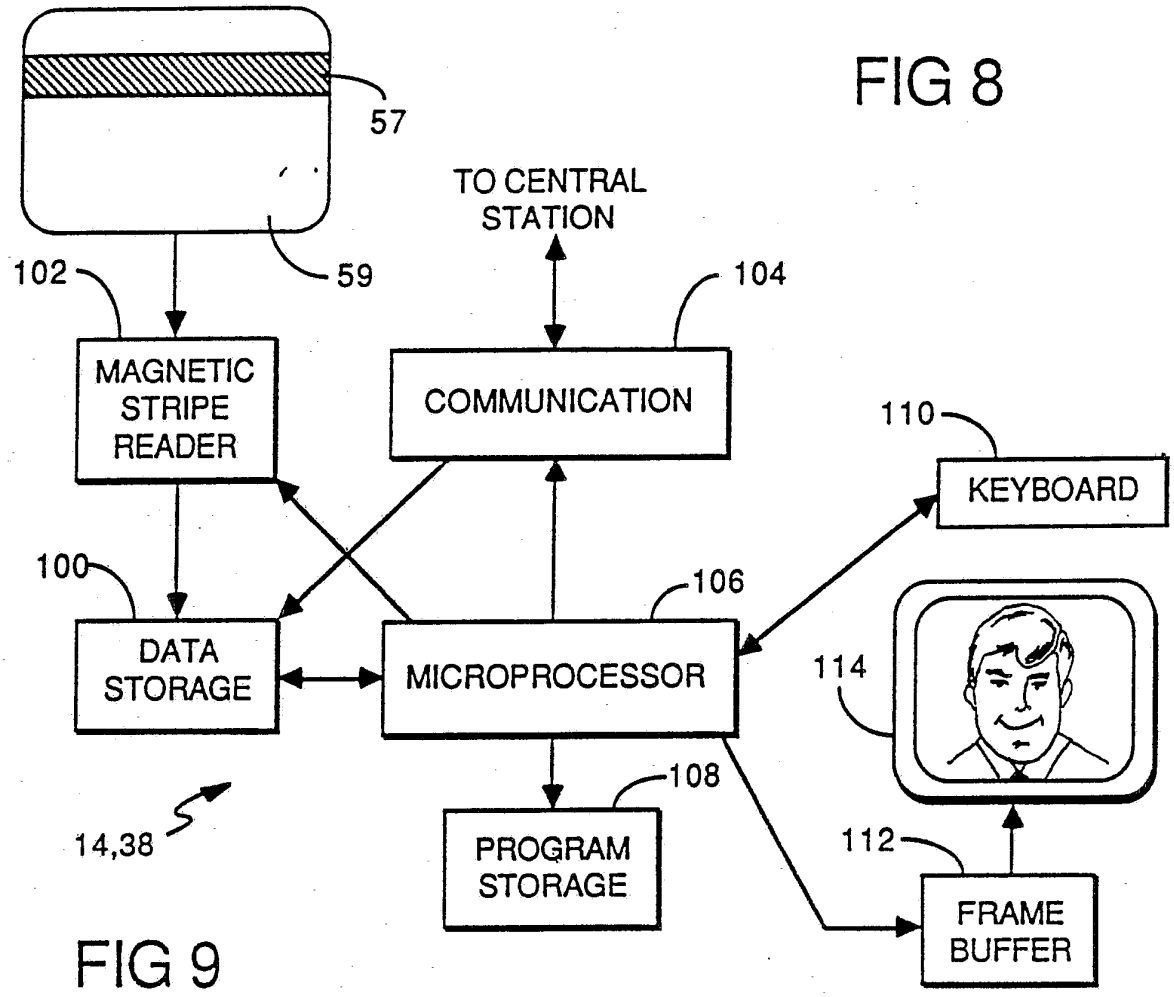


FIG 8

FIG 9

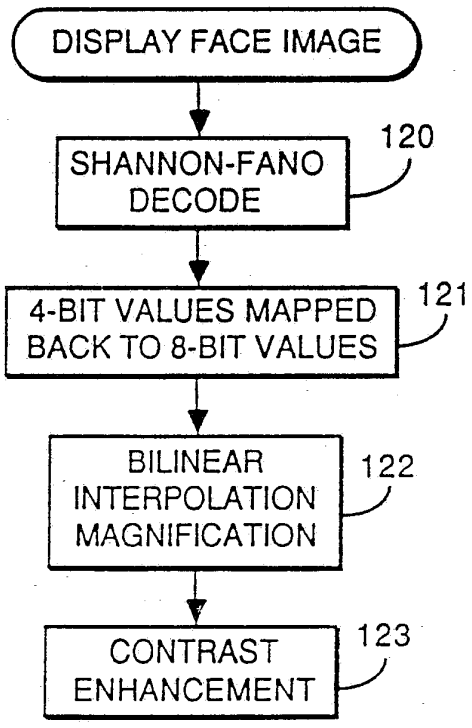
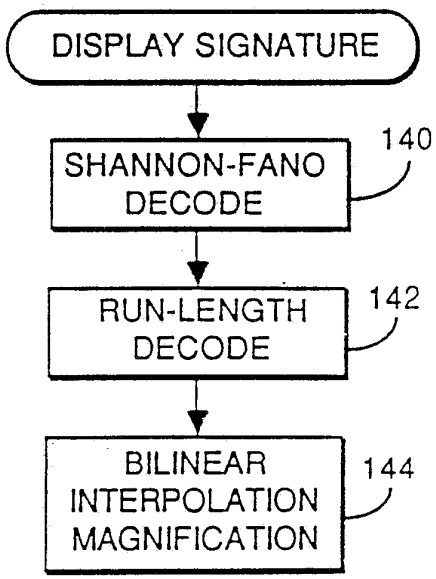


FIG 10



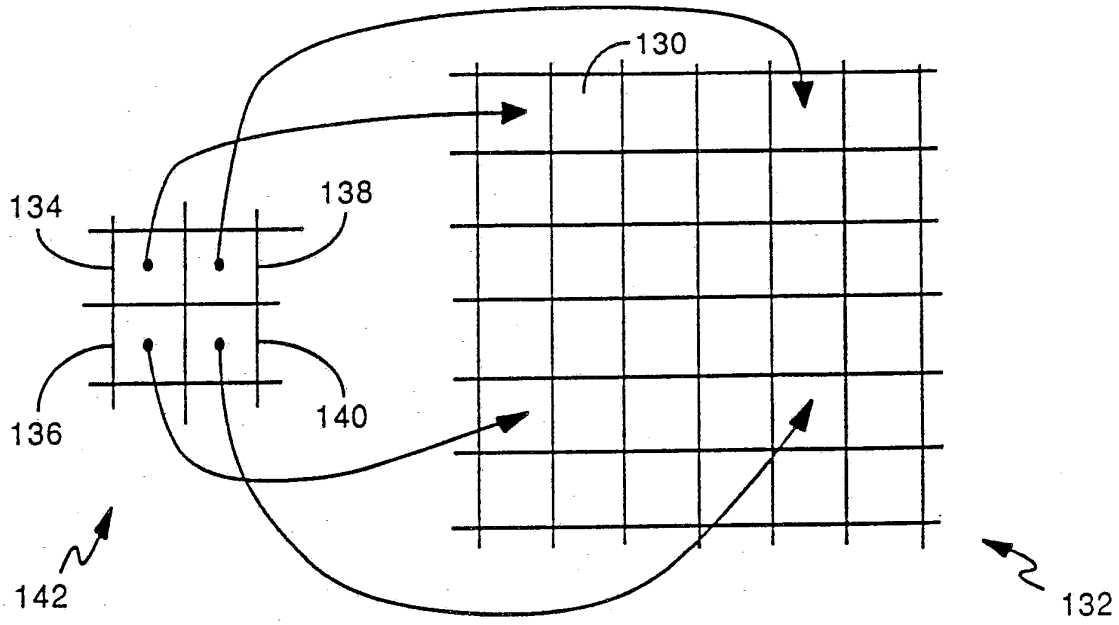
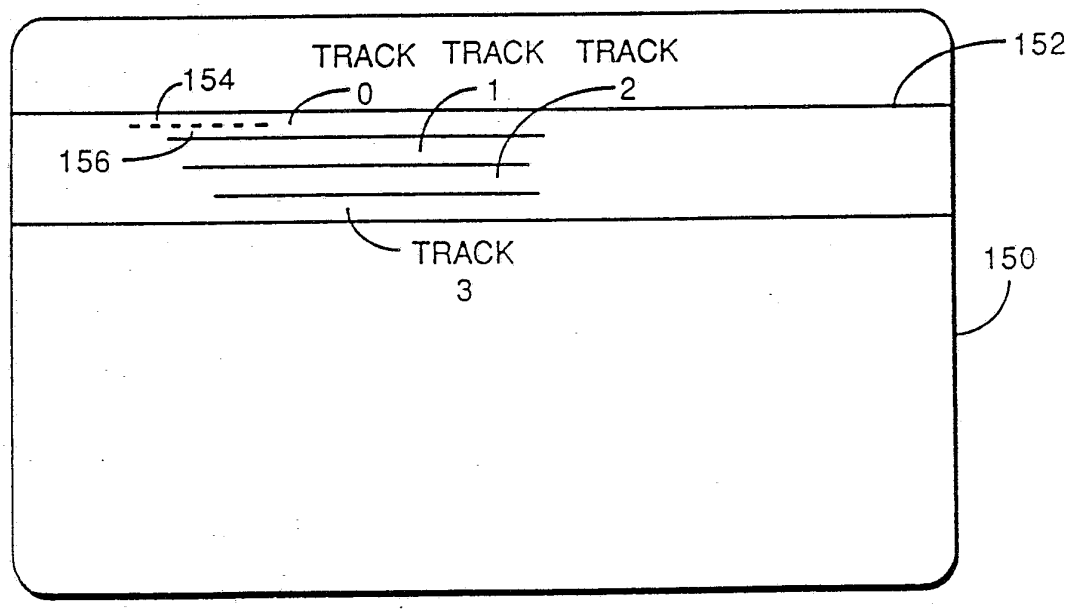

130
134
138
136
140
142
132

FIG 11

FIG 12


TRACK
0
TRACK
1
TRACK
2
154
152
156
TRACK
3
150

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US88/02503

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

IPC (4): G0 6 K 3/00

US CL. 235/380

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
US	235/380

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	US, A, 4,424,587 (WEVELSIEP et al.) 03 JANUARY 1984 SEE ENTIRE DOCUMENT.	1-14

* 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

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
10/5/88	18 NOV 1988
International Searching Authority	**Signature of Authorized Officer**
ISA/US	Harold Pitts

Form PCT/ISA/210 (second sheet) (Rev.11-87)