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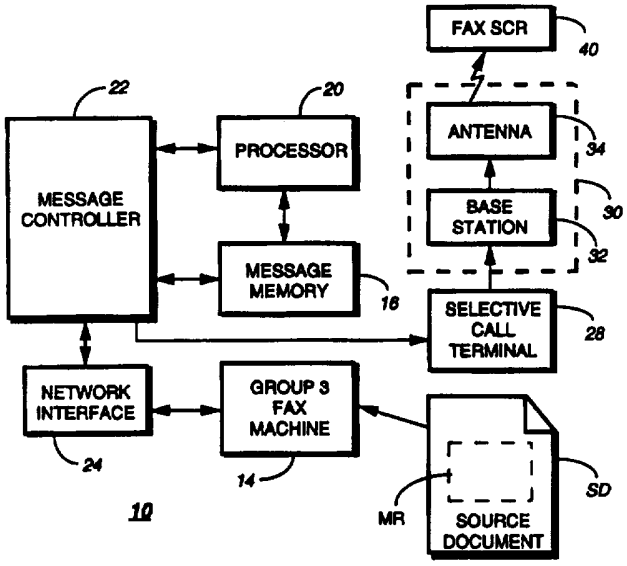
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(54) Title: SYSTEM AND METHOD FOR SEGMENTING IMAGE OF A FACSIMILE MESSAGE FOR TRANSMISSION TO SELECTIVE CALL RECEIVER



(57) Abstract

A system and method for transmitting a facsimile message to one or more of a plurality of facsimile selective call receivers (40) each capable of decompressing a facsimile message on the basis of a facsimile codebook which is optimized for an image of a predetermined fixed resolution. In a processor (20) of the selective call terminal, the image of the facsimile message is segmented into a plurality of subimages (I1-In). Each subimage is compressed on the basis of the codebook to generate a compressed subimage for each subimage. A paging protocol signal is generated including information representative of the plurality of compressed subimages. At the selective call receiver (40), the decoder/controller extracts the information representative of the compressed subimages (CI1-CIn) and decompresses each compressed subimage on the basis of the stored codebook to display the facsimile message.

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SYSTEM AND METHOD FOR SEGMENTING IMAGE OF A FACSIMILE MESSAGE FOR TRANSMISSION TO SELECTIVE CALL RECEIVER

Field of the Invention

The present invention relates to a facsimile selective call receiver, and more particularly a method and apparatus for transmitting a facsimile message to a selective call receiver in such a way so as to minimize memory requirements of the selective call receiver.

Background of the Invention

In a facsimile selective call receiver (pager) or other graphics portable communication devices, the transmission of images, for example facsimile messages, requires data compression in order to utilize the available bandwidth efficiently. The Group III and IV facsimile standards are defined under the CCITT (Consultative Committee on International Telegraph and Telephone). These standards for encoding and compressing data, as well as runlength coding in general, require the storage of a Huffman codebook in the portable device for decompression of the compressed image data.

In certain applications, it is desirable to minimize the amount of RAM or ROM necessary in the portable, by removing the dependence between codebook size and image resolution. In addition, it is desirable to avoid storing multiple codebooks in a portable unit to keep the cost of the device at a minimum.

Summary of the Invention

In accordance with one aspect, the present invention is directed to a method for transmitting a facsimile message to one or more of a plurality of facsimile selective call receivers each capable of decompressing a facsimile message on the basis of a facsimile codebook which is optimized for an image of a resolution that is less than or equal to a resolution of the facsimile message to be transmitted, the method comprising steps of:

segmenting the image of the facsimile message into a plurality of subimages;

separately compressing each subimage on the basis of said codebook to generate a compressed subimage for each subimage; and

generating a paging protocol signal including information representative of the plurality of compressed subimages;

receiving the paging protocol signal at one or more of the facsimile selective call receivers;

extracting the information representative of the compressed subimages; and

decompressing each compressed subimage on the basis of the codebook.

Further, in a first embodiment, the image is vertically divided into a plurality of subimages each having a horizontal width less than or equal to the image resolution of the codebook. In a second embodiment, the image is compressed line-by-line, and a given runlength of the line is divided into segments which are less than or equal to the maximum horizontal resolution of the codebook.

In accordance with another aspect, the present invention is directed to a facsimile selective call receiver system comprising:

a selective call terminal for connection to a communications network and having a selective call terminal processor, a base station for transmitting a paging signal to one or more of a plurality of selective call receivers, the selective call terminal receiving a facsimile message from a party desiring to transmit the facsimile message to a particular selective call receiver and an identifier of the particular selective call receiver, the selective call terminal processor segmenting an image of the facsimile message into a plurality of subimages and separately decompressing each subimage on the basis of a facsimile codebook, decoding the identifier to determine an address of the particular selective call receiver designated to receive the fax message, and generating a paging signal including information representing the compressed subimages; and

at least one facsimile selective call receiver having a receiver for receiving the paging signal, a processor and a display, the processor extracting the information representative of the compressed subimages and decompressing each compressed subimage on the basis of the codebook for displaying the decompressed subimages on the display.

Brief Description of the Drawings

FIG. 1 is a block diagram of a facsimile selective call receiver system in accordance with the preferred embodiment of the present invention.

FIG. 2 is an electrical block diagram of a facsimile selective call receiver according to the present invention.

FIG. 3 is an electrical block diagram of a decoder/controller of a facsimile selective call receiver according to the present invention.

FIG. 4 is a flow diagram illustrating in general the overall image compression, transmission and decompression process according to the present invention.

FIG. 5 is diagram illustrating segmentation of a source image into subimages for individual compression according to a first embodiment of the present invention.

FIG. 6 is a diagram illustrating decompression of compressed images stored in memory for display according to the first embodiment of the present invention.

FIG. 7 is a flow chart diagram illustrating a process for extracting and compressing subimages according to the first embodiment of the present invention.

FIG. 8 is a flow chart diagram illustrating a process for decompressing subimages according to the first embodiment of the present invention.

FIG. 9 is a diagram illustrating segmentation of a source image for compression according to a second embodiment of the present invention.

FIG. 10 is a diagram illustrating a process for extracting and compressing subimages according to the second embodiment of the present invention.

FIG. 11 is a diagram illustrating the assignment of codewords for compressing subimages according to the second embodiment of the present invention.

Description of a Preferred Embodiment

Referring first to FIG. 1, a facsimile selective call receiver (SCR) system is shown generally at 10 and is suitable for transmitting a source document via a fax machine 14 to a facsimile (fax) capable SCR 40. The system 10 comprises a processor 20, a message controller 22, a message memory 16, a network interface 24, such as the public telephone switching network (PTSN), a selective call terminal 28, and a transmitter 30 including a base station 32 and antenna 34.

A source document S includes a message region MR in which a handwritten message is made. The source document S includes other portions, such as a header, and a pager identification number (PIN) bubble block (not shown).

The entire source document is encoded and compressed by the fax machine 14 according to a Group III fax coding scheme which is well known to one of ordinary skill in the art. The Group III facsimile machine is defined under the CCITT (Consultative Committee on International Telegraph and Telephone). The Group III facsimile standards for encoding and compressing data are performed using the coding scheme known as the modified Huffman code. The modified Huffman code uses the standard Huffman code in conjunction with the modified READ (Relative Element Addressing Designate) code. Once the information is Group III encoded and compressed, the selective call terminal 28 is dialed by the fax machine 14 and a connection is made. Then, the fax message is transmitted by the fax machine 14 to the message controller 22 via the network interface (PTSN) 24. The message controller 22 directs the information to the selective call terminal processor 20 for providing additional processing of the information suitable for selective call communication. After storing at least a portion of the information in a message memory 16, the processor 20 and the message controller 22 process the compressed facsimile message.

It is at this stage that the present invention provides a unique process for facsimile compression of at least the message region MR (called the "source image") to the fax SCR 40.

FIG. 2 illustrates the components of the fax SCR 40. The fax SCR is similar to a conventional selective call receiver (pager), but further includes software for decoding and decompressing an incoming facsimile message embedded in a paging signal. The fax SCR 40 comprises an antenna 64, a receiver 66, a frequency synthesizer 67, a decoder/controller 68, a code-plug memory including an address memory 72 and a destination memory 74, selector switches 76, tactile alert 80, power switch 82, audible alert 84 and display 90. The interaction of the components shown in FIG. 2 is well known in the art.

FIG. 3 illustrates the decoder/controller 68 in greater detail. A detailed explanation of these components is not needed for purposes of understanding the present invention. Briefly, at its heart, the decoder/controller 68 comprises a central processing unit 410 which processes software instructions stored in a ROM 406. Data flow into and out of the decoder/controller 68 is controlled by input/output (I/O) ports 412 and 413. A timing mechanism for the fax SCR is generated by a crystal driven oscillator 418. A timer counter 402 is connected to the oscillator 418 for certain timing functions.

One or more decoders, shown at 420 and 422, are provided to, for example, decode different portions of a fax message, such as a header region encoded with ASCII characters. The central processing unit 410 generates display control signals which are used to drive the display 50 (FIG. 2), and to call for generation of alert signals via an alert generator 416. In addition, software for decompressing a facsimile message, including a facsimile compression code-book is stored in the RAM 404 or ROM 406.

FIG. 4 shows in general the overall process according to the present invention. Step 100 represents segmentation of the source image into subimages and compression of each subimage with the same codebook. Step 100 is performed by the selective call terminal processor 20 after the facsimile message is received by the selective call terminal processor 20 and decompressed using standard Group III or IV decompression techniques. Step 102 represents transmission of the compressed subimages in a paging protocol signal, which is well known in the art. As will be explained in more detail hereinafter, the subimages need not be transmitted in exact order of extraction and compression. Step 104 represents reception of the compressed images in a fax selective

call receiver that has detected the designated paging signal. In step 106, the compressed subimages are stored in a memory of the fax SCR, and in step 108 the stored subimages are decompressed using a single stored codebook. Finally, in step 110, the decompressed subimages are displayed on the display of the fax SCR, either individually or all together.

Turning now to FIGS. 5-8, the first embodiment of the present invention will be described. In accordance with the first embodiment of the present invention, at the selective call terminal processor 20, the decompressed message region MR of the source document SD is segmented into subimages as shown, for compression with a codebook which is optimized for the display capability of the fax SCR 40. The codebook varies for different applications, but a codebook is chosen which is found to most efficiently compress and decompress images which are typically sent to a fax SCR. Thus, the codebook is preferably the smallest capable codebook, so as to occupy minimal memory space in the portable fax SCR.

FIG. 7 illustrates the methodology for compressing the message region MR, which is performed by the processor 20 in conjunction with message memory 16. FIG. 5 illustrates the manner in which the source image is segmented according to the first embodiment. FIG. 8 illustrates the methodology for decompressing the subimages in the fax SCR according to the first embodiment. FIG. 6 is a pictorial representation of how the received compressed sub-images are stored for decompression.

Referring to FIGS. 5 and 7, a source image, such as message region MR, is divided or segmented into subimages I1-I6. The codebook compression-decompression technique used in accordance with the present invention is one dimensional Huffman/runlength encoding. Thus, the source image resolution is defined by its width, as shown in FIG. 5. The codebook which is found from *a priori* tests, represents the best and maximum resolution that the selective call receiver can handle, based on display size and resolution. This maximum codebook resolution is called m and the source image resolution is called N.

In the first step 200 of the procedure, N and m are compared to determine whether the image resolution is greater than the codebook resolution. If N is greater than m, then the source image must be segmented to use the codebook with resolution m. In this case, in step 202, the number of subimages Ns is determined by taking the nearest

integer greater than or equal to N/m. Also in step 202, the increment counter n is initialized to 1. Next, in step 204, the subimage In is extracted from the source image, and in step 206, the subimage In is compressed using the stored codebook. Each compressed subimage In is stored in the message memory 16 in preparation for transmission in the appropriate queue of a paging signal. In step 210, the counter n is incremented and steps 204 to 208 are repeated. The loop is terminated when in step 212, the value of n exceeds the number of subimages Ns.

It should be noted that if the source image resolution N is not greater than the codebook resolution m, then step 202 is skipped and steps 204-208 are performed once, generating a single compressed file representative of the source image.

The following example is provided with reference to FIG. 5. In this example, N equals 640 pixels which is the source image resolution. The number of lines in the source image is not relevant because the codebook performs one-dimensional Huffman/runlength coding. Assume in the example that the codebook resolution m is equal to 120, indicating that the codebook has codes which can represent a maximum of 120 runs of black or white.

Ns = [640/120] = [5.33] = 6 subimages. Therefore, the source image is segmented into 6 subimages. Subimages I1-I5 are 120 pixels wide, and subimage I6 is 40 pixels wide. Each of the 6 subimages are compressed and stored separately. Each line of compressed data is terminated by an "EOL" as is the case in the CCITT Group III spec.

The compressed subimages are incorporated in a paging signal, with a header that indicates the number of subimages. The subimages, for example I1-I6, are transmitted in order. Alternatively, the subimages are transmitted out of sequence, and the header includes appropriate information to identify the sequence of the subimages for detection and decompression by the selective call receiver. Further yet, as each subimage is compressed and stored, it can be incorporated in a paging signal with the appropriate header information.

Turning now to FIGS. 6 and 8, the process for reception and decompression is illustrated. In step 214, the header is received including the number of subimages Ns (and possible other header information such as sequence information), and each of the compressed subimages are received. The compressed subimages CI1-CI6 are stored in

a memory of the SCR, such as RAM 404, as shown in FIG. 6. Next, in step 216, the position Column_Start and the counter n are initialized. In step 218, the image In is decompressed using the stored codebook. In step 220, the decompressed image is stored in a video RAM of display driver 414 starting at the position corresponding to the value of Column_Start, as shown in FIG. 6. In step 22, Column_Start is incremented according to the resolution of the codebook m, and n is incremented. Steps 218-222 are repeated, until in step 224, it is determined that n is greater than Ns, in which case the procedure is terminated.

It is not necessary to decompress each subimage entirely for display. For example, if the display of the fax SCR can only handle one-half of the number of total subimage lines at a time, then only one-half of the subimage is decompressed at a time. In addition, not all of the subimages need be decompressed before the image is displayed. Rather, any subset of the total number of subimages can be decompressed for display, while the remaining compressed subimages remain in memory awaiting decompression.

Turning now to FIGS. 9 and 10, the second embodiment of the present invention will be described. In this embodiment, the source image is segmented into subimages on a line-by-line basis. Specifically, when the run of black or white on a particular line exceeds the codebook resolution, then the line is broken into subparts which have lengths less than or equal to the codebook resolution m.

The rule for compressing the source image on a line-by-line basis where R is the length of a given run and m is the maximum resolution of the codebook, is as follows:

(A) If a given run R > m, then:
  (1) encode a run of m;
  (2) append a codeword for a run of 0 of the opposite color (w or b);
  (3) let R = R-m; and
  (4) go to (A)

(B) Else
  encode a run of R.

FIG. 10 illustrates a procedure according to the second embodiment. In step 300, a line of the source image is obtained for compression. The number of runs of white are determined in step 302.

The codebook rule is invoked to encode the run of white with the appropriate codeword in step 304. The run of black is determined in step 306 and in step 308, the run of black is encoded using the codebook rule. In step 310, it is determined whether the entire line is coded. If not, then steps 302-308 are repeated. If so, then instep 312, an "EOL" is appended to the compressed data (the link of codewords). In step 314, it is determined whether there are more lines left in the source image, and if so, steps 300-312 are repeated, and if not, the procedure is terminated.

Reference is made to FIGS. 9 and 11 for an example of the procedure for compression in accordance with the second embodiment. In the example, the codebook resolution m is 120. Thus, to code Line 1, the run of 360w is divided into segments which are 120 or shorter in length. Thus, the 360w is broken down into 120w + 0b + 120w + 0b+ 120w. Thus, the codeword for 360w becomes the combination of the codewords for each of 120w + 0b + 120w + 0b+ 120w. Similarly, in Line 2, the run of 480w is divided into segments of 120w + 0b + 120w + 0b +120w + 0b + 120w, and the codeword for each of these segments is combined to form the codeword for the run of 480w. FIG. 11 illustrates an even more extreme example with the run of 630b.

Decompression of the compressed information according to the second embodiment follows standard table look-up procedures. When decompressing the compressed information, the first codeword is assumed to be that of a white runlength, the second codeword that of a black runlength, the third codeword that of a white runlength, ..., until an EOL is found. This is the standard Group III decompression procedure, and is well known in the art.

According to the present invention, the amount of memory space for storing facsimile codebook information in the portable unit is minimized, while permitting transmission and reception of images having greater resolution than the stored codebook can handle.

The above description is intended by way of example only and is not intended to limit the present invention in any way except as set forth in the following claims.

What is claimed is:

CLAIMS

1. A method for transmitting a facsimile message to one or more of a plurality of facsimile selective call receivers each capable of decompressing a facsimile message on the basis of a facsimile codebook which is optimized for an image having a resolution that is less than or equal to a resolution of the facsimile message to be transmitted, the method comprising steps of:

segmenting an image of the facsimile message into a plurality of subimages;

separately compressing each subimage on the basis of said codebook to generate a compressed subimage for each subimage; and

generating a paging signal including information representative of the plurality of compressed subimages;

receiving the paging protocol signal at a facsimile selective call receiver;

extracting the information representative of the compressed subimages; and

decompressing each compressed subimage on the basis of the codebook.

2. The method of claim 1, wherein the step of transmitting comprises the step of incorporating information representative of the number of said plurality of compressed subimages in the paging protocol signal.

3. The method of claim 2, wherein the step of generating a paging signal includes generating a header including information representing the number of compressed subimages.

4. The method of claim 3, wherein the step of generating a paging signal comprises generating information representative of the sequence that the compressed subimages are transmitted.

5. The method of claim 1, wherein the codebook has a maximum horizontal resolution for one-dimensional runlength coding,

and the step of segmenting comprises vertically dividing the image of the facsimile message into a plurality of vertical subimages each having a width less than or equal to the maximum horizontal resolution of the codebook.

6. The method of claim 5, wherein the step of decompressing comprises separately decompressing each compressed vertical subimage.

7. The method of claim 6, and further comprising the step of displaying the decompressed vertical subimages on a display of a facsimile selective call receiver.

8. The method of claim 7, wherein the step of displaying comprises displaying in sequence the decompressed vertical subimages beginning at a column start position of the display.

9. The method of claim 7, wherein the step of displaying comprises displaying a portion of a decompressed vertical subimage beginning at a particular column of the display.

10. The method of claim 7, wherein the step of displaying comprises displaying a subset of the plurality of decompressed subimages.

11. The method of claim 1, wherein the codebook has a maximum horizontal resolution for one-dimensional runlength coding, and the step of segmenting comprises dividing each horizontal line of the image of the facsimile messages into a plurality of line segments each having a runlength less than or equal to the maximum horizontal resolution of the codebook.

12. The method of claim 11, wherein a line segment of a horizontal line of the image of the facsimile message which has a runlength greater than the maximum horizontal resolution of the codebook is divided into composing segments having a runlength less than or equal to the maximum horizontal resolution.

13. The method of claim 12, wherein the step of decompressing comprises decompressing the compressed line segments representative of line segments of the horizontal lines of the image of the facsimile message.

14. The method of claim 1, and further comprising the step of displaying the decompressed subimages on a display of a facsimile selective call receiver.

15. The method of claim 14, wherein the step of displaying comprises simultaneously displaying a subset of the plurality of decompressed subimages on the display.

16. The method of claim 15, wherein the step of displaying comprises simultaneously displaying a portion of each decompressed subimage if the resolution of the decompressed subimage is greater than a resolution of the display.

17. A facsimile selective call receiver system comprising:

a selective call terminal for connection to a communications network and having a selective call terminal processor, a base station for transmitting a paging signal to one or more of a plurality of selective call receivers, the selective call terminal receiving a facsimile message from a party desiring to transmit the facsimile message to a particular selective call receiver and an identifier of the particular selective call receiver, the selective call terminal processor segmenting an image of the facsimile message into a plurality of subimages and separately decompressing each subimage on the basis of a facsimile codebook, decoding the identifier to determine an address of the particular selective call receiver designated to receive the fax message, and generating a paging signal including information representing the compressed subimages;. and

at least one facsimile selective call receiver having a receiver for receiving the paging signal, a processor and a display, the processor extracting the information representative of the compressed subimages

and decompressing each compressed subimage on the basis of the codebook for displaying the decompressed subimages on the display.

18. The system of claim 17, wherein the codebook has a maximum horizontal resolution for one-dimensional runlength coding, and the selective call terminal processor means vertically divides the image of the facsimile message into a plurality of subimages each having a width less than or equal to the maximum horizontal resolution of the codebook.

19. The system of claim 17, wherein the codebook has a maximum horizontal resolution for one-dimensional runlength coding, and the selective call terminal processor means divides each horizontal line of the image of the facsimile messages into a plurality of line segments each having a runlength less than or equal to the maximum horizontal resolution of the codebook.

20. The system of claim 19, wherein a line segment of a horizontal line of the image of the facsimile message which has a runlength greater than the maximum horizontal resolution of the codebook is divided into composing segments having a runlength less than or equal to the maximum horizontal resolution.

21. A method for transmitting a facsimile message to one or more of a plurality of facsimile selective call receivers each capable of decompressing a facsimile message on the basis of a facsimile codebook which is optimized for an image of a predetermined resolution, the method comprising steps of:

comparing the resolution of the image of the facsimile message with the resolution of the codebook;

determining the number of subimages for segmenting the image of the facsimile message if the resolution of the image of the facsimile message is greater than the resolution of the codebook, and if resolution of the image of the facsimile message is less than or equal to the resolution of the codebook, compressing the image of the facsimile message on the basis of the codebook;

segmenting the image of the facsimile message into the number of subimages determined by said determining step;

separately compressing each subimage on the basis of said codebook to generate a compressed subimage for each subimage; and

generating a paging signal including information representative of the plurality of compressed subimages and the number of subimages;

receiving the paging signal at one or more of the facsimile selective call receivers;

extracting the information representative of the compressed subimages; and

decompressing each compressed subimage on the basis of the codebook.

22. A facsimile selective call receiver for receiving a paging signal including information representative of a plurality of compressed subimages which define an image of a facsimile message, the selective call receiver comprising a processor and a display, the processor extracting the information representative of the compressed subimages and decompressing each compressed subimage on the basis of a codebook for displaying the decompressed subimages on the display.

23. A selective call terminal for connection to a communications network and having a selective call terminal processor, a base station for transmitting a paging signal to one or more of a plurality of selective call receivers, the selective call terminal receiving a facsimile message from a party desiring to transmit the facsimile message to a particular selective call receiver and an identifier of the particular selective call receiver, the selective call terminal processor segmenting an image of the facsimile message into a plurality of subimages and separately decompressing each subimage on the basis of a facsimile codebook, decoding the identifier to determine an address of the particular selective call receiver designated to receive the fax message, and generating a paging signal including information representing the compressed subimages.

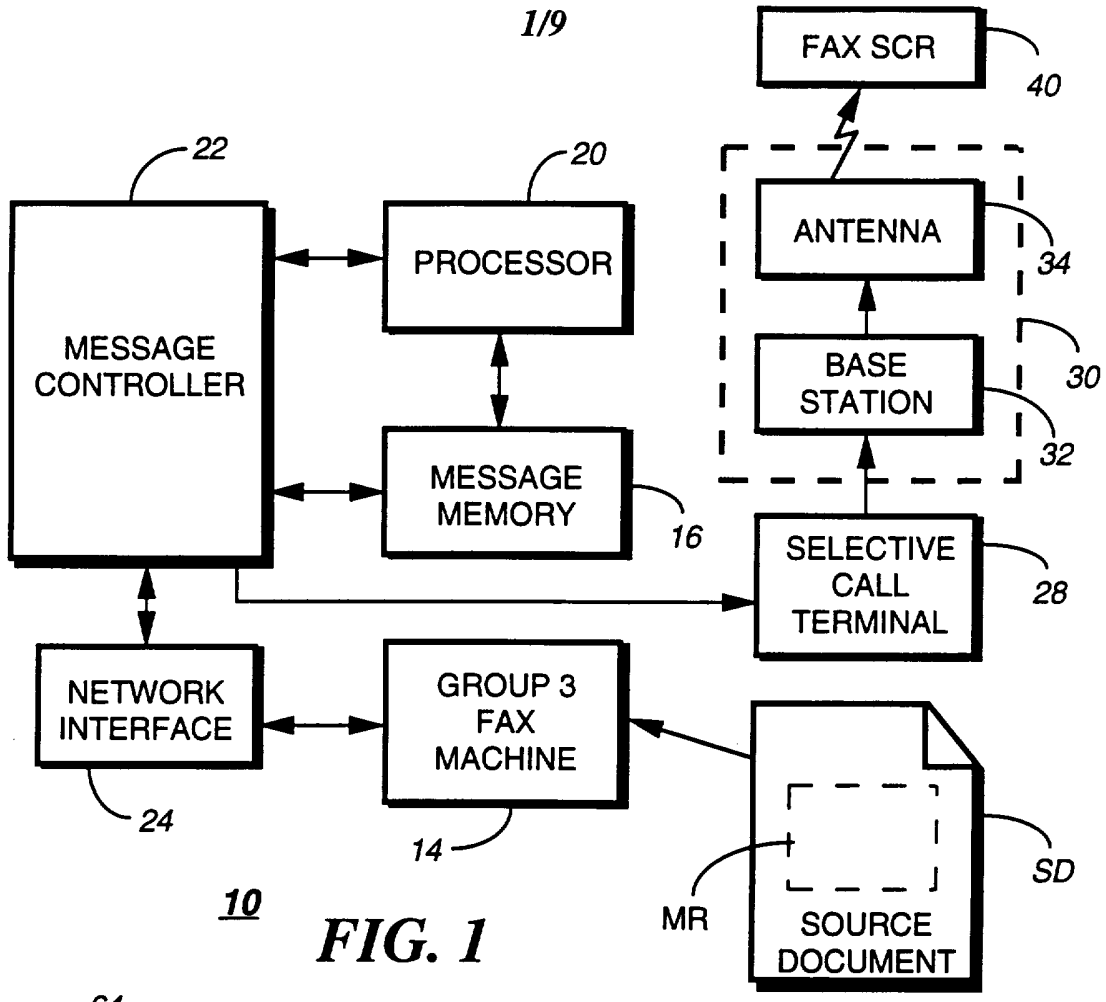

FAX SCR
40
22
20
ANTENNA
34
PROCESSOR
MESSAGE CONTROLLER
BASE STATION
30
32
MESSAGE MEMORY
16
SELECTIVE CALL TERMINAL
28
NETWORK INTERFACE
24
GROUP 3 FAX MACHINE
14
SD
MR
SOURCE DOCUMENT
10

FIG. 1

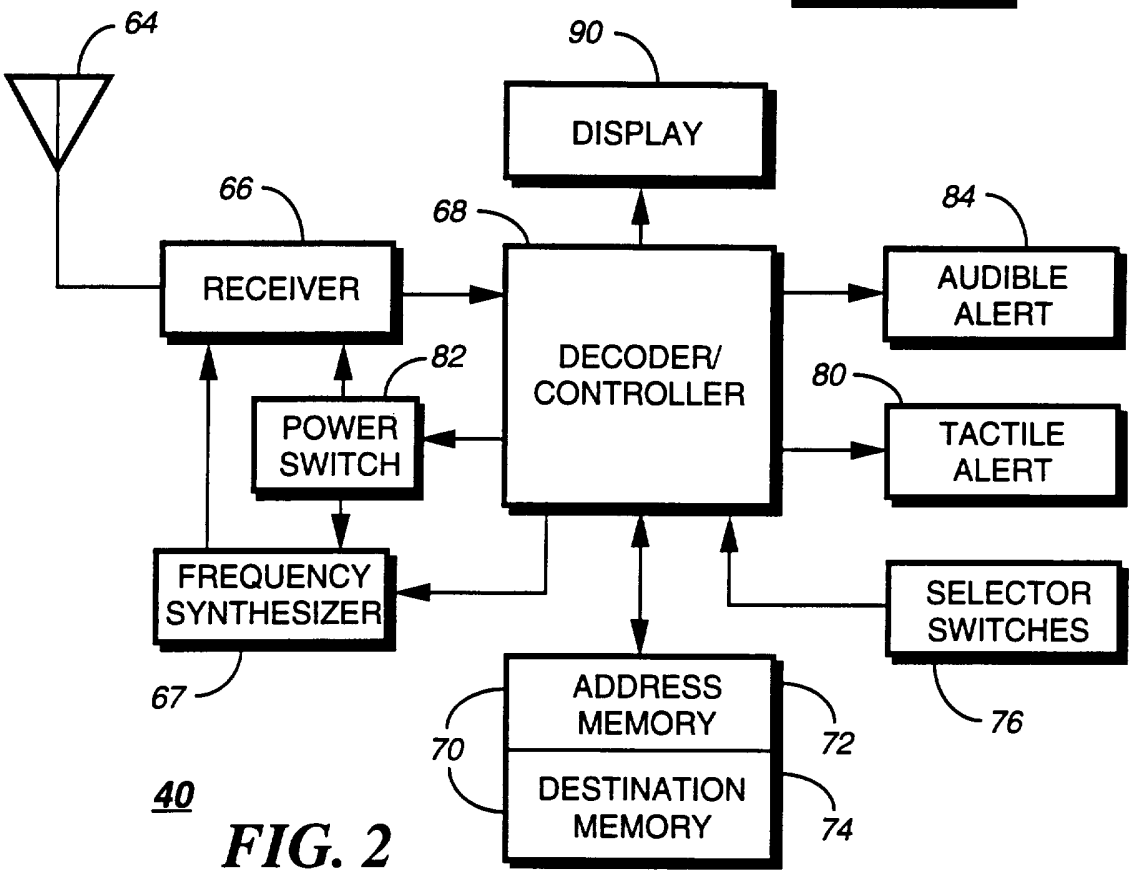

64
90
DISPLAY
66
68
84
RECEIVER
AUDIBLE ALERT
82
DECODER/ CONTROLLER
80
POWER SWITCH
TACTILE ALERT
FREQUENCY SYNTHESIZER
SELECTOR SWITCHES
67
ADDRESS MEMORY
72
76
70
DESTINATION MEMORY
74
40

FIG. 2

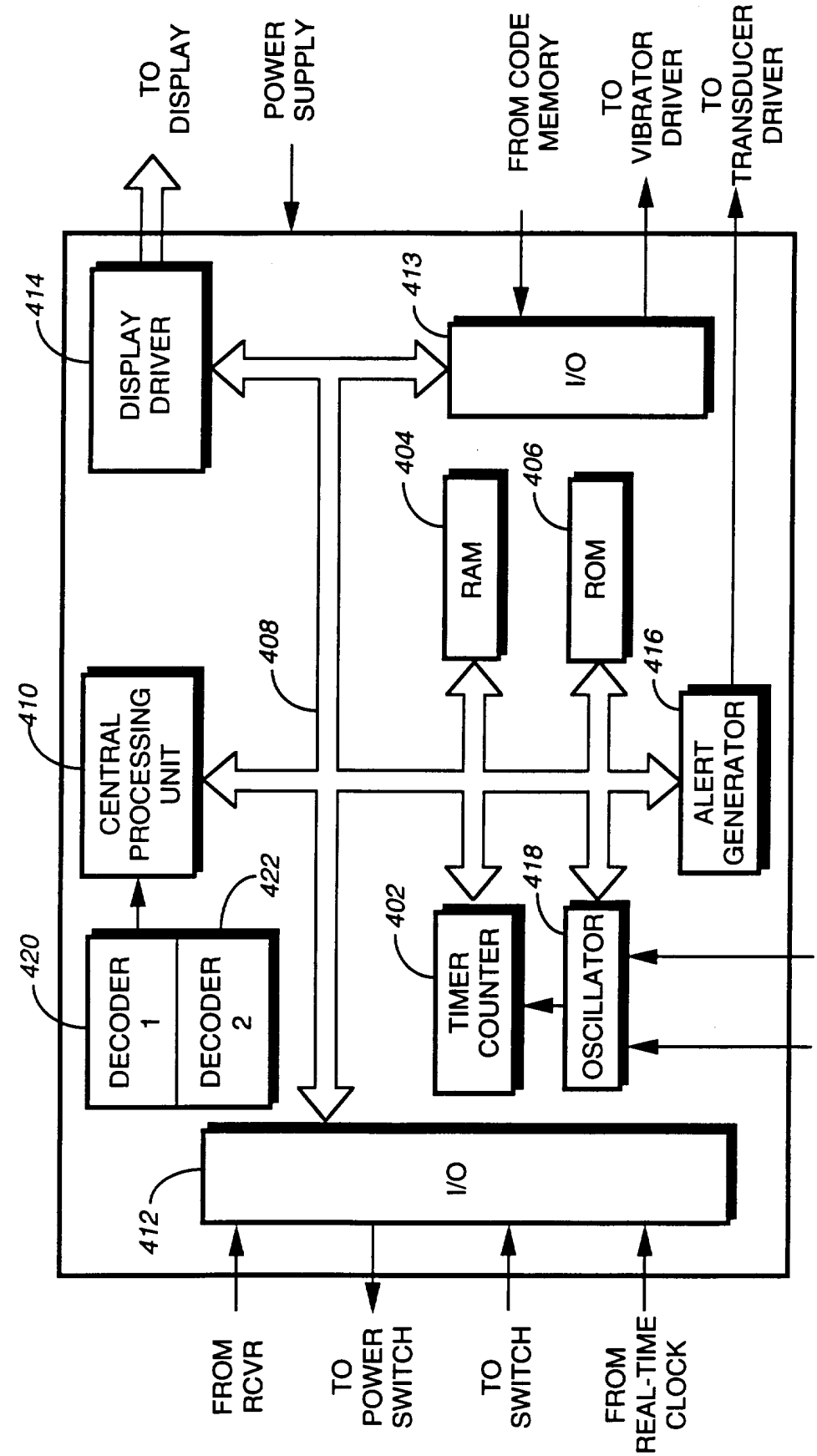

TO DISPLAY
POWER SUPPLY
FROM CODE MEMORY
TO VIBRATOR DRIVER
TO TRANSDUCER DRIVER
414
DISPLAY DRIVER
413
I/O
404
RAM
406
ROM
408
410
CENTRAL PROCESSING UNIT
416
ALERT GENERATOR
422
420
DECODER 1
DECODER 2
402
TIMER COUNTER
418
OSCILLATOR
CRYSTAL
412
I/O
FROM RCVR
TO POWER SWITCH
TO SWITCH
FROM REAL-TIME CLOCK
68

FIG. 3

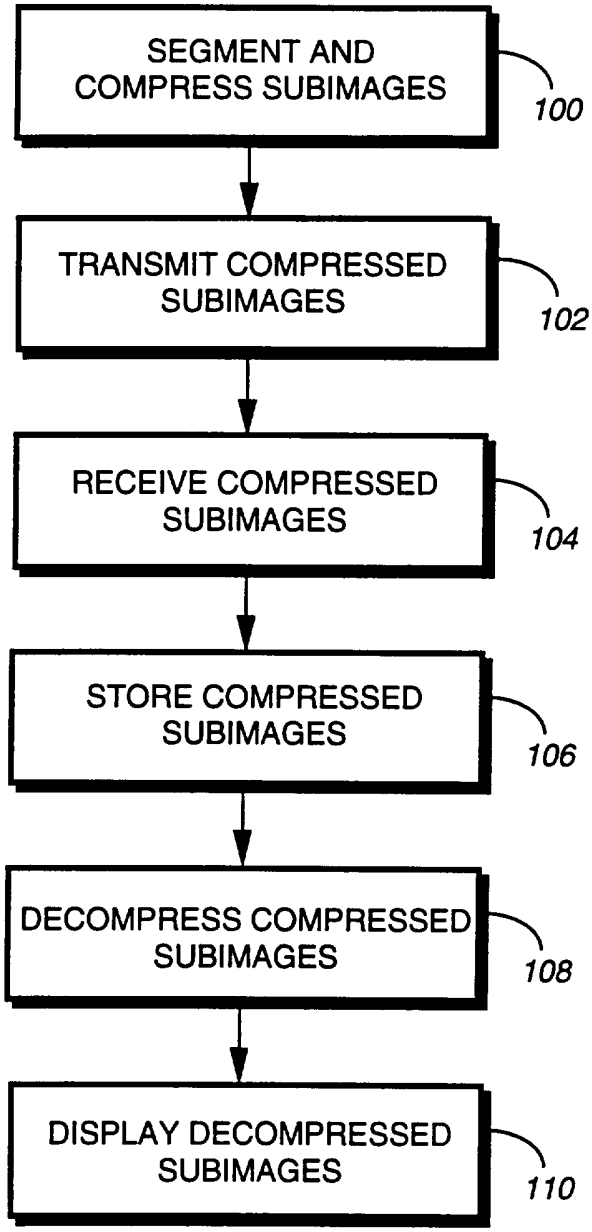

SEGMENT AND COMPRESS SUBIMAGES
100
TRANSMIT COMPRESSED SUBIMAGES
102
RECEIVE COMPRESSED SUBIMAGES
104
STORE COMPRESSED SUBIMAGES
106
DECOMPRESS COMPRESSED SUBIMAGES
108
DISPLAY DECOMPRESSED SUBIMAGES
110

FIG. 4

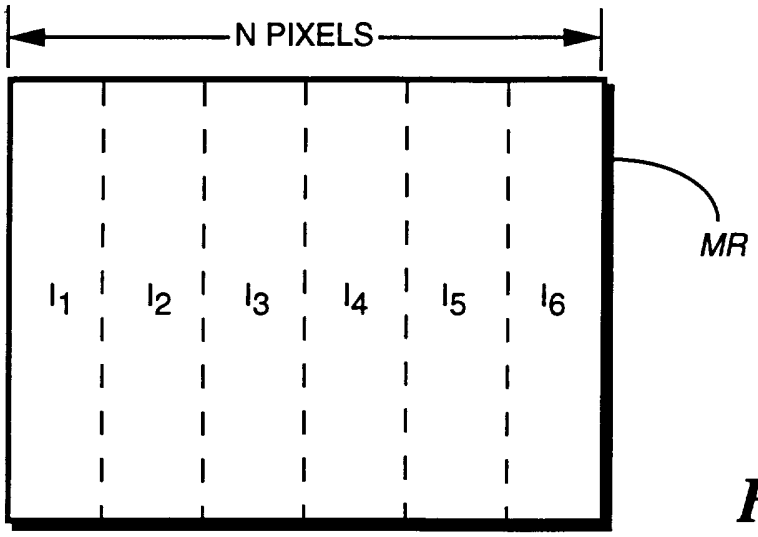

N PIXELS
MR
I1
I2
I3
I4
I5
I6

FIG. 5

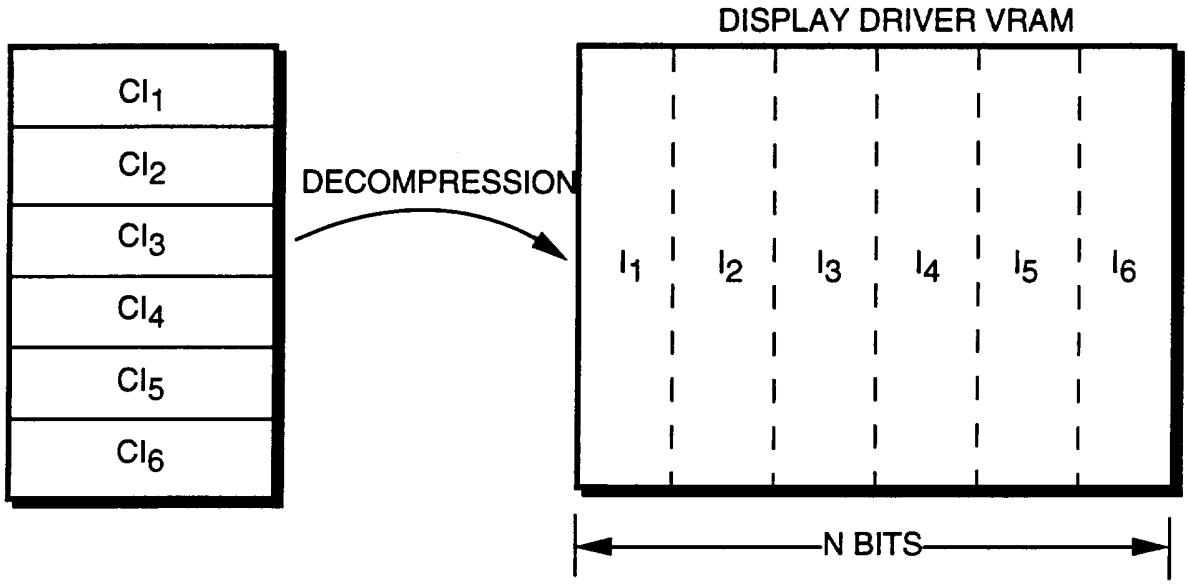

DISPLAY DRIVER VRAM
CI1
CI2
CI3
CI4
CI5
CI6
DECOMPRESSION
I1
I2
I3
I4
I5
I6
N BITS

FIG. 6

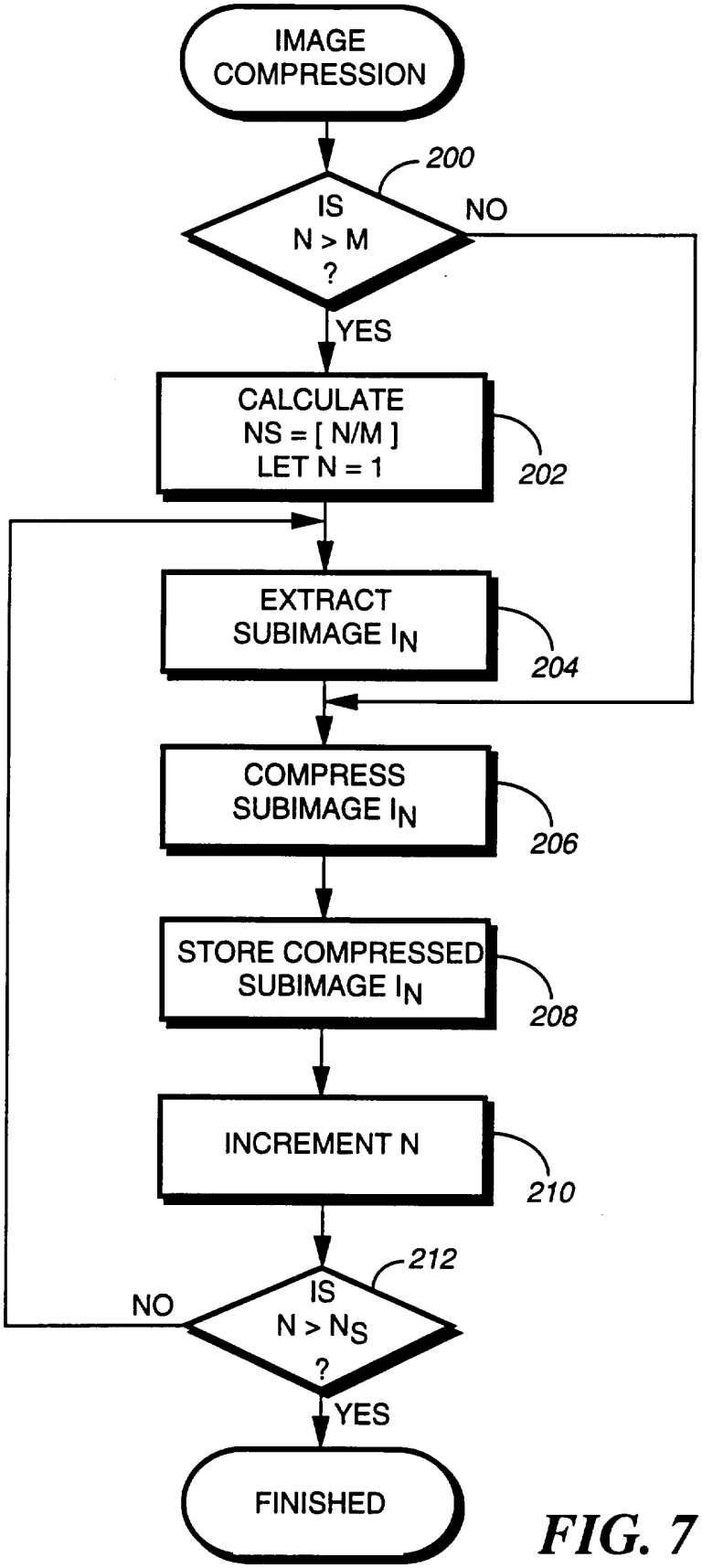

IMAGE COMPRESSION
200
IS N > M ?
NO
YES
CALCULATE NS = [N/M] LET N = 1
202
EXTRACT SUBIMAGE I_N
204
COMPRESS SUBIMAGE I_N
206
STORE COMPRESSED SUBIMAGE I_N
208
INCREMENT N
210
212
IS N > N_S ?
NO
YES
FINISHED

FIG. 7

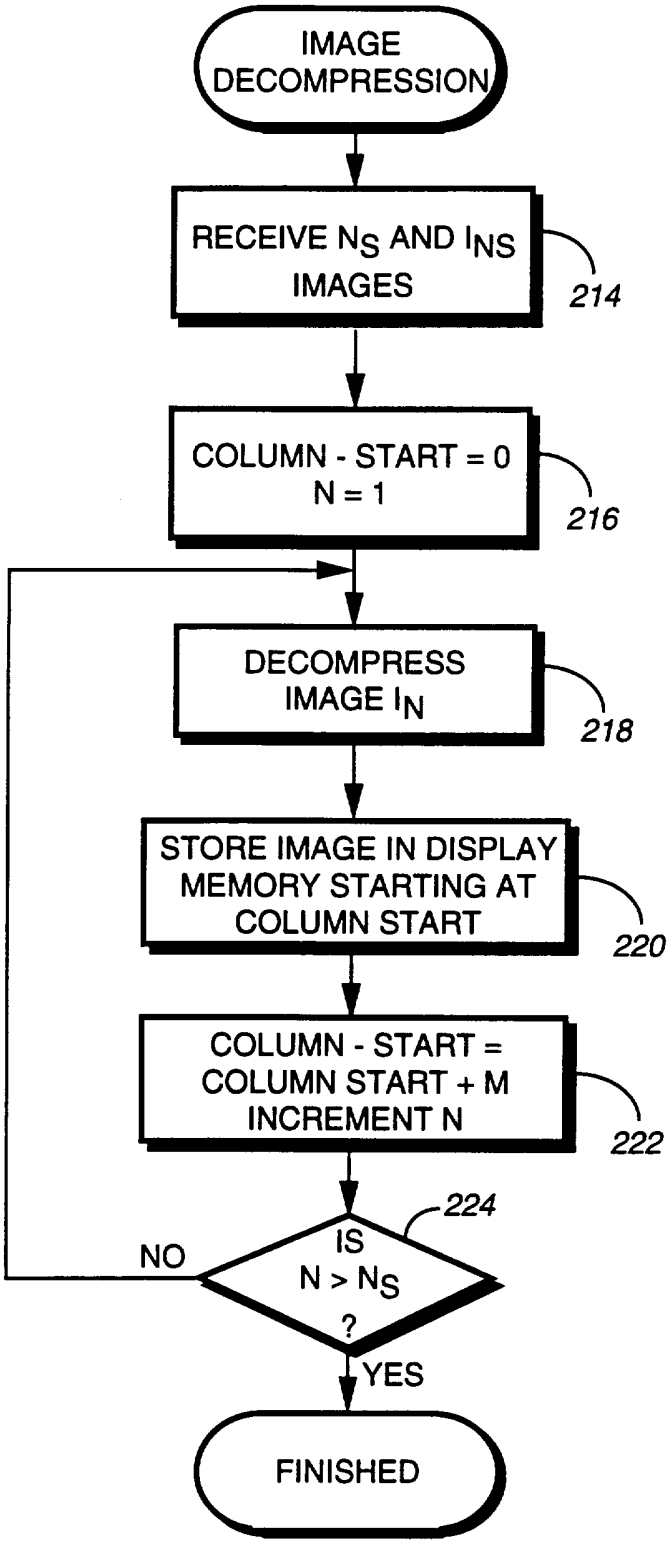

IMAGE DECOMPRESSION
RECEIVE N_S AND I_{NS} IMAGES
214
COLUMN - START = 0
N = 1
216
DECOMPRESS IMAGE I_N
218
STORE IMAGE IN DISPLAY MEMORY STARTING AT COLUMN START
220
COLUMN - START = COLUMN START + M
INCREMENT N
222
224
IS $N > N_S$?
NO
YES
FINISHED

FIG. 8

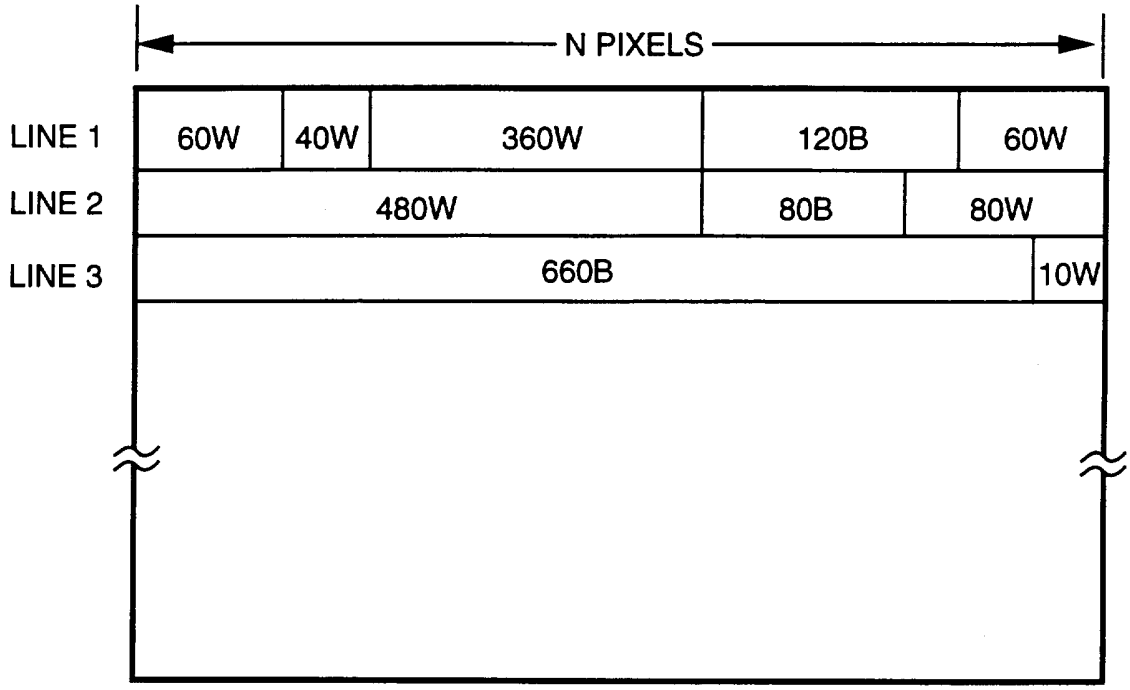

N PIXELS
LINE 1
LINE 2
LINE 3
60W
40W
360W
120B
60W
480W
80B
80W
660B
10W

FIG. 9

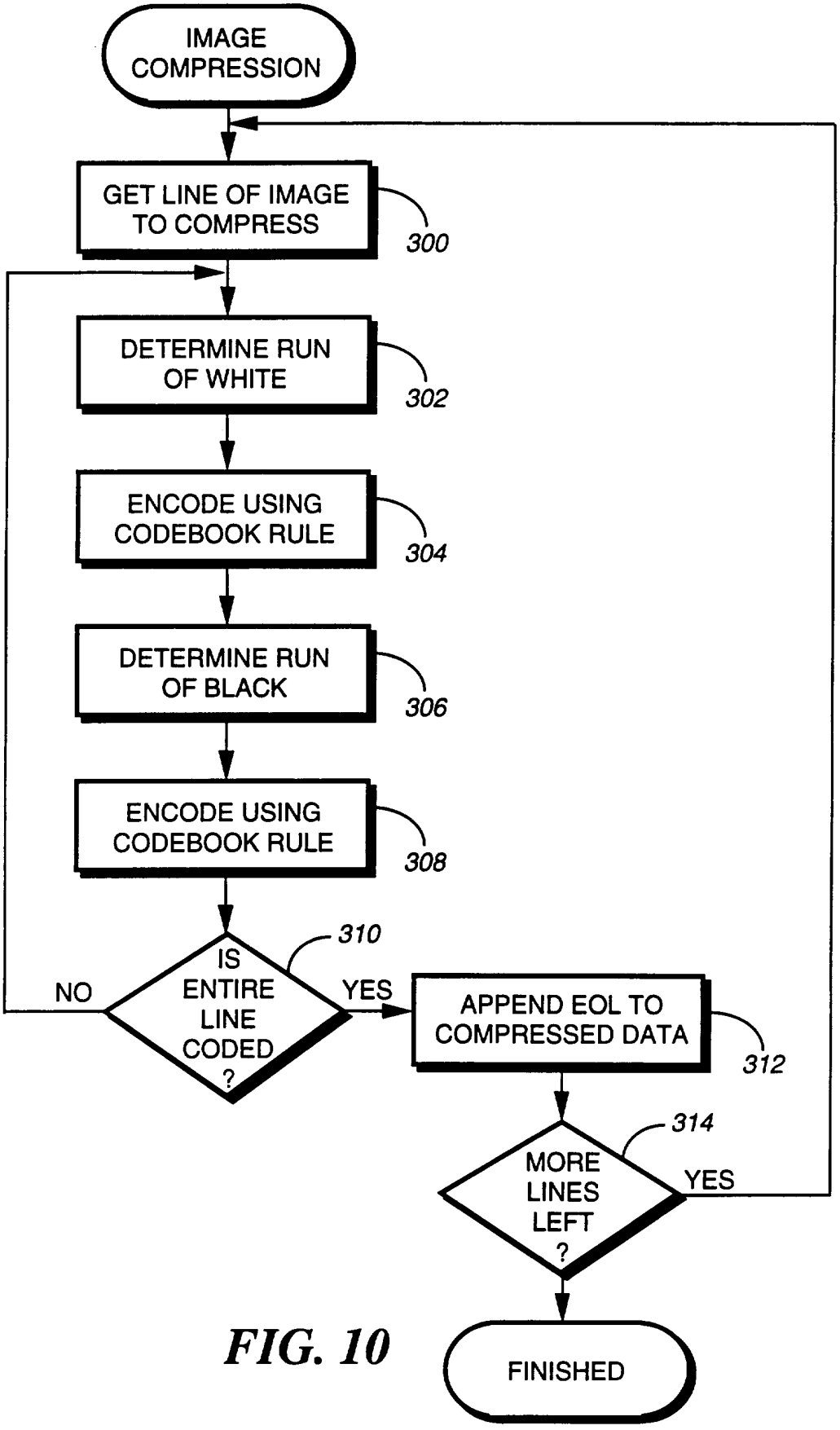

IMAGE COMPRESSION
GET LINE OF IMAGE TO COMPRESS
300
DETERMINE RUN OF WHITE
302
ENCODE USING CODEBOOK RULE
304
DETERMINE RUN OF BLACK
306
ENCODE USING CODEBOOK RULE
308
310
IS ENTIRE LINE CODED ?
NO
YES
APPEND EOL TO COMPRESSED DATA
312
314
MORE LINES LEFT ?
YES
FINISHED

FIG. 10

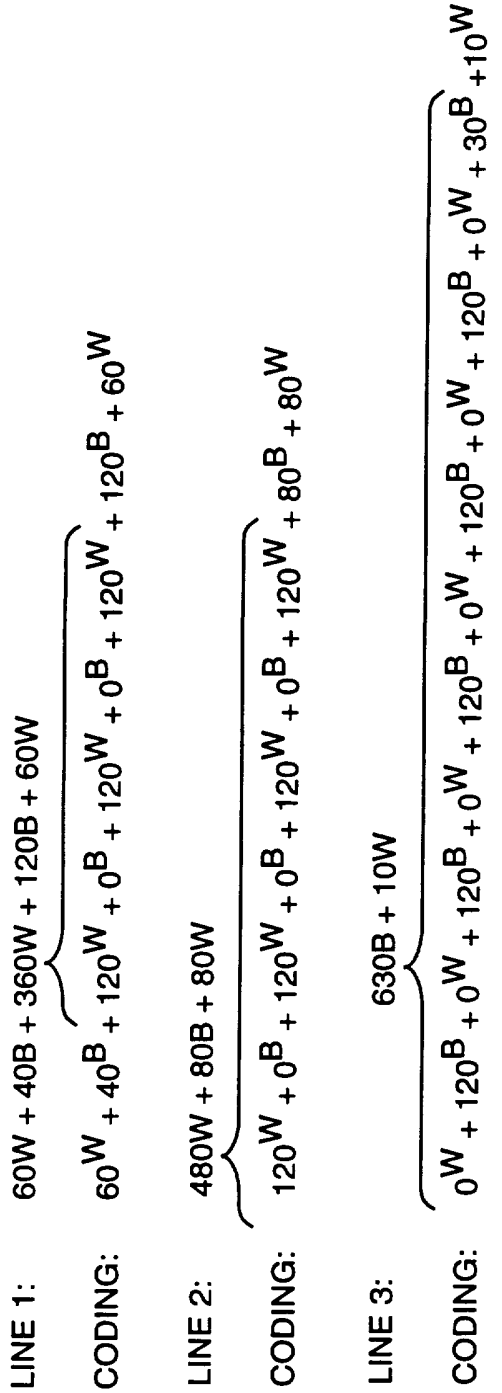

LINE 1: 60W + 40B + 360W + 120B + 60W
CODING: 60W + 40B + 120W + 0B + 120W + 0B + 120W + 120B + 60W
LINE 2: 480W + 80B + 80W
CODING: 120W + 0B + 120W + 0B + 120W + 0B + 120W + 80B + 80W
LINE 3: 630B + 10W
CODING: 0W + 120B + 0W + 120B + 0W + 120B + 0W + 120B + 0W + 120B + 0W + 30B +10W

FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/10567

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04N 1/387
US CL :358/453

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)

U.S. : Please See Extra Sheet.

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 practicable, search terms used)

APS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y, P	US, A, 5,398,115 (Lin et al) 14 March 1995, see col. 3, line 29 - col. 4, line 20; col. 5, lines 48-58; col. 8, lines 48-64; col. 10, line 43 - col. 11, line 11.	1-20, 22, 23
Y	US, A, 5,331,425 (Ozaki et al) 19 July 1994, see Abstract, Fig. 1.	1-20, 22, 23
Y	US, A, 4,058,672 (Crager et al) 15 November 1977, see Fig. 19.	2-4

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"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
"A"	document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"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
"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)	"&"	document member of the same patent family
"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		

Date of the actual completion of the international search 10 OCTOBER 1995	Date of mailing of the international search report 20 DEC 1995
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer THOMAS D. LEE Telephone No. (703)305-4870

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/10567

B. FIELDS SEARCHED
Minimum documentation searched
Classification System: U.S.

358/453, 400, 403, 407, 426, 261.1, 427, 433, 442, 444, 448; 340/825.44; 382/173, 232, 233, 245, 246; 379/57, 58; 455/31.1, 38.4