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None

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INT CL[4] H04B, H04Q

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(54) Decoding arrangements

(57) The total number of addresses available in, for example, a paging system can be increased by including an extended address portion in one or more message words following an address word, the full address for each pager being made up of a basic address portion (in the address word) and the extended address portion (in part of the message word or words).

Once the basic address has been detected by a basic address decoder 18, the address word is checked for an indication that a message word is to follow. If so, the message is decoded by a message decoder 20, and the extended address is sought by an extended address decoder 22. If the required extended address is detected, an audible alert is provided and/or the message content of the message word(s) is displayed.

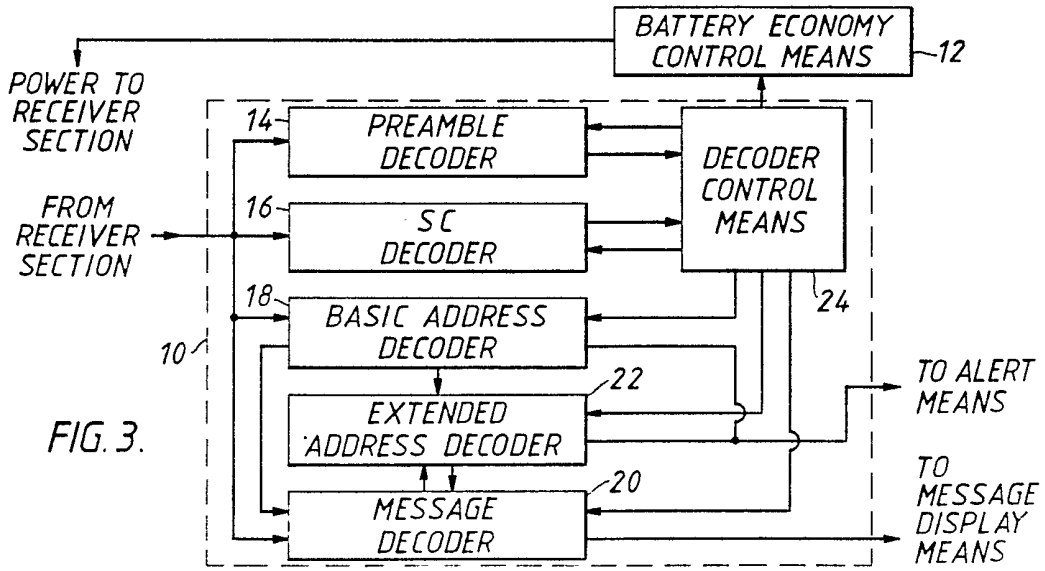

FIG. 3.

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FIG.1.

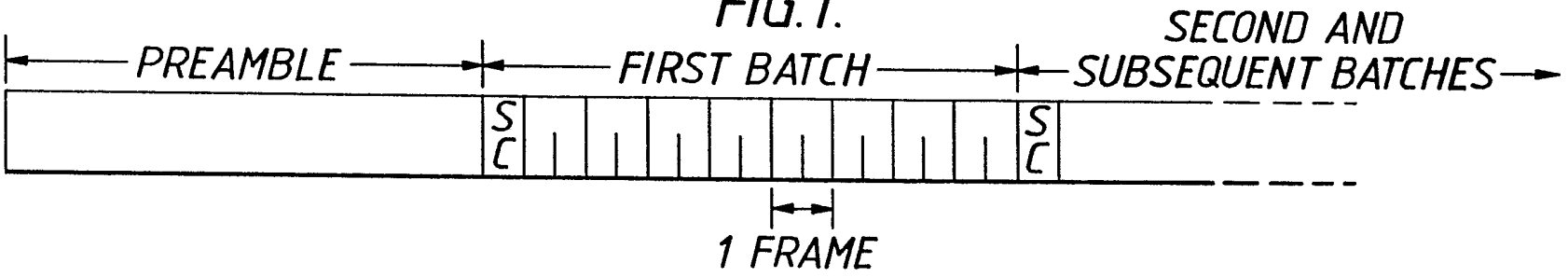


FIG.2A.

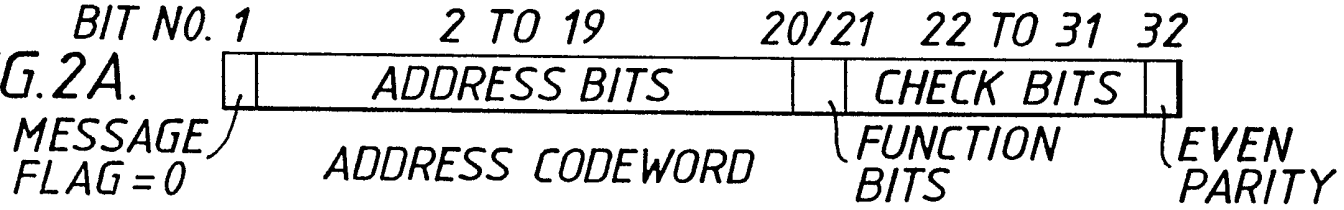
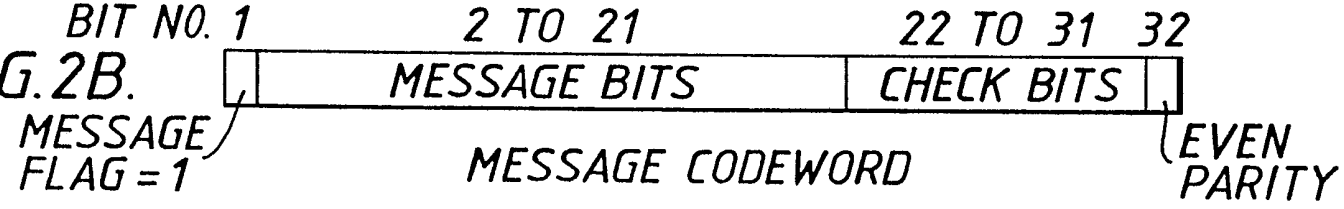


FIG.2B.



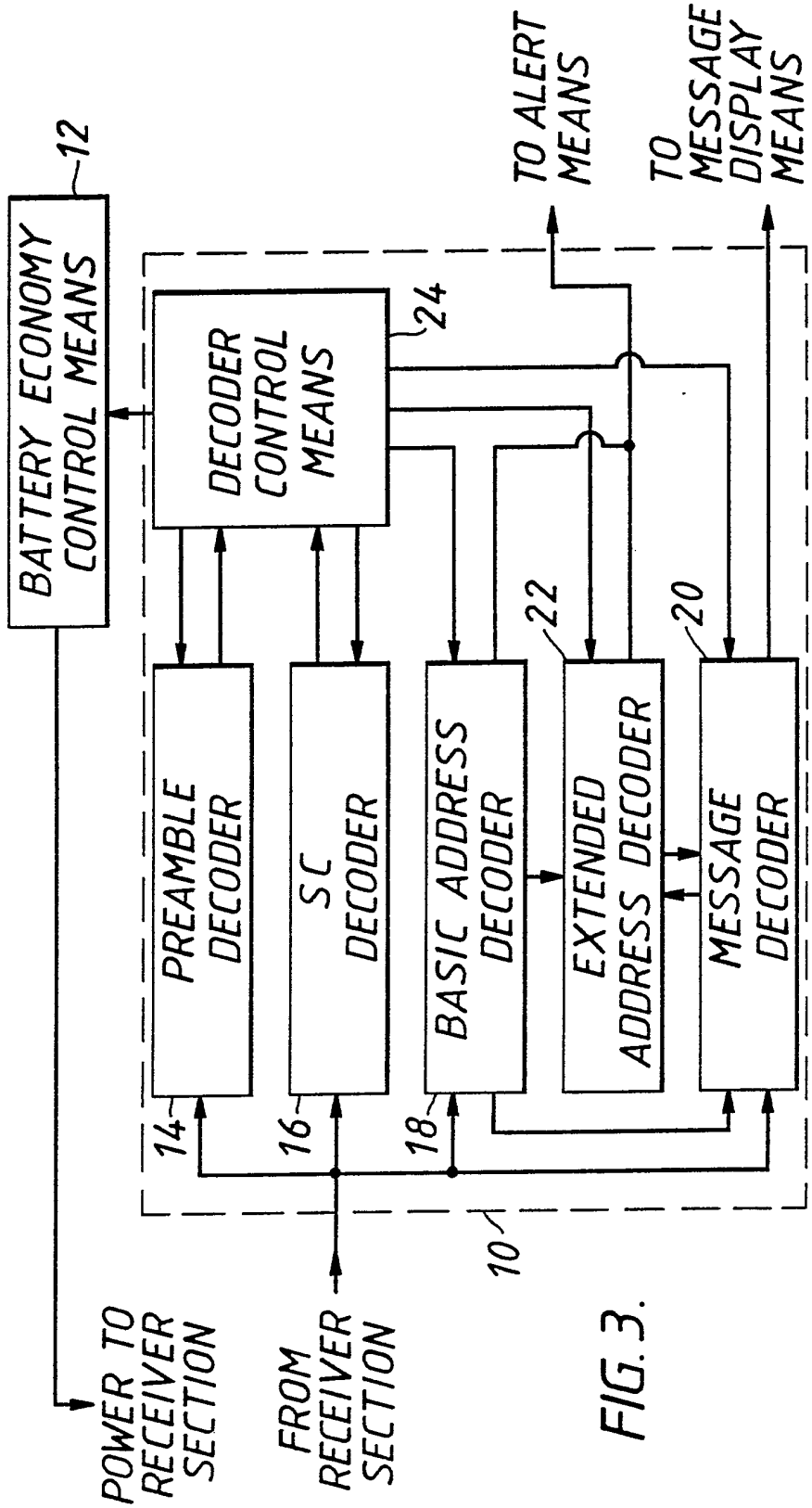

BATTERY ECONOMY CONTROL MEANS
12
DECODER CONTROL MEANS
24
TO ALERT MEANS
TO MESSAGE DISPLAY MEANS
PREAMBLE DECODER
SC DECODER
BASIC ADDRESS DECODER
EXTENDED ADDRESS DECODER
MESSAGE DECODER
14
16
18
22
20
10
POWER TO RECEIVER SECTION
FROM RECEIVER SECTION

FIG. 3.

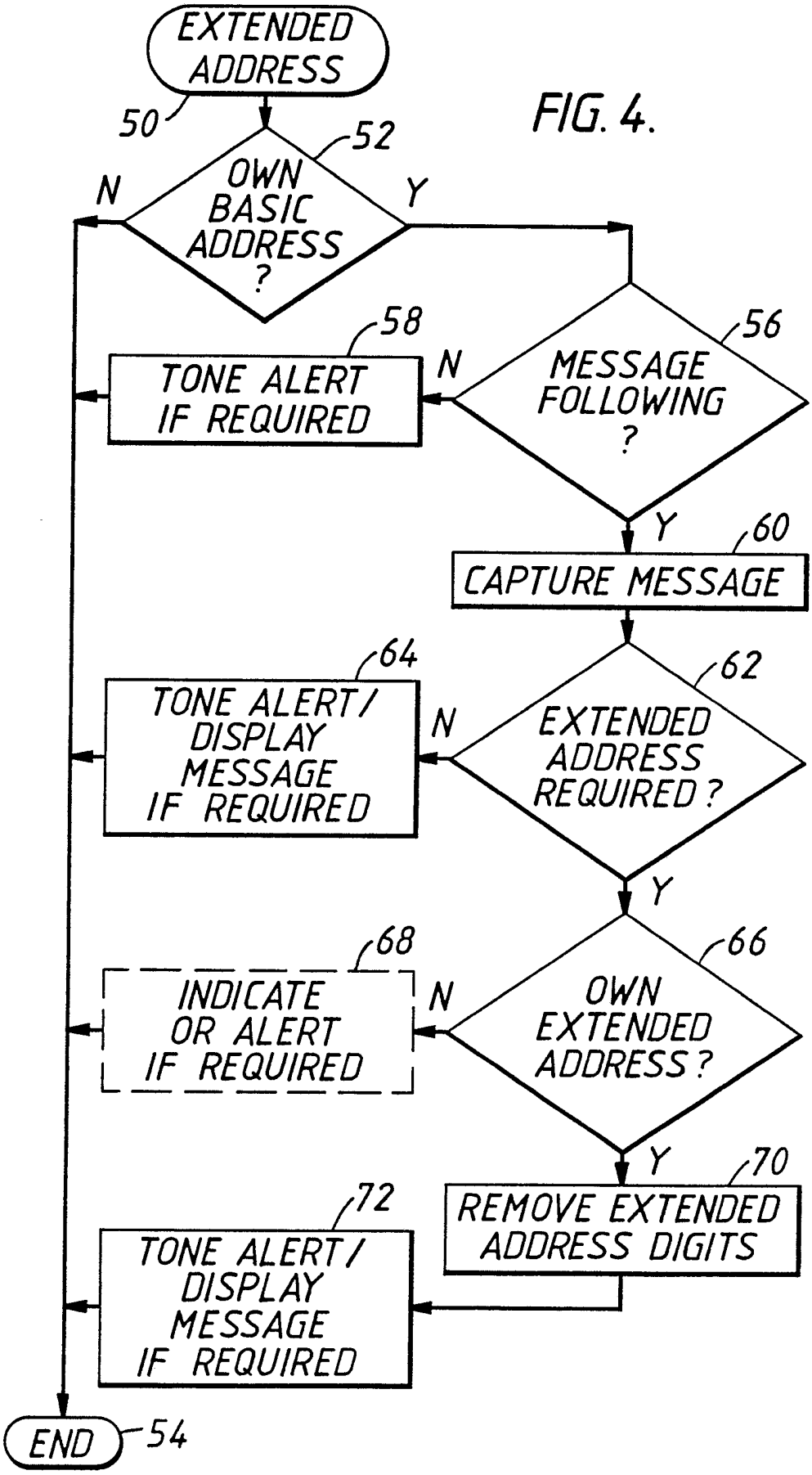

EXTENDED ADDRESS
50
52
OWN BASIC ADDRESS ?
N
Y
56
MESSAGE FOLLOWING ?
58
TONE ALERT IF REQUIRED
N
Y
60
CAPTURE MESSAGE
62
EXTENDED ADDRESS REQUIRED ?
64
TONE ALERT/ DISPLAY MESSAGE IF REQUIRED
N
Y
66
OWN EXTENDED ADDRESS ?
68
INDICATE OR ALERT IF REQUIRED
N
Y
70
REMOVE EXTENDED ADDRESS DIGITS
72
TONE ALERT/ DISPLAY MESSAGE IF REQUIRED
END
54

FIG. 4.

FIG.5.

EXTENDED ADDRESS / NUMERIC MESSAGE WORD

	BCD CHARACTER 'E'	BCD CHARACTER 'E'	1ST BCD MESSAGE NUMERAL	2ND BCD MESSAGE NUMERAL	3RD BCD MESSAGE NUMERAL		

NUMERIC MESSAGE TRANSMITTED TO A GROUP OF 100 PAGERS

FIG.6A.

EXTENDED ADDRESS / NUMERIC MESSAGE WORD

	BCD CHARACTER 'E'	BCD ADDRESS NUMERAL 0-9	1ST BCD MESSAGE NUMERAL	2ND BCD MESSAGE NUMERAL	3RD BCD MESSAGE NUMERAL		

NUMERIC MESSAGE TRANSMITTED TO A SUB-GROUP OF 10 PAGERS

FIG.6B.

EXTENDED ADDRESS / NUMERIC MESSAGE WORD

	BCD ADDRESS NUMERAL 0–9	BCD CHARACTER 'E'	1ST BCD MESSAGE NUMERAL	2ND BCD MESSAGE NUMERAL	3RD BCD MESSAGE NUMERAL		

NUMERIC MESSAGE TRANSMITTED TO A DIFFERENT SUB–GROUP OF 10 PAGERS

FIG.7A.

EXTENDED ADDRESS / NUMERIC MESSAGE WORD

	BCD CHARACTER 'E'	BCD CHARACTER 'E'	BCD ADDRESS NUMERAL 0–9	1ST BCD MESSAGE NUMERAL	2ND BCD MESSAGE NUMERAL		

NUMERIC MESSAGE TRANSMITTED TO 10 GROUPS OF 100 PAGERS

FIG.7B.

EXTENDED ADDRESS / NUMERIC MESSAGE WORD

	BCD ADDRESS NUMERAL 0–9	BCD ADDRESS NUMERAL 0–9	BCD CHARACTER 'E'	1ST BCD MESSAGE NUMERAL	2ND BCD MESSAGE NUMERAL		

NUMERIC MESSAGE TRANSMITTED TO 100 GROUPS OF 10 PAGERS

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DECODING ARRANGEMENTS

This invention relates to decoding arrangements and, more particularly but not exclusively, to decoding arrangements for use in paging receivers or pagers of a radiopaging system.

In radiopaging systems, it is known to send a transmission which comprises a series of predetermined address signals intended for different pagers or groups of pagers. The address signals are generally in the form of specific codewords, typically 32 bit words, and in systems intended for transmission of numeric or alphanumeric characters, the address codewords may be followed by message codewords. Thus, when a pager detects its specific address (or one of its specific addresses, where more than one is provided), it may then detect and decode the message formed by the following message codeword(s). In this type of system, the total number of addresses available is limited by the number of possible address codeword permutations. In a typical system, almost half of each address codeword is taken up with check or parity bits and system flag bits, as a result of which the total number of bits in the address code is further limited, which imposes a corresponding further limitation on the total number of available addresses.

In order to expand the address capacity of a system, it would be possible to enlarge the number of bits in each codeword. However, this would lead to a number of disadvantages and problems, including lack of compatibility with existing equipment and systems.

According to one aspect of the invention there is provided a decoding arrangement for decoding a transmission of codewords including address words and message words, the arrangement comprising:

basic address detection means operative to detect a specific address word in the transmission;

message detection means for detecting when a message word follows the address word detected by the basic address detection means;

message decoding means responsive to detection of a following message word by the message detection means to decode the message word; and

extended address detection means operative to detect an extended address portion in the decoded message word and, upon such detection,

to provide an indication.

According to another aspect of the invention there is provided a method of decoding a transmission of codewords including address words and message words, the method comprising:

detecting a specific address word in the transmission;

detecting when a message word follows the detected address word in the transmission;

decoding the message word following the detected address word;

detecting an extended address portion in the decoded message word; and

providing an indication when the extended address portion is detected.

In a preferred embodiment of the invention, to be described in greater detail hereinafter, the message detection is achieved by checking for the presence of an indication in the detected address word that a message word is to follow. Once this indication has been found, the message word may be decoded and detection of the extended address portion in the message word may be performed.

Thus it is possible to retain the basic code structure and address decoding algorithm by extending the address identity into one or more subsequent message words. Since the complete address is made up of the basic address (in the address word) and an extended address portion (in the subsequent message word or words), the increased address length allows the capacity of paging systems to be enlarged.

Once the paging system capacity has been increased, it becomes possible to provide enhanced features, such as group call facilities (in which a number of pagers within a group can be called simultaneously as well as each pager individually) which could previously only be achieved by limiting still further the total capacity of the system.

The invention will now be further described, by way of illustrative and non-limiting example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic representation of the format of a signal transmitted according to a known system standard;

Figures 2A and 2B respectively show address and message codewords forming part of the signal in Figure 1;

Figure 3 is a block diagram of a decoding arrangement in a pager circuit according to an embodiment of the invention;

Figure 4 is a flow diagram illustrating the operation of the decoding arrangement shown in Figure 3;

Figure 5 shows an extended address/numeric message word format intended for a group of 100 pagers;

Figure 6A shows a format similar to that of Figure 5, but intended for a sub-group of 10 pagers;

Figure 6B shows a format similar to that of Figure 6A, but intended for a different sub-group of 10 pagers;

Figure 7A shows a format similar to that of Figure 5, but suitable for transmission to 10 groups of 100 pagers each; and

Figure 7B shows a format similar to that of Figure 7A, but suitable for transmission to 100 groups of 10 pagers each.

Figure 1 shows the format of a signal transmitted by one or more transmitters in a wide area radiopaging system. The format illustrated is that devised by the British Post Office Code Standardisation Advisory Group (POCSAG). This format is in use in the UK and other countries and widely becoming accepted as an international standard. For fuller details, reference should be made to "A Standard Code for Radiopaging - a Report of the Studies of the British Post Office Code Standardisation Advisory Group (POCSAG)", published 1978 by British Telecom (then part of the British Post Office). For present purposes, it should be noted that the signal format comprises a series of address signals for individual pagers using the system. The series of address signals is assembled in accordance with requests and transmitted as a continuous transmission. The transmission is of digital format and starts with a preamble which has a duration of at least 576 bits, equivalent to the duration of one batch (see below) and at least one codeword (see below). The preamble is followed by one or more batches of codewords. Each batch begins with a synchronisation codeword (SC) and is followed by eight "frames" each having a duration equivalent to two codewords. (Thus, each batch has a duration equivalent to one synchronisation codeword plus eight frames, namely seventeen codewords.) Transmission of the signal ceases at the end of a batch.

In more detail, the preamble comprises a pattern of reversals, i.e. the bits 101010...., repeated for a period of at least 576 bits.

The intention of the preamble is to permit the pagers to attain bit synchronisation and to prepare them to acquire word synchronisation. Codewords are then transmitted in batches, each of which comprises a synchronisation codeword SC followed by eight frames each containing two codewords, such as an address codeword and a message codeword. Alternatively, the two codewords in a frame might both be address codewords, or message codewords, or one or more idle words, or any combination of these. The pagers of the system are each allocated a specific one of the eight frames and will examine only address codewords in that frame. Each pager has one or more predetermined address codewords stored therein and such address codeword(s) will only be transmitted in the frame allocated to the associated pager.

In addition to the provision of an audible alert facility, which is satisfied by the transmission of the address codeword only for that pager, the POCSAG system includes provision for the transmission also of messages in the form of message codewords that can indicate a numeric or alphanumeric message which can be displayed by the pager. Message codewords for any pager may be transmitted in any frame but will follow directly the associated address codeword. A message may comprise any number of codewords transmitted consecutively and may embrace one or more batches, but the synchronisation codeword SC must not be displaced by message codewords or by an "idle" codeword. In any frame, an idle codeword is transmitted whenever there is no address codeword or message codeword to be transmitted.

Each synchronisation codeword is of a standard bit pattern and all pagers are capable of recognising its receipt. Each address codeword is specific only to one particular pager and comprises a pattern of bits denoting the address together with check bits. Message codewords similarly comprise a bit pattern together with check bits. Address and message codewords commence with respective different flag bits so that they can mutually be distinguished. The framing rules of the code format do not apply to a message and message codewords continue until terminated by the transmission of the next address codeword or idle codeword or end of batch. Each message displaces at least one address codeword or idle codeword and the displaced address codewords will be delayed and transmitted in the next available appropriate frame. Although, therefore, message codewords may continue

into the next batch, the normal batch structure will be maintained in that each batch will comprise sixteen codewords preceded by a synchronisation codeword SC.

Figures 2A and 2B provide further details of the address codeword format and the message codeword format, respectively. Both address and message codewords each contain 32 bits with the most significant bit (MSB) being transmitted first.

From Figure 2A, it will be seen that bit 1 of an address codeword is always a zero. This acts as an address flag (message flag = 0) and distinguishes address codewords from message codewords. Bits 2 to 19 are address bits corresponding to the 18 MSBs of a 21-bit identity assigned to each pager. The three least significant bits (LSBs) of this identity are not transmitted but serve to define the frame in which the address codeword is to be transmitted. The three LSBs provide eight possible combinations and, as stated above, there are eight frames of which pagers are each allocated a specific one. Since each pager has a 21-bit identity, the total number of identities, which may be called the radio identity codes (RICs), is 2^{21}, namely 2,097,152. Bits 20 and 21 are termed function bits, and these may be used to select the required address from four addresses assigned to each pager. Hence, the total number of addresses is 2^{23}, namely 8,388,608. Bits 22 to 31 are check bits, and bit 32 (the final bit) is selected to give even parity.

From Figure 2B, it will be seen that bit 1 of a message codeword is always a one. This bit constitutes the message flag. The complete message follows directly after the corresponding address codeword. Since the framing rules of the code format do not apply to messages, message codewords will continue within each batch until they are either terminated by the next address codeword or idle codeword, or the next synchronisation codeword SC is to be transmitted. Bits 2 to 21 of each message codeword are message bits, and bits 22 to 31 are check bits with bit 32 being selected to give even parity as with the address codewords. The twenty available message bits within each codeword can be utilised as follows. In a numeric-only message format, there are four bits per character; these will provide the decimal numerals with six spare characters remaining which may typically be used to define spaces, hyphens, opening and closing brackets, and an urgency symbol

(U); accordingly, it is possible to fit five such 4-bit characters into each codeword. In an alphanumeric or general data message format, in accordance with the ISO 7-bit coded or ASCII character set, providing full alphanumeric and other symbols, there are seven bits per character. The complete message is partitioned into contiguous 20-bit blocks so as to fill consecutive message codewords. Thus a character may be split between one message codeword and the next.

The function bits in the address codeword define the type of message, if any, which will follow.

Pagers capable of responding to a POCSAG format transmission operate as follows. The receiver section of each pager is switched on at intervals defined by a battery economy control circuit. If preamble is detected, the pager is bit-synchronised by the preamble and the receiver section remains switched on until a synchronisation codeword SC is detected and the pager attains word-synchronisation. The receiver section is then switched off until a timer detects that the specific frame for the pager is about to commence, whereupon the receiver section is again switched on for address detection. If the pager's address is detected, the receiver section remains switched on for reception of any following message. If the address is not detected, the receiver section is switched off until the corresponding frame in the next batch, in general having also been switched on for the duration of the intervening synchronisation word SC for maintaining word synchronisation.

As discussed above, in any specific paging system using the POCSAG format, the total number of RICs is limited to just over 2 million, and the total number of addresses (each pager having a maximum of four defined by the function bits in the address codeword) is somewhat over 8 million. In cases where this number is insufficient, the solution proposed by the present invention involves retaining the basic code structure and address decoding algorithm by extending the address identity into one or more subsequent message words.

Referring to Figure 3, part of a pager circuit is shown including a decoder section 10 and a battery economy control means 12. The decoder section 10 includes a preamble decoder 14, a synchronisation codeword (SC) decoder 16, a basic address decoder 18, and a message decoder 20, each arranged to receive the demodulated output from the

receiver section of the pager. An extended address decoder 22 receives an output from the message decoder 20. The decoders 14, 16, 18, 20 and 22 are controlled by a decoder control means 24 and are respectively operative to detect the preamble signal of a transmission, synchronisation codewords in the transmission, the basic address of the associated pager, any message codewords which are transmitted for that particular pager, and (if appropriate) the extended address of the pager. Outputs from the message decoder 20 and the extended address decoder 22 are connected to an alert means (not shown), and an output from the message decoder 20 is connected to a message display means (not shown).

The battery economy control means 12 responds to the decoder control means 24 of the decoder section 10 to supply power selectively to the receiver section, in order to effect battery saving.

The operation of the pager circuit shown in Figure 3 will now be described with reference to the flow diagram of Figure 4, in the situation that the extended address received by the pager consists of the basic POCSAG address (formed by the address codeword) and an extended address part, in this example, of two characters (formed by the first two characters in the message codeword immediately following the address codeword).

Referring to Figure 4, a transmission is received, preamble is detected (by the preamble decoder 14 of Figure 3), the synchronisation codeword is detected (by the SC decoder 16 of Figure 3) and the address detection process begins at a step 50. As in the standard POCSAG technique, the decoder control means 24 causes the battery economy control means 12 to switch off power to the receiver section until the particular pager's allocated frame is reached, whereupon the receiver section is switched on again, and the basic address decoder 18 checks in a step 52 whether the received address codeword is the pager's basic address (in other words that part of the address included in the address codeword). If not, the process ends in a step 54, reverting in general to further seeking of synchronisation words and then address searching in the corresponding frame of subsequent batches. If the received address codeword is the pager's basic address, the message decoder 20 checks in a step 56 whether a message codeword follows. Having determined that the received address codeword is the pager's

basic address and that the function bits are those associated with a message, in the step 56, then the message is captured and decoded in a step 60. If the function bits are not associated with a message, then the pager may, if required, generate a tone alert in a step 58. If a message has been captured in the step 60, a check is then made in a step 62 whether the extended address is required. The result of this check is generally dependent on the pager's programming. If the extended address is not required, a step 64 causes the tone alert to be provided, or the message to be displayed if required, and then the process ends with the step 54. If the extended address is required in the step 62, the extended address decoder 22 checks in a step 66 whether the first two characters of the captured message in the message decoder 20 represent the pager's own extended address part. If not, an indication or alert to this effect may optionally be provided in a step 68; however, if the extended address check in the step 66 is positive, a step 70 removes the extended address characters from the message codeword, and the remaining part of the message codeword (together with any subsequent message codewords) is supplied from the message decoder 20 to the message display means, if required, and a tone alert is provided by the alert means, in a step 72. The process then ends at the step 54.

Thus it will be apparent that, if extended address detection is required, the pager first checks for its basic address in the received address codeword, and then, assuming that the check is positive and also that a message codeword follows, checks a predetermined part of the message codeword for the extended part of its address. If the full address is detected as a result of the two comparisons, an appropriate alert is provided and/or the message is displayed, after the extended address part of the message codeword has been removed since this is not required for display.

In the above example, it has been assumed that the extended address includes two characters in the message codeword. However, the extended address may consist of any number of characters, from one upwards, depending on the desired extent of increased capacity of the paging system. As described above, the characters may be either 4-bit numeric-only or 7-bit alphanumeric characters. For numeric-only decimal characters, each character used for the extended address will

increase the address capacity tenfold.

Paging systems embodying the present invention may have further advantageous features. For example, the only means by which standard POCSAG receivers can provide group or team calling (in which a number of pagers constituting a predetermined group can be called simultaneously) is by sacrificing one of the four possible addresses contained within the RIC, that address then constituting the group address common to all receivers in that group. Extended address techniques can provide this group calling facility without such loss. Assuming the use of two extended address characters, a group of 100 users may be called simultaneously by transmitting a predetermined character in both positions. Referring to Figure 5, it will be seen that the hexadecimal character 'E', which is one of the unused BCD combinations of the 4-bit numeric-only code, is used for this purpose, by way of example. In this case, it is then possible to select sub-groups of ten from the main group of 100 by transmitting the predetermined character, such as the character 'E', in either the first or second character positions. Pagers must then be capable of responding not only to their individual addresses but also to the presence of the character "E" in the specific selected character position or positions. In Figure 6A, the character 'E' is in the first position, and this will define a first sub-group of ten pagers. In Figure 6B, the character 'E' is in the second position, and this will define a second sub-group of ten pagers. All pagers with the same decimal character in the other position will be alerted. This feature can be used in an expanded way by introducing more characters into the address extension. For example, in Figure 7A, there is shown an example of a numeric message transmitted to ten groups of 100 pagers; in Figure 7B, a similar message is shown but for transmission to 100 groups of ten pagers.

Standard POCSAG pagers having more than one RIC are likely to have these assigned to different frames unless particular care is taken in allocation of frames within the paging system. Since such a pager then has to be switched on several times in each batch (at the different frames), this leads to a reduction in battery life. Using the extended address technique, the pager is then automatically assigned to a single frame.

In situations where the number of telephone lines which can be allocated to the paging system is limited, then address extension can expand the capacity of the system. The address extension facility can also provide information extension. The source of a call, the length of a message, its type or class, may be identified by the receiver. Where the receiver has inherent capability for reprogramming of its address and user options these may also be enabled or disabled by means of this facility.

Although the embodiment of the invention described above with reference to Figure 3 includes separate circuit blocks for decoding different portions of the received transmission, the invention may be embodied by a suitably-programmed microprocessor providing the decoding and control functions.

The code format described above is a POCSAG-type format. However, the invention can be applied to any other code format in which address words are followed by message or other data-carrying words into which an extended address may be inserted.

CLAIMS

1. A decoding arrangement for decoding a transmission of codewords including address words and message words, the arrangement comprising:

basic address detection means operative to detect a specific address word in the transmission;

message detection means for detecting when a message word follows the address word detected by the basic address detection means;

message decoding means responsive to detection of a following message word by the message detection means to decode the message word; and

extended address detection means operative to detect an extended address portion in the decoded message word and, upon such detection, to provide an indication.

2. A decoding arrangement according to claim 1, wherein the indication provided by the extended address detection means comprises an audible alert.

3. A decoding arrangement according to claim 1 or claim 2, wherein the indication provided by the extended address detection means comprises a visual indication.

4. A decoding arrangement according to claim 3, wherein the visual indication comprises a message display of characters in the decoded message word and in any succeeding message words, other than the extended address portion.

5. A decoding arrangement according to any one of the preceding claims, wherein the message detection means is responsive to an indication in the address word that a message word is to follow.

6. A decoding arrangement according to any one of the preceding claims, wherein the extended address detection means is operative to detect more than one extended address in the decoded message word.

7. A decoding arrangement according to claim 6, wherein one of the extended addresses includes at least one non-decimal hexadecimal character, such that a group call facility can be provided for arrangements which share the same extended address with the non-decimal hexadecimal character.

8. A decoding arrangement for decoding a transmission of codewords including address words and message words, the decoding arrangement being substantially as hereinbefore described with reference to the accompanying drawings.

9. A paging receiver including a decoding arrangement in accordance with any one of the preceding claims.

10. A paging system including a transmitter for transmitting batches of words, each batch including a respective synchronisation word followed by a plurality of codewords including address words and message words, at least some of the message words including extended address portions, the system including a plurality of paging receivers according to claim 9.

11. A method of decoding a transmission of codewords including address words and message words, the method comprising:

detecting a specific address word in the transmission;

detecting when a message word follows the detected address word in the transmission;

decoding the message word following the detected address word;

detecting an extended address portion in the decoded message word; and

providing an indication when the extended address portion is detected.

12. A method of decoding a transmission of codewords including address words and message words, the method being substantially as hereinbefore described with reference to the accompanying drawings.

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