(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
21 December 2000 (21.12.2000)

PCT

(10) International Publication Number
WO 00/77700 A1

(51) International Patent Classification[7]: G06F 17/60

(21) International Application Number: PCT/US00/14991

(22) International Filing Date: 31 May 2000 (31.05.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/332,634 14 June 1999 (14.06.1999) US

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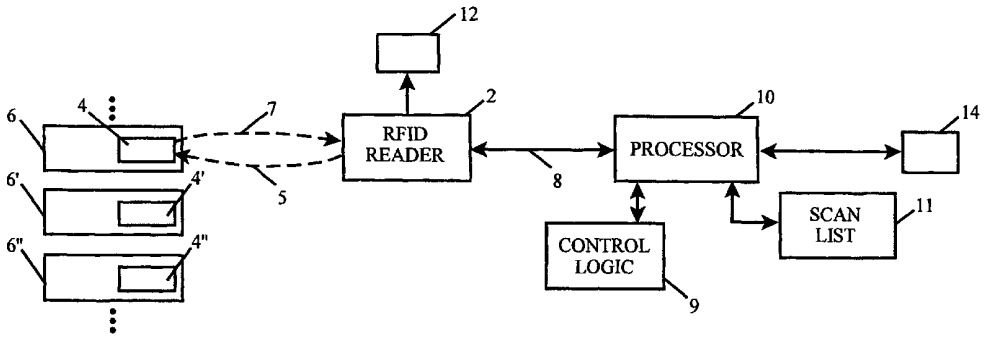
(81) Designated States *(national)*: AU, BR, CA, JP.

(84) Designated States *(regional)*: European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

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

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: FEEDBACK SYSTEM AND METHOD FOR READING OF RFID TAGS



(57) Abstract: An RFID reader (2) sends an interrogation signal (5) to a series of RFID tags (6, 6', 6''), which respond (7) with their ID. The RFID reader checks a database (11) for the scanned ID, and adds the ID if it is not found. The RFID reader also performs an error detection routine to determine whether the ID is valid, and provides feedback using an indicator (12, 14) to the user when valid tags are read.

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FEEDBACK SYSTEM AND METHOD FOR READING OF RFID TAGS

CROSS REFERENCES TO RELATED APPLICATIONS

N/A

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

N/A

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates generally to radio frequency identification (RFID) for inventory control and more particularly to operator feedback for an RFID reader when reading RFID tags.

Description of the Related Art

Taking inventory of articles is a time demanding task that often must be performed in commercial, industrial, and other environments. The development of bar code and graphic readers has helped in inventory taking and inventory tracking applications. However, bar code and graphic reading have certain limitations that include a line-of-sight requirement for proper reading, and the capability of only one way data transfer of small amounts of data.

It is known in the art to utilize RFID tags attached to articles for inventory tracking and control. An RFID tag is attached to each article that is desired to be inventoried or tracked. The RFID tag stores data associated with the article. An RFID reader scans for tags by transmitting an interrogation signal at a known frequency. In one RFID system,

the RFID tag responds to the interrogation signal with a response signal containing the data associated with the article. The RFID reader detects the response signal and decodes the data. The act of the RFID reader capturing data is called an RFID read.

In an alternate RFID system, the RFID tag responds to the interrogation signal with a response signal that contains an RFID tag ID. The RFID reader detects the response signal and decodes the RFID tag ID. The reader then uses the RFID tag ID to interrogate the specific RFID tag identified by the decoded tag ID to receive the stored data associated with the article to which the tag is attached.

Typically, the RFID reader or scanner, is a handheld unit similar in size and appearance to a bar code reader. However, the two-way RF communication between the RFID reader and the RFID tag does not need to be line-of-sight, as in a bar code system. The data stored in the RFID tag can also be changed. A main drawback to the use of an RFID reader is the lack of any feedback to the operator from the reader. When the operator moves an RFID reader past a plurality of RFID tagged items, there is no easy way for the operator to tell if all of the tags have been read. For example, if the operator moves the RFID reader too quickly past the plurality of RFID tags the reading of one or more RFID tags could be missed. The operator may not be aware that the tags were missed. To prevent missing tag reads, the operator may go very slowly to insure that all of the tags have been read, but could in fact go much faster and still not miss any tags. What is needed is feedback to the operator of the RFID tag reader to optimize the speed of reading RFID tags.

BRIEF SUMMARY OF THE INVENTION

A first aspect of the present invention provides a system and method for providing operator feedback when reading an RFID tag utilizing an RFID reader. When scanning for

RFID tags, the RFID reader sends out an interrogation signal to the RFID tags. An RFID tag responds with an RFID tag ID, which the RFID reader receives. In the first aspect of the present invention, only the RFID tag ID is desired. The RFID reader compares the RFID tag ID with a list of RFID tag IDs that have already been read. If the RFID tag ID is on the read RFID tag list, the reader continues to scan for RFID tags. If the RFID tag ID is not on the list of read RFID tags, a positive feedback signal is generated, and the RFID tag ID is added to the list of read RFID tags. The positive feedback signal can be utilized to activate a feedback indicator that produces a human detectable indication. A distinctive audio signal such as a tone or beep, or a distinctive visual signal such as a light flash or blink, or both an audio and visual signal, or other signal such as tactile can be produced. For example, if the positive feedback signal triggers an audible tone or beep, then the operator can move the reader past the RFID tags until no more beeps are heard indicating that all of the RFID tag IDs have been read.

In a second aspect of the present invention, and preferred embodiment, RFID tag ID and RFID tag data associated with an article is desired. In the second aspect of the present invention, a system and method for scanning for an RFID tag by utilizing an RFID reader is provided. The RFID reader when scanning for RFID tags sends out an interrogation signal to the RFID tags. An RFID tag responds with an RFID tag ID, which the RFID reader receives. The RFID reader compares the RFID tag ID with a list of RFID tag IDs that have already been read. If the RFID tag ID is on the read RFID tag list, the reader continues to scan for RFID tags. If the RFID tag ID is not on the list of read RFID tags, the RFID reader uses the RFID tag ID to address the specific tag, and the RFID tag responds with the stored tag data, which the RFID reader receives. The RFID reader includes an error detection routine to determine whether the read of the RFID tag data was

valid. If the tag data was not properly read, a negative feedback signal is generated, and the RFID reader attempts to again use the RFID tag ID to read the specific tag's data. The negative feedback signal continues until the tag data read is valid. If the tag data was properly read, the RFID tag ID is added to the read RFID tag list, and a positive feedback signal is generated. The RFID reader can then return to scanning for RFID tags.

The feedback signals can be used to trigger an indicator that produces an audio, visual, tactile, or other human detectable indication. As described above, the positive feedback signal can trigger a distinct audible beep to indicate to the operator that the RFID tag has been properly read. The negative feedback signal can trigger, for example, a series of beeps that will continue until the RFID tag data has been captured. In operation, a user can sweep the RFID reader in the vicinity of RFID tagged items to scan for RFID tags. As each tag is properly read, a positive indication or distinct audible beep will be generated. When an identified tag is not properly read, a negative indication, such as a series of distinct audible beeps will be generated, and will continue until the RFID reader is brought back into the vicinity of the RFID tag to obtain a proper read.

In a third aspect of the present invention, the RFID tag data does not include a separate RFID tag ID, but consists of all of the data collected from the RFID tag when scanned by the RFID reader. In the third aspect, a system and method for scanning for an RFID tag by utilizing an RFID reader is provided. The RFID reader when scanning for RFID tags sends out an interrogation signal to the RFID tags. An RFID tag responds with RFID tag data, which the RFID reader receives. The RFID reader then checks an error routine to see if the RFID data read was valid. If the read was not valid, the reader rescans to obtain a valid tag read. If the RFID data is properly read, a list of properly read RFID tags is checked to see if the RFID tag has already been read. If the RFID tag has already

been read, the reader continues to scan for RFID tags. If the RFID tag has not been previously read, the RFID tag is added to the list of properly read RFID tags, and a positive feedback signal is generated. The RFID reader can then continue to scan for RFID tags.

Accordingly, it is an object of the present invention to provide feedback to the operator of an RFID reader to improve the usability of the RFID reader for scanning RFID tags.

It is another object of the present invention to provide a positive feedback indication when an RFID reader has identified and read an RFID tag.

It is yet another object of the present invention to provide a negative feedback indication when an RFID reader has not properly read an RFID tag's data.

It is still another object of the present invention to maintain a list of RFID tags that have been scanned by an RFID reader to prevent duplicate feedback indications.

Other objectives, advantages, and applications of the present invention will be made apparent by the following detailed description of the preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

Figure 1 is a block diagram of one embodiment of the present invention.

Figure 2 is a block diagram of one format for data received from an RFID tag.

Figure 3 is a flowchart of one embodiment of the present invention.

Figure 4 is a flowchart of the preferred embodiment of the present invention.

Figure 5 is a flowchart of an alternate embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Fig. 1, a preferred embodiment of the present invention uses handheld RFID reader 2 to scan for RFID tags 4, 4', 4'', and so on to include any number of RFID

tags, which are connected to, attached to, enclosed within, or in some way associated with articles 6, 6', 6'', and so on to include any number of articles. Articles 6, 6', 6'', and so on, referred herein collectively as articles 6 and individually as an article 6, can be any items of interest such as items to be inventoried, tracked, or sorted in a commercial or industrial setting. The RFID reader is preferably a handheld RFID reader 2, but could be a fixed reader by which articles 6 pass. A suitable RFID tag and RFID reader, under the name Intellitag 500, can be purchased from Intermec Technologies Corporation of Everett, Washington, and Intermec's Amtech Systems Division in Albuquerque, New Mexico. RFID reader 2 can be connected via link 8 to processor 10. Link 8 can be hardwired, an infrared modem connection, an RF modem connection, a combination of connections, or any other suitable connections as known in the art. RFID reader 2 can also include a self-contained microprocessor and be capable of storing large amounts of data, and may or may not interface with a remote processor. Processor 10 includes logic control 9 for communication control with RFID reader 2, and an RFID scan list 11. RFID scan list 11 is a database containing tag IDs of RFID tags that have been previously scanned by RFID reader 2, as fully described hereinbelow. RFID reader 2 can include a feedback indicator 12, as fully described below. A remote feedback indicator 14 can be used in place of, or in conjunction with, indicator 12.

The RFID reader 2 scans for RFID tags 4, 4', 4'' and so on, referred to herein collectively as RFID tags 4, and individually as an RFID tag 4, by transmitting an interrogation signal 5 to the RFID tags 4. RFID tags 4 respond to the interrogation signal 5 by transmitting an RFID tag response signal 7, which the RFID reader 2 receives. The RFID reader 2 includes anti-collision avoidance programming to sort out conflicts when

more than one RFID tag 4 simultaneously responds to the RFID reader interrogation signal 5.

Referring to Fig. 2, an RFID tag 4 includes, in the preferred embodiment, 128 bytes or 1024 bits of stored data. The 1024 bit data message can include a tag ID 16 and user defined tag data 18. In one embodiment, the 1024 bits of data includes 24 bytes of tag ID 16 and configuration information and 104 bytes of user defined data 18. The tag ID 16 provides a unique ID for each RFID tag 4. The 104 bytes of user defined tag data 18 provides programmable data storage for data associated with an article 6 to which the RFID tag 4 is attached. The communication between RFID tag 4 and RFID reader 2 includes error detection to make certain that the data read by RFID reader 2 is valid, or in other words, to verify that the read data has no detected errors. When RFID reader 2 initially scans for RFID tags 4, a specific RFID tag responds with its unique ID. When the RFID reader 2 receives the RFID tag ID, the reader uses the tag ID as an address to interrogate the specific RFID tag 4 having that ID. When the RFID tag 4 is interrogated with its unique ID, the tag responds with the user-defined data and the error status, which are all captured by RFID reader 2.

For the preferred RFID embodiment available from Intermec, instructions are sent from processor 10 to RFID reader 2 in the form of a computer command string, which instructs RFID reader 2 to interrogate RFID tags 4. RFID reader 2 responds to processor 10 in the form of a response, which is also computer code, in which the results of the interrogation are given, which includes the RFID tag ID. The RFID tag ID is used by processor 10 to send another computer command to RFID reader 2 to transmit an interrogation to the specific RFID tag with that ID. The specific RFID tag responds with the RFID tag data or an error indication. RFID reader 2 responds to processor 10 with the

RFID tag ID or an error indication, which tells processor 10 that the RFID read was not valid.

Referring to Fig. 3, operation for an embodiment in which only the tag ID 16 is captured by RFID reader 2 is illustrated. Initially, RFID reader 2 scans for RFID tags at 20. If the RFID reader 2 does not receive a tag ID at 22, RFID reader 2 continues to scan for RFID tags at 20. If RFID reader 2 receives an RFID tag ID at 22, it compares the tag ID 16 to a scan list at 24. The RFID scan list, shown at 11 in Fig. 1, is a database containing a list of tag IDs that have already been scanned by RFID reader 2. The scan list 11 will retain the list of tag IDs that have been scanned until a user clears the list. The list would typically be cleared at the start of an inventory operation, and at other suitable times as determined by the user.

If the tag ID 16 is on the scan list at 26, then that tag has already been scanned, and RFID reader 2 continues to scan for tags at 20. If the tag ID 16 is not on the scan list at 26, the tag ID is added to the scan list at 28, and a positive feedback signal is generated by processor 10 at 29. RFID reader 2 can then return to scanning for tags at 20. The positive feedback signal at 29 can be used to trigger an indication that the RFID tag has been read. Referring back to Fig. 2, an indicator such as 12 on RFID reader 2, and/or a remote indicator 14 can be utilized. In a preferred embodiment, an audible beep can be implemented at indicator 12. In operation, as RFID reader 2 reads each RFID tag 4, a beep will be heard from indicator 12. When a plurality of RFID tags 4 are being read by RFID reader 2, the operator will hear a plurality of audible beeps, and will know all of the RFID tags 4 have been read when no further beeps are heard.

Referring to Fig. 4, operation for the preferred embodiment in which the tag ID 16 and user defined data 18 are captured by RFID reader 2 is illustrated. RFID reader 2 scans

for RFID tags at 30. If an RFID tag ID 16 is received at 32, RFID tag ID 16 is compared against the scan list at 34 of previously read RFID tags. If the tag ID 16 is on the scan list at 36, the RFID reader 2 continues to scan for RFID tags at 30. If the tag ID 16 is not on the scan list at 36, the tag ID 16 is used by RFID reader 2 to interrogate the RFID tag 4 having that particular tag ID 16, and to read the remainder of the tag data at 38. The tag ID 16 is sent by processor 10 as a parameter in a read command to RFID reader 2, causing RFID reader 2 to interrogate the RFID tag 4 having that particular ID. The RFID reader 2 then responds with the user defined tag data 18 or an error status flag that indicates the RFID read was either valid or invalid. If the read was not valid at 40, processor 10 generates a negative feedback signal at 42, and RFID reader 2 attempts to reread the tag data at 38. If the RFID data read was valid at 40, the tag ID 16 is added to the scan list at 44, and a positive feedback signal is generated by processor 10 at 46. RFID reader 2 can then continue to scan for RFID tags at 30. As discussed above, the scan list 11 retains a list of tag IDs for tags that have already been scanned, until the scan list cleared by a user.

The positive feedback signal at 46 can be used to trigger an indication, such as an audible beep, as described above. The negative feedback signal at 42 can be used to trigger an indicator such as indicator 12 and/or remote indicator 14. In a preferred embodiment, the negative feedback signal at 42 triggers a plurality of audible beeps from indicator 12, which continue until RFID reader 2 successfully reads the RFID tag data at 38. The audible beeps indicating positive feedback signals and the audible beeps indicating negative feedback signals are preferably distinct from each other for easy operator differentiation.

The positive and negative feedback indications permit a user to optimize the scan speed for scanning a plurality of RFID tags 4. For example, for taking inventory of a

plurality of items, a user may move the RFID reader 2 past the plurality of RFID tagged items 6. The positive feedback indications tell the user that the RFID tags 4 attached to the items are being properly read. If the RFID reader 2 is passed too quickly over the items 6, an RFID tag 4 may not be properly read and a negative feedback indication will be given. The user will continue to receive the negative indication until the RFID reader 2 is brought back into the vicinity of the improperly read RFID tag 4 and the tag is properly read. If the user receives negative feedback indications frequently, the RFID reader 2 is being moved too fast past the RFID tagged items 6. If the user never receives negative feedback indications, RFID reader 2 is not being moved too fast past the RFID tagged items 6, and therefore performance can be improved by moving the RFID reader 2 faster. Thus, by trial and error using the feedback indications, the user will become accustomed to the maximum speed that the RFID reader 2 can be moved past RFID tagged items 6 to obtain proper RFID tag 4 reading.

Alternate embodiments of the present invention can be implemented for various RFID communication protocols. For example, in certain RFID systems, when the RFID reader interrogates an RFID tag, the tag replies to the reader by transmitting all of the data contained within the tag. This differs from the embodiment discussed above in which only the tag ID is initially transmitted in response to the RFID reader interrogation.

Referring to Fig. 5, operation for an alternate embodiment of the present invention is illustrated. Initially an RFID reader scans for tags at 50. If the RFID tag data is not received at 52, the RFID reader continues to scan for RFID tags at 50. If the RFID tag data is received at 52, the tag data is compared with a scan list comprised of previously read tag data at 54. In this embodiment, scan list 11 contains RFID tag data instead of the RFID tag ID as discussed above. If the tag data is on the scan list at 56, the reader can continue

to scan for tags at 50. If the tag data is not on the scan list of tag data at 56, the tag data is added to the scan list at 58, a positive feedback signal is generated by processor 10 at 60, and the reader can continue to scan for tags at 50. The positive feedback signal can trigger an indicator as described above. Preferably an audible beep will be triggered by the positive feedback signal.

It is to be understood that variations and modifications of the present invention can be made without departing from the scope of the invention. It is also to be understood that the scope of the invention is not to be interpreted as limited to the specific embodiments disclosed herein, but only in accordance with the appended claims when read in light of the forgoing disclosure.

CLAIMS

What is claimed is:

1. A method of providing feedback when reading RFID tags with an RFID scanner, comprising the steps of:

a) scanning for an RFID tag;

b) receiving an RFID tag ID from a scanned RFID tag;

c) comparing the received RFID tag ID with a database of scanned RFID tag IDs and returning to step a) if the received RFID tag ID is in said database of scanned RFID tag IDs;

d) generating a feedback signal if said RFID tag ID is not in said database of scanned RFID tag IDs; and,

e) adding said RFID tag ID to said database of scanned RFID tag IDs.

2. A method of providing feedback when reading RFID tags with an RFID scanner, comprising the steps of:

a) scanning for an RFID tag;

b) receiving an RFID tag ID from a scanned RFID tag;

c) comparing the received RFID tag ID with a database of scanned RFID tags and returning to step a) if the received RFID tag ID is in said database of RFID tag IDs;

d) reading RFID tag data associated with said RFID tag ID from said scanned RFID tag;

e) verifying that said RFID tag data is valid, and

1) generating a first feedback signal if said RFID tag data is invalid and returning to step d); and,

2) adding said RFID tag ID to said database of scanned RFID tag IDs and generating a second feedback signal if said RFID tag data is valid.

3. A method of providing feedback when reading RFID tags with an RFID scanner, comprising the steps of:

a) scanning for an RFID tag;

b) receiving RFID tag data from a scanned RFID tag;

c) verifying that said RFID tag data is valid and returning to step a) if said RFID tag data is not valid;

d) comparing said RFID tag data with a database of scanned RFID tag data, and

1) returning to step a) if said RFID tag data is in said database of RFID tag data; and,

2) generating a feedback signal if said RFID tag data is not in said database of scanned RFID tag data and adding said RFID tag data to said database of scanned RFID tag data.

4. A system of providing feedback when reading RFID tags with an RFID scanner, comprising:

means for scanning for an RFID tag;

means for receiving an RFID tag ID from a scanned RFID tag;

a database of scanned RFID tag IDs;

means for comparing said RFID tag ID with said database of scanned RFID tag IDs;

means for generating a feedback signal if said RFID tag ID is not in said database of scanned RFID tag IDs; and,

means for adding said RFID tag ID to said database of scanned RFID tag IDs if said RFID tag ID is not in said database of scanned RFID tag IDs.

5. A system of providing feedback when reading RFID tags with an RFID scanner, comprising:

means for scanning for an RFID tag;

means for receiving an RFID tag ID from a scanned RFID tag;

a database of scanned RFID tag IDs;

means for comparing said RFID tag ID with said database of scanned RFID tag IDs;

means for reading an RFID tag data associated with said RFID tag ID if said RFID tag ID is not in said database of scanned tag IDs;

means for verifying that said RFID tag data is valid;

means for generating a first feedback signal if said RFID tag data is invalid; and,

means for adding said RFID tag ID to said database of scanned RFID tag IDs if said RFID tag data is valid, and means for generating a second feedback signal if said RFID tag data is valid.

6. A system of providing feedback when reading RFID tags with an RFID scanner,

6. A system of providing feedback when reading RFID tags with an RFID scanner, comprising:

means for scanning for an RFID tag;

means for receiving an RFID tag data from a scanned RFID tag;

means for verifying that said RFID tag data is valid;

a database of scanned RFID tag data;

means for comparing said RFID tag data with said database of scanned RFID tag data if said RFID tag data is valid;

means for generating a feedback signal if said RFID tag data is not in said database of scanned RFID tag data and means for adding said RFID tag data to said database of scanned RFID tag data.

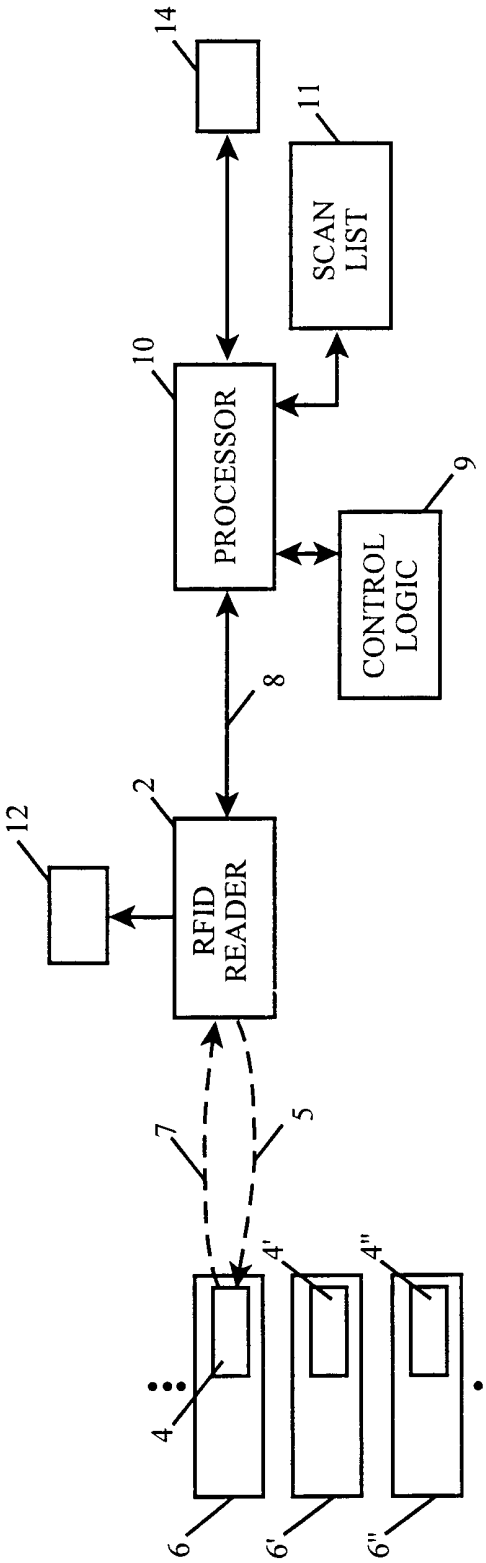
14
11
SCAN LIST
10
PROCESSOR
9
CONTROL LOGIC
8
12
2
RFID READER
7
5
4'
4"
4
6
6'
6"

FIG. 1

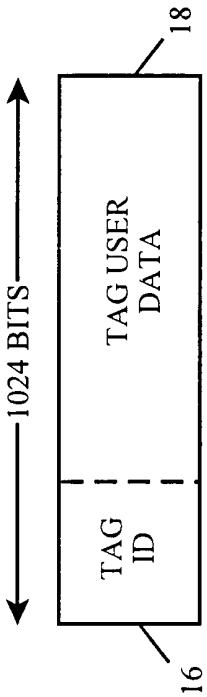
18
1024 BITS
TAG USER DATA
TAG ID
16

FIG. 2

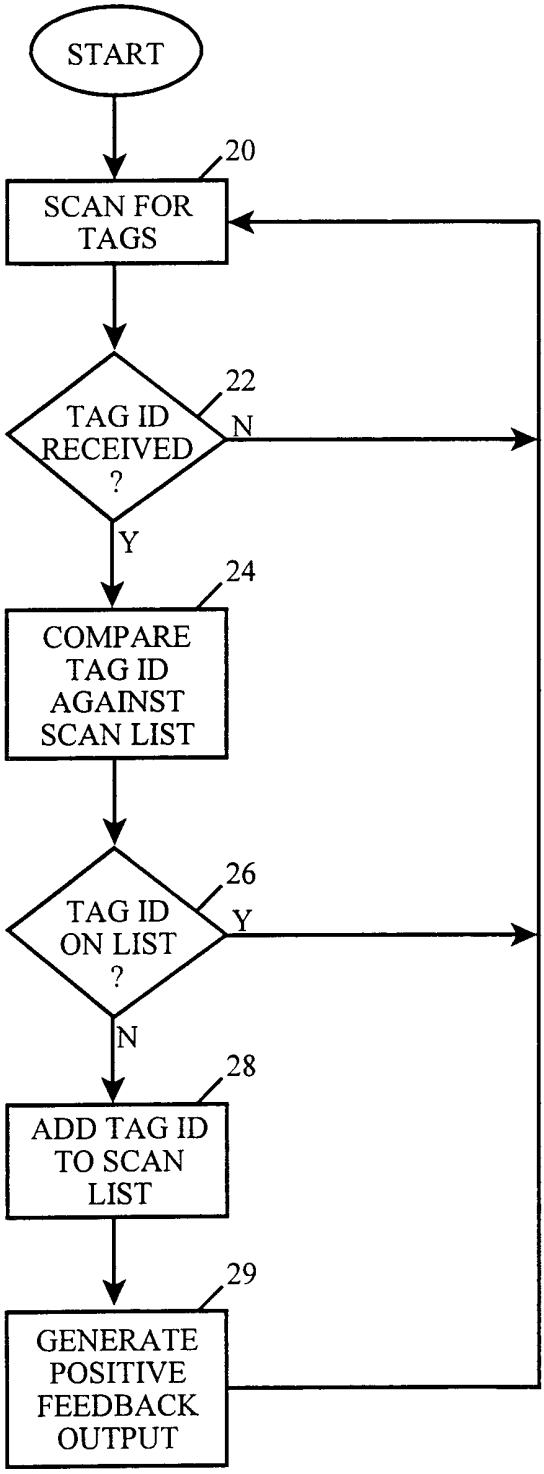
START
20
SCAN FOR TAGS
22
TAG ID RECEIVED ?
N
Y
24
COMPARE TAG ID AGAINST SCAN LIST
26
TAG ID ON LIST ?
Y
N
28
ADD TAG ID TO SCAN LIST
29
GENERATE POSITIVE FEEDBACK OUTPUT

FIG. 3

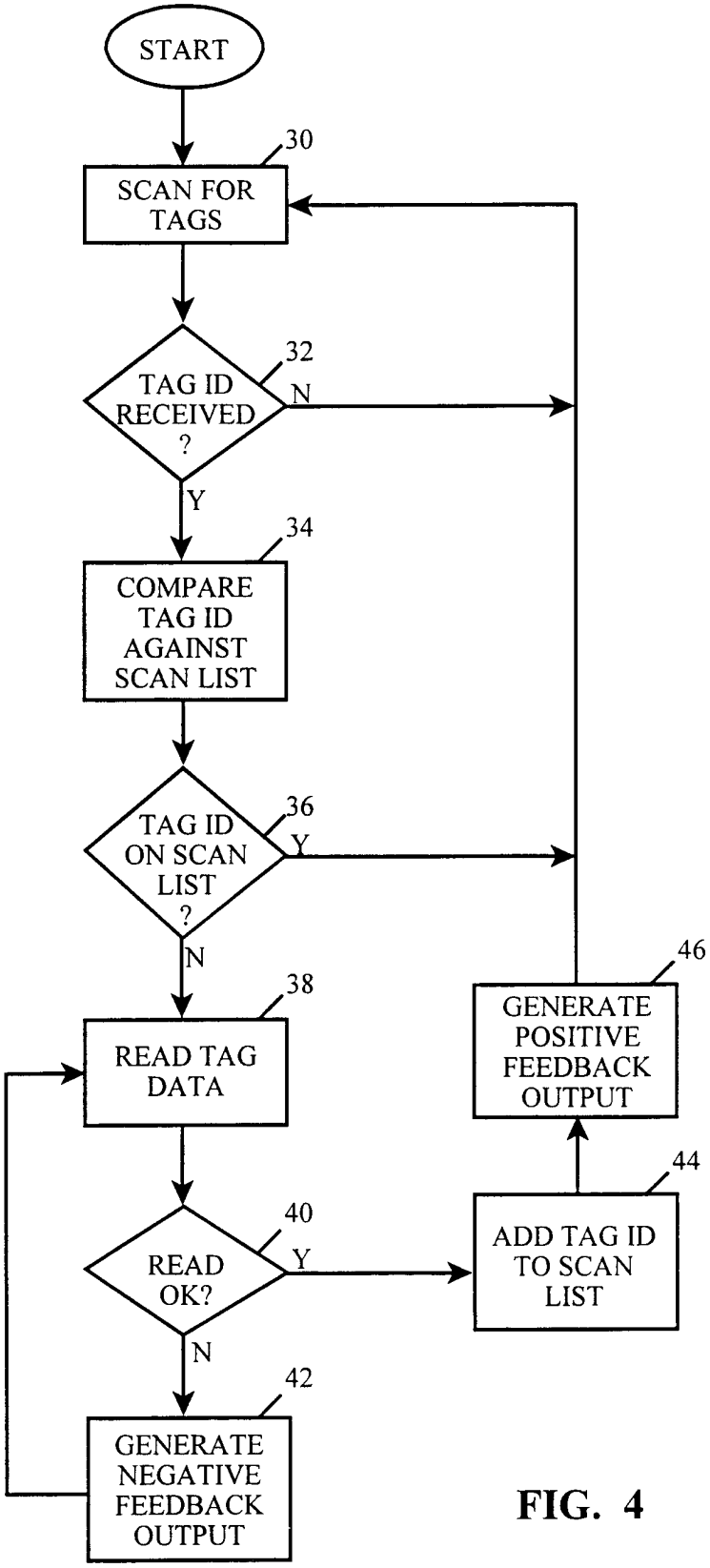
START
30
SCAN FOR TAGS
32
TAG ID RECEIVED ?
N
Y
34
COMPARE TAG ID AGAINST SCAN LIST
36
TAG ID ON SCAN LIST ?
Y
N
38
READ TAG DATA
40
READ OK?
Y
N
42
GENERATE NEGATIVE FEEDBACK OUTPUT
44
ADD TAG ID TO SCAN LIST
46
GENERATE POSITIVE FEEDBACK OUTPUT

FIG. 4

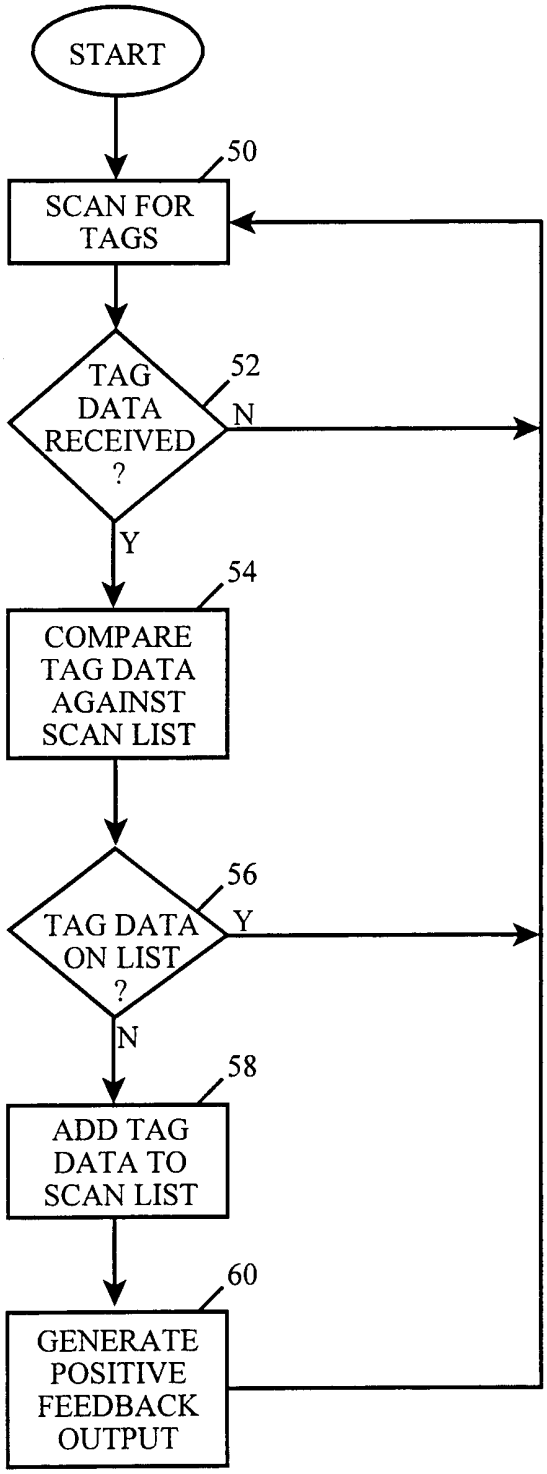
START
50
SCAN FOR TAGS
52
TAG DATA RECEIVED ?
N
Y
54
COMPARE TAG DATA AGAINST SCAN LIST
56
TAG DATA ON LIST ?
Y
N
58
ADD TAG DATA TO SCAN LIST
60
GENERATE POSITIVE FEEDBACK OUTPUT

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/14991

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :G06F 17/60
US CL :235/385

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. : 235/385, 383, 375; 340/572.1

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

NONE

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

USPTO APS EAST
search terms: RFID beep audible wireless speaker confirmation valid tag error inventory

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 4,688,026 A (SCRIBNER et al) 18 August 1987 (18.10.1987), col. 2, lines 1-15 and 33-37 and col. 7, lines 20-29.	1, 4 ------ 2-3, 5-6
Y,P	US 6,008,727 A (WANT et al) 28 December 1999 (28.12.1999), col. 12, lines 1-4.	2-3, 4-6
A	US 5,689,238 A (CANNON, JR. et al) 18 November 1997 (18.10.1997), see entire document.	1-6
A	WO 99/05660 A (CHECKPOINT SYSTEMS, INC.) 04 February 1999 (04.02.1999), see entire document.	1-6

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 SEPTEMBER 2000	25 OCT 2000
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Form PCT/ISA/210 (second sheet) (July 1998)★