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TITLE OF THE INVENTION

"Person Location System"

BACKGROUND OF THE INVENTIONField of the Invention

The present invention relates to a person location system comprising a plurality of base stations which are respectively located at the sites of microcells with radius of about 100 meters.

Description of the Related Art

In a proposed person location system, a plurality of radio base stations are located to serve microcells and users are always carrying a hand-held transmitter for periodically transmitting a signal identifying the user. Each base station monitors the field intensity of the transmitted signal and informs it to a management center via a dedicated network of radio or wire-line circuits. However, such a dedicated network would be complex and costly if implemented solely with dedicated wire-line circuits, or if implemented with radio circuits since a switched network would be required for routing signals from the base stations.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a person location system which enables low-cost implementation.

According to a broader aspect of the present invention, there is provided a person location system which includes a plurality of radio base stations, connected to a public switched telephone network, for respectively covering microcells, in one of which is located a user station which is uniquely identified by a user's address. A radio central station is provided for covering an area containing all of the microcells. The central station is connected to the public switched telephone network for receiving a polling signal containing a user's address of the desired user station via the telephone network and broadcasting a copy of the polling signal within the area. A management center is connected to the public

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1 switched telephone network for transmitting the polling signal through
2 the telephone network to the central station. Each of the base stations is
3 responsive to the polling signal from the central station for returning field
4 intensity data of the user station through the telephone network to the
5 management center if the polling signal identifies the user station.

6 According to a first specific aspect of the present invention, the user
7 station periodically measures the field intensity of a signal from each of
8 surrounding base stations, selects one of the surrounding base stations
9 which is transmitting a signal of highest field intensity, and transmits to the
10 selected base station a field intensity signal containing the measured field
11 intensities of the surrounding base stations and identifiers of the
12 surrounding base stations. Each of the base stations receives the field
13 intensity signal from the user station and stores the received field intensity
14 signal, and is responsive to the polling signal broadcast from the central
15 station for transmitting the stored field intensity signal to the management
16 center via the telephone network as the field intensity data.

17 According to a second specific aspect of the present invention, each
18 of the base stations is responsive to the polling signal from the central
19 station for broadcasting a copy of the polling signal, and the user station
20 periodically measures the field intensity of a signal from each of
21 surrounding base stations, and stores the measured field intensities and
22 identifiers of the surrounding base stations. On receiving the copy of the
23 polling signal broadcast from the base station, the user station transmits
24 to the base station a field intensity signal containing the stored field
25 intensities of the surrounding base stations and the identifiers of the
26 surrounding base stations. The base station responds to the transmitted
27 field intensity signal from the user station by transmitting a copy of the
28 field intensity signal to the management center via the telephone network
29 as the field intensity data.

30 Advantageously, the central station is a paging station which



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1 transmits a radio paging signal to radio pagers, and each of the base
2 stations serves mobile telephone units.

3 BRIEF DESCRIPTION OF THE DRAWINGS

4 The present invention will be described in further detail with reference
5 to the accompanying drawings, in which:

6 Fig. 1 is a block diagram of a person location system according to
7 the present invention;

8 Fig. 2 is a flowchart of operations performed by the user station
9 according to a first embodiment of the present invention;

10 Fig. 3 is a flowchart of operations performed by the base station
11 according to the first embodiment of the present invention;

12 Fig. 4 is a flowchart of operations performed by the user station
13 according to a second embodiment of the present invention; and

14 Fig. 5 is a flowchart of operations performed by the base station
15 according to the second embodiment.

16 DETAILED DESCRIPTION

17 Referring to Fig. 1, a first embodiment of a person location system of
18 the present invention comprises cell-site base stations 4-8 which are
19 located in respective small zones or "microcells" each with a radius of
20 about 100 meters. Base stations 4-8 are connected to a public switched
21 telephone network (PSTN) 3 through respective exchange lines 4a-8a.
22 At the center of a larger area 2 that covers all microcells of base stations
23 4-8 there is located a radio paging station 1, which is connected to the
24 PSTN 3 through exchange line 1a. Each user of the system carries a
25 hand-held radio transceiver, or user station 9, which is uniquely identified
26 by a user's address. The user station 9 periodically scans across the
27 spectrum of frequencies used by all the base stations, and measures the
28 field intensity of each signal transmitted from surrounding base stations.
29 The management center 10 transmits a polling signal containing the user'
30 address of a desired user station through the PSTN to the paging station



1 1 where it is broadcast. When the polling signal from the paging station
2 is received by a base station, a copy of the polling signal is broadcast
3 from the base station to elicit a response from the polled user station to
4 collect the measured field intensity data, or field intensity data, which
5 have already been received from the user station and stored in the base-
6 station memory, are transmitted from the base station to the
7 management center in a manner as will be described in detail below.

8 It is advantageous to use the existing cellular telephone network and
9 paging system as the person location system of the present invention. In
10 such instances, conventional mobile (personal) telephone units 11 are
11 radio pagers 12 are located in the area 2 as shown in Fig. 1.

12 Figs. 2 and 3 are flowcharts of the user station and the base station,
13 respectively, according to a first embodiment of the present invention. In
14 Fig. 2, the program execution of the user station begins with initialization
15 step 20 that initializes a variable k to zero. Exit then is to step 21 to cause
16 the frequency synthesizer of the user station to scan across the spectrum
17 of frequencies assigned to all base stations of the system and measures
18 the field intensities of signals transmitted from nearby base stations (step
19 22) and receive the base-station identifiers which are transmitted with
20 these signals to identify the base stations surrounding the user station.
21 The measured field intensities are stored in a memory together with the
22 received base-station identifiers (step 23). Control then moves to step 24
23 to check to see if variable k is equal to a maximum value which
24 represents the total number of radio channels allocated to the system. If
25 the answer is negative, control returns to step 21 to repeat the process
26 until variable k equals the maximum value. If the answer is affirmative,
27 control branches at step 24 to step 25 to read data from the memory
28 and selects a base station which is transmitting the signal of highest
29 intensity. Exit then is to step 26 to transmit the stored intensity valued, the
30 base-station identifiers and the address of the user station to the selected

1 base station. Following a predetermined wait interval, control returns to
2 step 20 to repeat the above process (step 27).

3 In Fig. 3, the program execution of each base station begins with
4 decision step 30 to check for the reception of field intensity data from a
5 use station. If there is one, control branches to step 31 to store the
6 received field intensity data in a base-station memory together with base-
7 station identifiers and a user's address accompanying the field intensity
8 data. A timer is then to set (step 32) and a check is made whether the
9 timeout period set of the timer has expired (step 33). If the timeout
10 period has expired, control branches at step 33 to step 37 to erase the
11 stored field intensity data of the user station and returns to step 30 to
12 repeat the process. Therefore, if the user has moved out of the
13 boundary of a base station, the field intensity data stored in the base
14 station together with the base-station identifiers of the user station are
15 erased.

16 If the timeout period is not expired, control branches at step 33 to
17 step 34 to determine whether a polling signal is received from the
18 management center 10 via the PSTN. If the answer is affirmative, control
19 branches at step 34 to step 35 to check to see if there is a match between
20 the user's address contained in the received polling signal and a user's
21 address stored in the base-station memory. If there is a match between
22 the two, control proceeds to step 36 to read the stored field intensity data
23 and base-station identifiers which have been received from the polled
24 user station and transmit it as a response signal to the management
25 center 10 via the PSTN. If the decision at each of steps 34 and 35 is
26 negative, control returns to step 33 to repeat the polling signal reception
27 process until the timeout expires. Following the transmission of the field
28 intensity data and associated base-station identifiers to the management
29 center, control returns to step 30 to repeat the process.

30 The operation of the first embodiment is as follows. If the user station

1 9 is located in the microcell of base station 5, as illustrated in Fig. 1, it
2 measures and stores the field intensity of signal from this base station as
3 well as the field intensities of signals from nearby base stations 4 and 6 at
4 periodic intervals to make a set of records, and then selects base station
5 5 as one transmitting the highest intensity signal, and communicates all
6 the records of field intensity values and base-station identifiers to base
7 station 5 together with the address of the user station 9 to be stored in
8 the memory of the base station 5. The stored records of user station 9
9 are recalled from the memory of base station 5 when the latter receives a
10 polling signal from the management center via the paging station 1
11 which identifies the user station 9. A response signal containing the
12 stored records of the user station 9 is sent from base station 5 to the
13 management center through the PSTN. On receiving the response signal
14 from base station 5, the management center 10 analyzes the field
15 intensities measured at the user station 9 and determines its location.

16 Figs. 4 and 5 are flowcharts of the user station and the base station,
17 respectively, of a second embodiment of the present invention. In Fig. 4,
18 the program execution of the user station begins with initialization step 40
19 to initialize a variable k to zero. Exit then is to step 41 to cause the
20 frequency synthesizer of the user station to scan across the spectrum of
21 frequencies assigned to all base stations of the system and measures the
22 field intensities of signals transmitted from nearby base stations (step 42)
23 and receive the base-station identifier transmitted from such stations. The
24 measured field intensities are stored in a user-station memory together
25 with the received base-station identifiers (step 43). The variable k is then
26 checked (step 44) to see if it is equal to the maximum value representing
27 the total number of radio channels allocated to the system. If the answer
28 is negative, control returns to step 41 to repeat the process until variable k
29 equals the maximum value. A timer is then set (step 45) and a check is
30 made at step 46 whether the timeout period set of the timer has expired.

1 If the timeout period has expired, control returns to step 40, otherwise it
2 proceeds to step 47 to check to see if a polling signal is received from a
3 base station. If this is the case, control branches at step 47 to step 48 to
4 check the received address against the address of the user station. If
5 there is a match between the two, control proceeds to step 49 to read
6 field intensity data and base-station identifiers from the memory and
7 transmits them as a response signal to the base station from which the
8 polling signal has been received. Following the transmission of the
9 response signal, control returns to step 40 to repeat the process.

10 In Fig. 5, the program execution of the base station starts with
11 decision step 50 that checks for the reception of a polling signal from the
12 paging station 1. If there is one, control branches at step 50 to step 51 to
13 broadcast a copy of the polling signal to urge user stations to return a
14 response signal. Exit then is to step 52 to check to see if a response signal
15 containing field intensity data, base-station identifiers and a user's address
16 is received from a user station. If the answer is affirmative, control
17 branches to step 53 to transmit a copy of the response signal to the
18 management center 10 via the PSTN, and returns to step 50 to repeat the
19 process.

20 The operation of the second embodiment is as follows. If the user
21 station 9 is located in the microcell of base station 5 as in the case of the
22 first embodiment it measures and stores the field intensity of signal from
23 this base station as well as the field intensities of signals from nearby base
24 stations 4 and 6 at periodic intervals to make a set of records in a
25 memory. When the management center sends a polling signal through
26 the PSTN and through paging station 1 to base station 5, the user station
27 9 is polled and sends a response signal containing all the records of field
28 intensity values and base-station identifiers to base station 5 together with
29 the address of the user station 9. A copy of the received records of user
30 station 9 is transmitted from base station 5 to the management center

- 1 through the PSTN. On receiving the response signal from base station 5,
- 2 the management center 10 analyzes the field intensities measured at the
- 3 user station 9 and determines its location in a manner similar to the
- 4 previous embodiment.

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What is claimed is:



1 1. A person location system comprising:
2 a plurality of radio base stations, connected to a public switched
3 telephone network, for respectively covering microcells, in one of which
4 is located a user station which is uniquely identified by a user's address;
5 a radio central station for covering an area containing all of said
6 microcells, the central station being connected to said public switched
7 telephone network for receiving a polling signal containing said user's
8 address via the telephone network and broadcasting a copy of the
9 polling signal within said area; and
10 a management center connected to said public switched telephone
11 network for transmitting said polling signal through said telephone
12 network to said central station,
13 each of said base stations being responsive to said polling signal from
14 said central station for returning field intensity data of said user station
15 through said telephone network to said management center if said
16 polling signal identifies said user station.

1 2. A person location system as claimed in claim 1, wherein said user
2 station comprises means for periodically measuring field intensity of a
3 signal from each of surrounding base stations, selecting one of the
4 surrounding base stations which is transmitting a signal of highest field
5 intensity, and transmitting to the selected base station a field intensity
6 signal containing the measured field intensities of said surrounding base
7 stations and identifiers of the surrounding base stations,
8 wherein each of said base stations comprises means for receiving the
9 field intensity signal from the user station and storing the received field
10 intensity signal, and means responsive to the polling signal broadcast
11 from said central station for transmitting the stored field intensity signal to



12 the management center via said telephone network as said field intensity
13 data.

1 3. A person location system as claimed in claim 2, wherein said field
2 intensity signal additionally contains the address of the user station.

1 4. A person location system as claimed in claim 2, wherein each of
2 said base stations comprises means for erasing the stored field intensity
3 signal if a prescribed timeout period expires after the reception of the
4 field intensity signal from the user station.

1 5. A person location system as claimed in claim 1, wherein each of
2 said base stations comprises means responsive to said polling signal from
3 said central station for broadcasting a copy of the polling signal,
4 wherein said user station comprises means for periodically measuring
5 field intensity of a signal from each of surrounding base stations, and
6 storing the measured field intensities and identifiers of the surrounding
7 base stations, and means responsive to receipt of the copy of the polling
8 signal broadcast from the base station for transmitting to the base station
9 a field intensity signal containing the stored field intensities of said
10 surrounding base stations and the identifiers of the surrounding base
11 stations, and

12 wherein the base station comprises means responsive to receipt of
13 the transmitted field intensity signal for transmitting a copy of the field
14 intensity signal to the management center via said telephone network as
15 said field intensity data.

1 6. A person location system as claimed in claim 5, wherein said field
2 intensity signal additionally contains the address of the user station.

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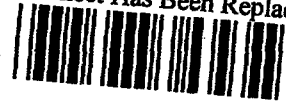
- 1 7. A person location system as claimed in claim 1, wherein said
2 central station is a paging station which transmits a radio paging signal to
3 radio pagers.

- 1 8. A person location system as claimed in claim 1, wherein each of
2 said base stations serves mobile telephone units.

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"Person Location System"

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ABSTRACT OF THE DISCLOSURE

1 A person location system comprises radio base stations and a radio
2 central station, all stations being connected to a public switched
3 telephone network. The base stations respectively cover small areas, or
4 "microcells", in one of which is located a user station, and the central
5 station covers an area containing all of the microcells. The central station
6 receives a polling signal containing the user's address via the telephone
7 network and broadcasts a copy of the polling signal. A management
8 center is connected to the telephone network for transmitting the polling
9 signal to the central station when a location demand arises. Each base
10 station is responsive to the polling signal from the central station for
11 returning field intensity data of the user station through the telephone
12 network to the management center if the polling signal identifies the user
13 station.

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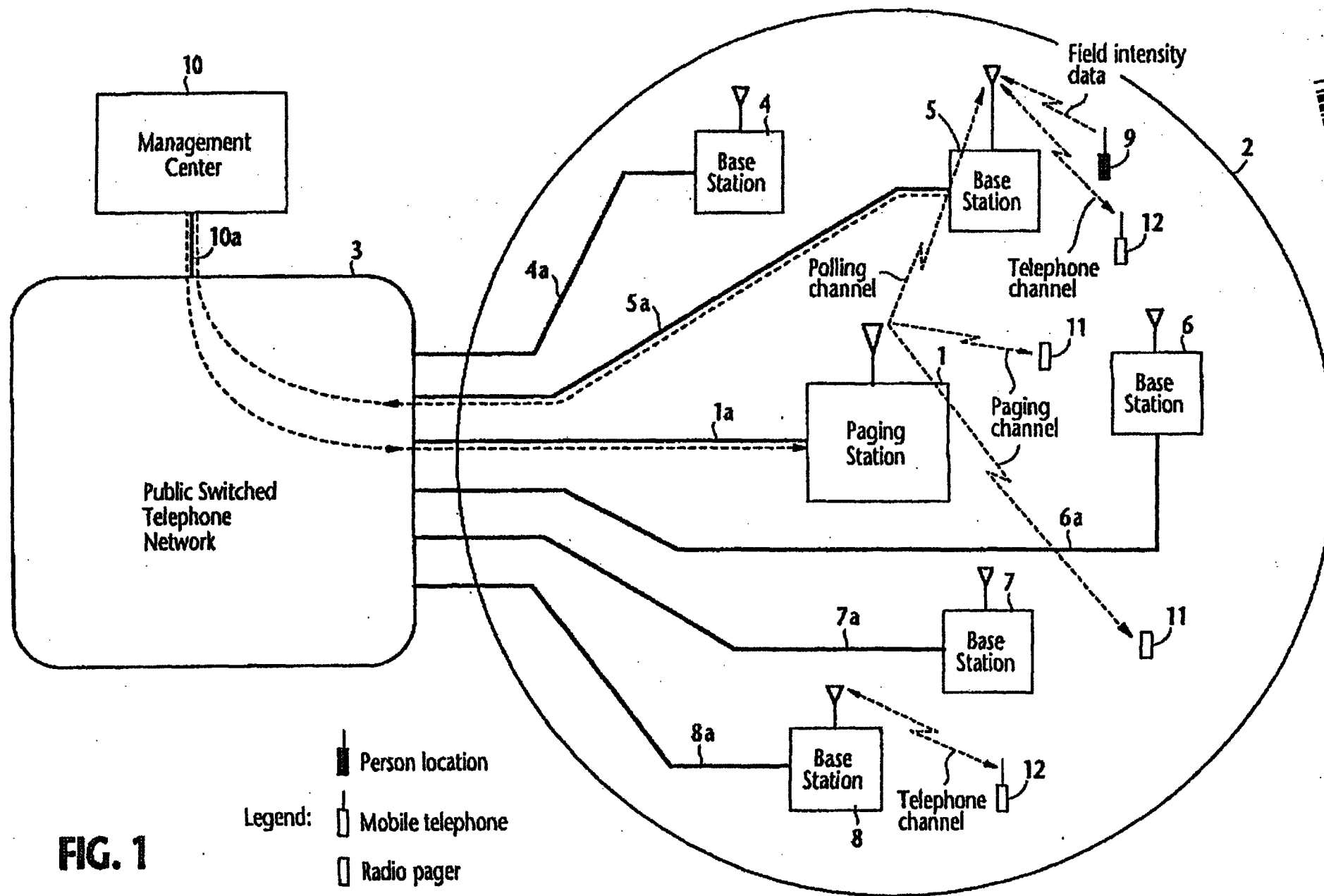


FIG. 1

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FIG. 2
USER STATION

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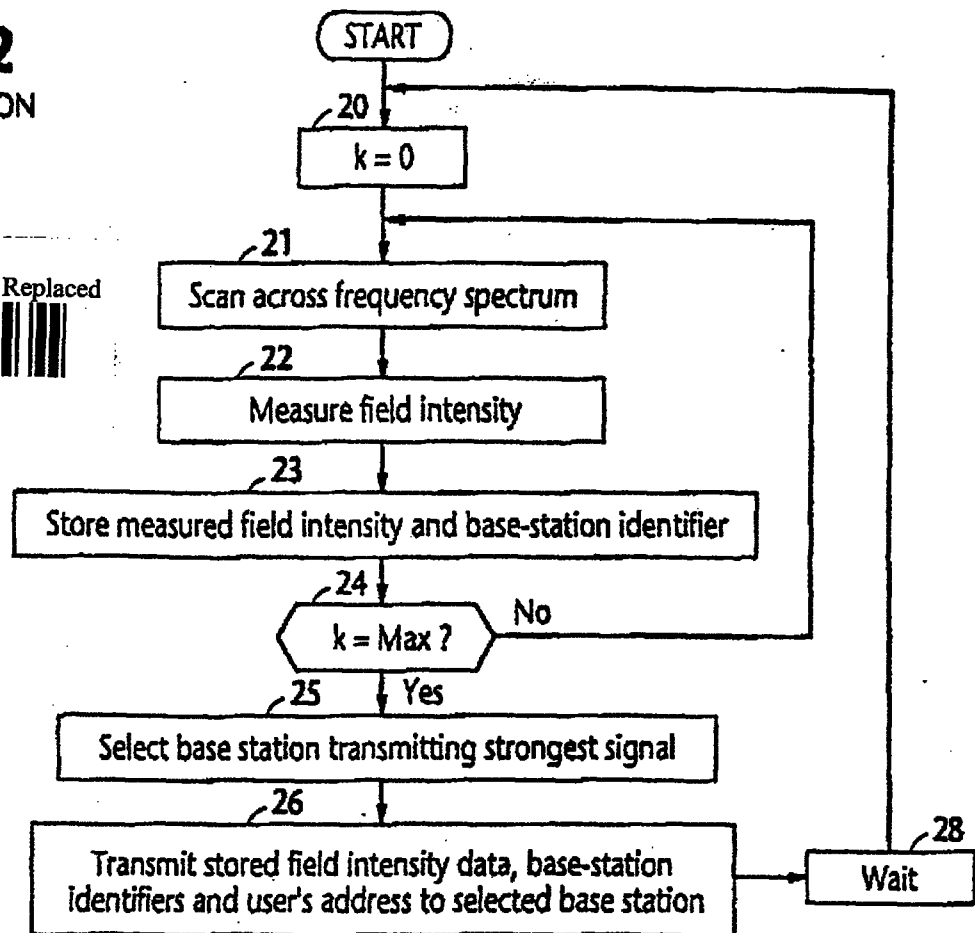
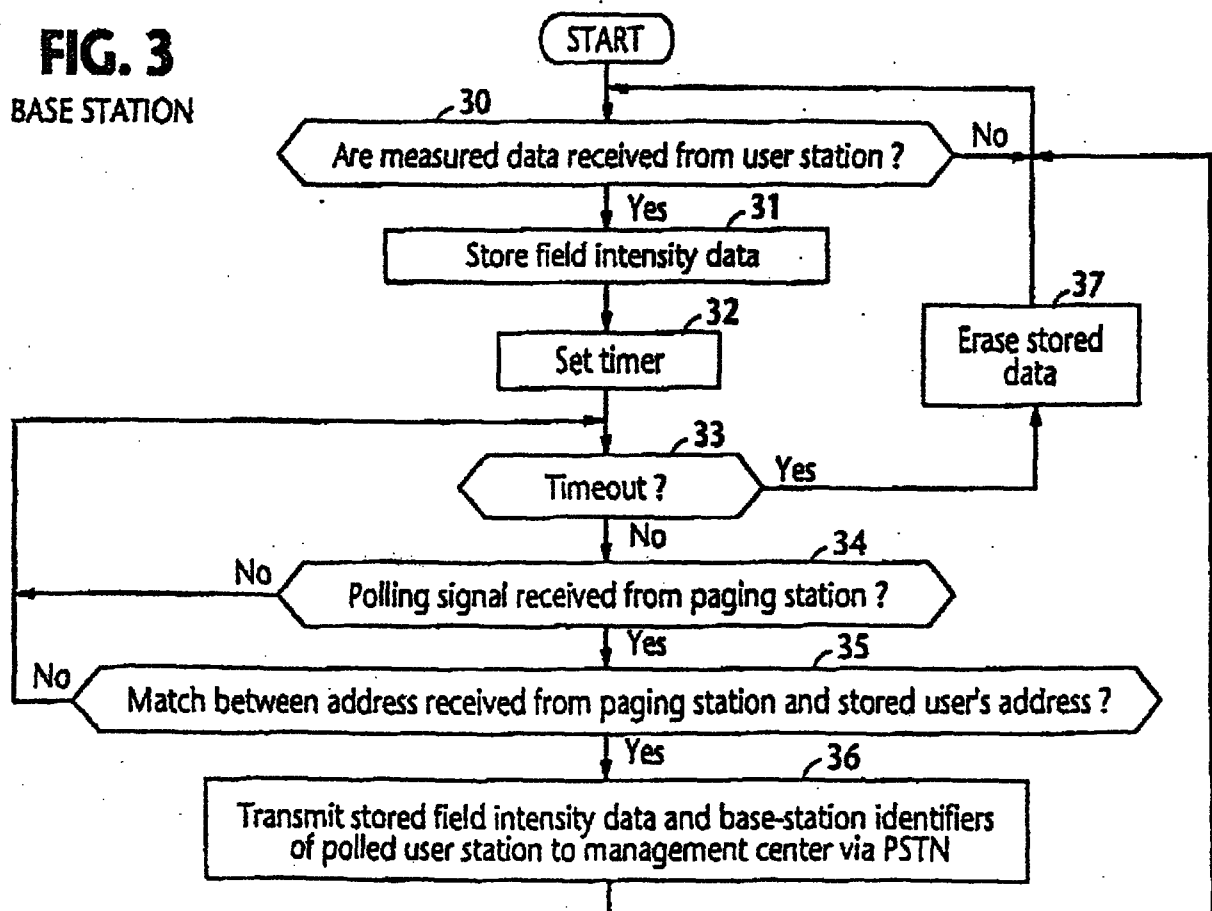
**FIG. 3**
BASE STATION



FIG. 4
USER STATION

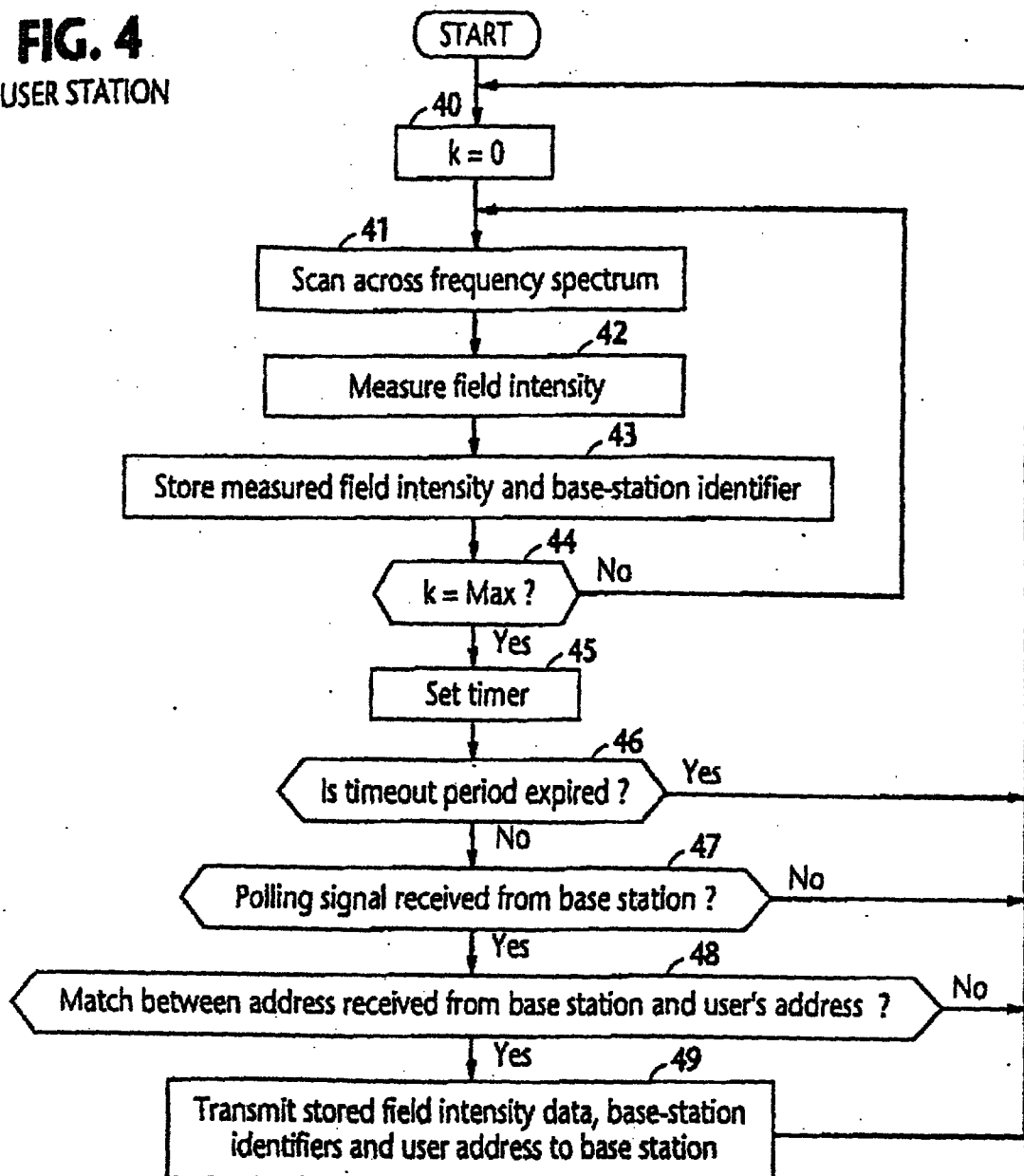
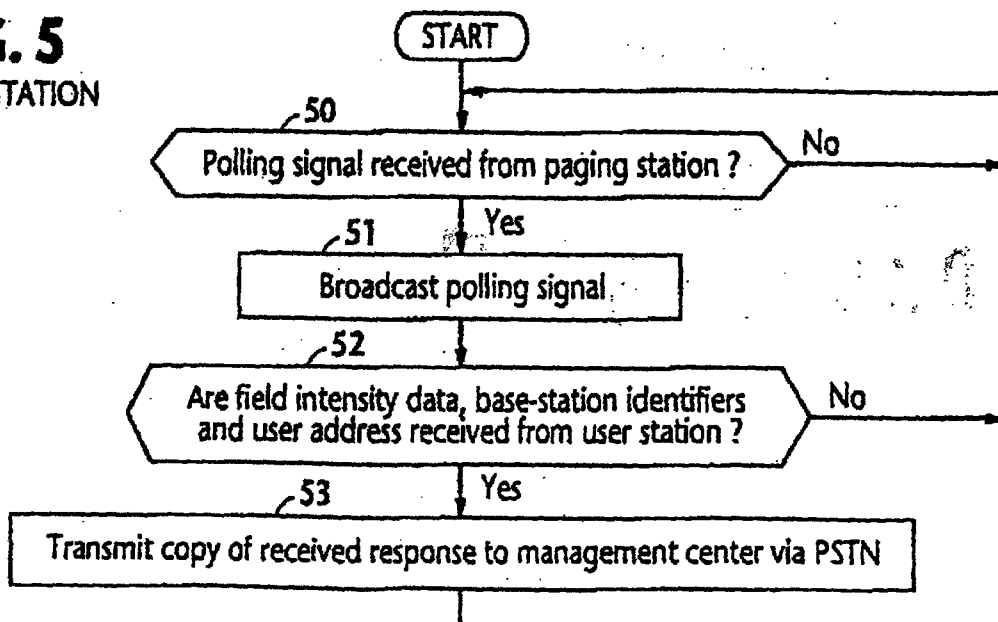


FIG. 5
BASE STATION



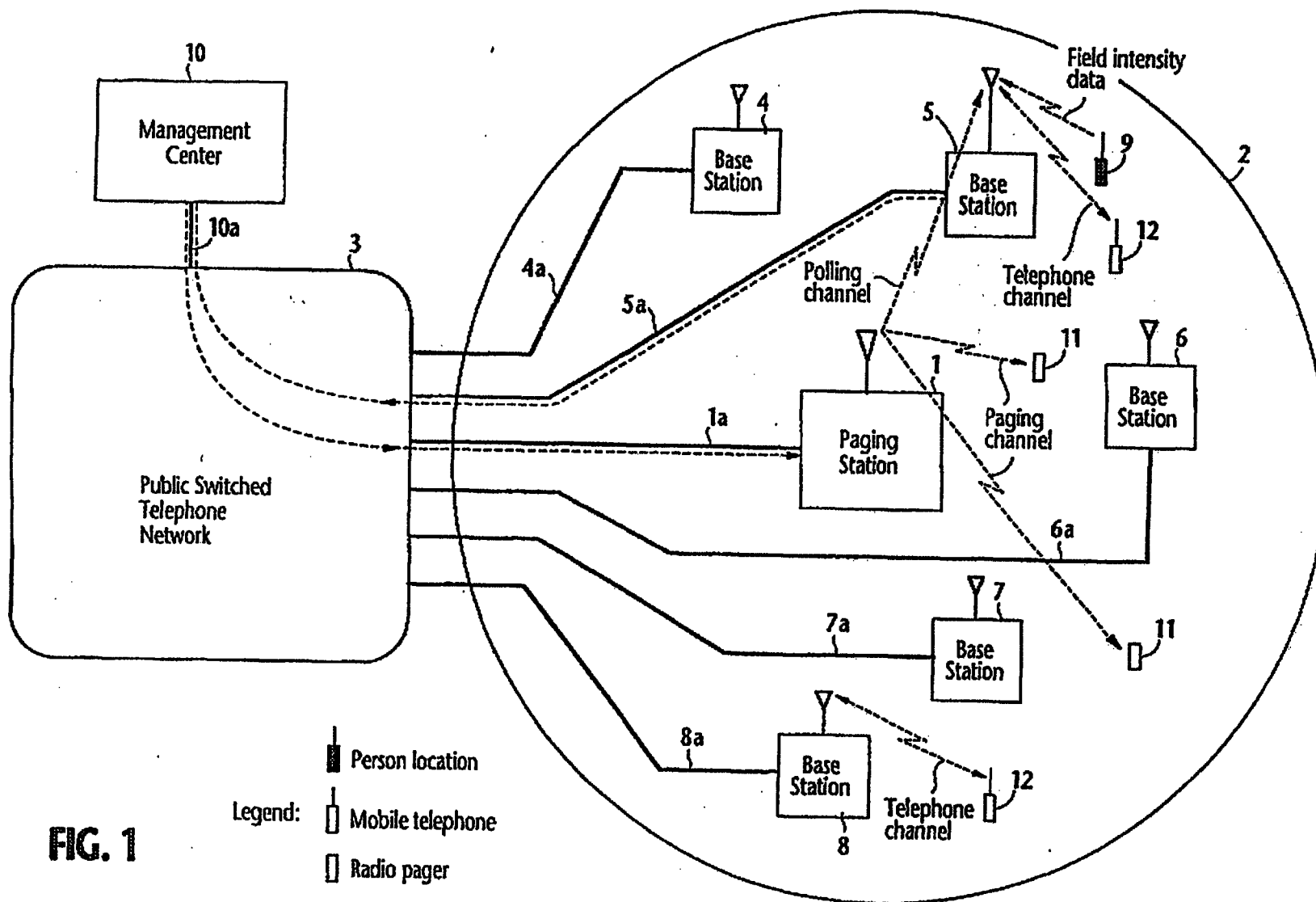
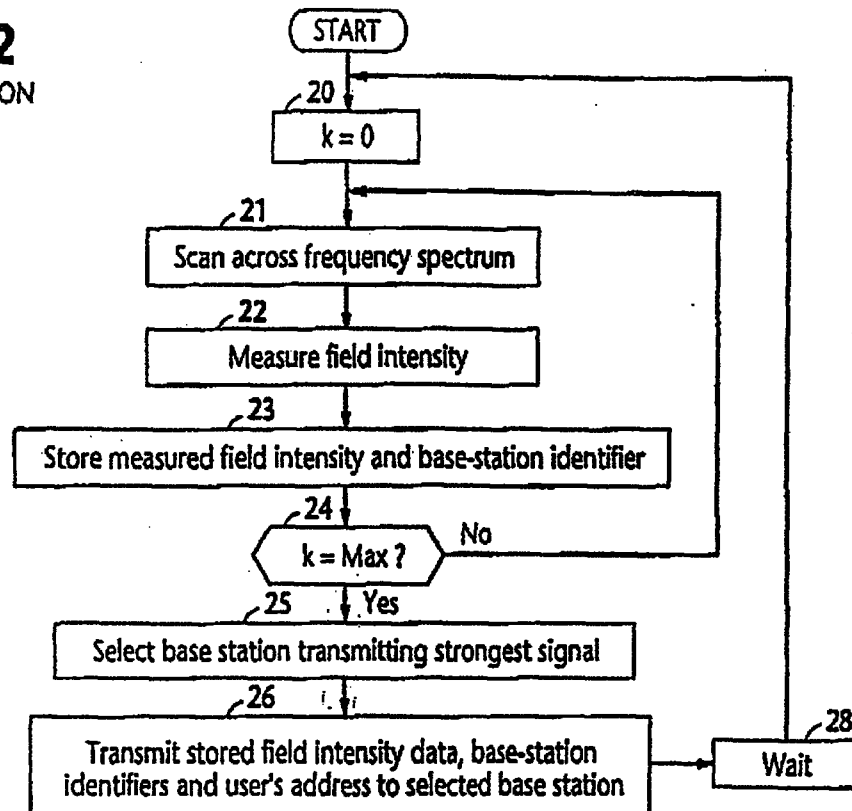
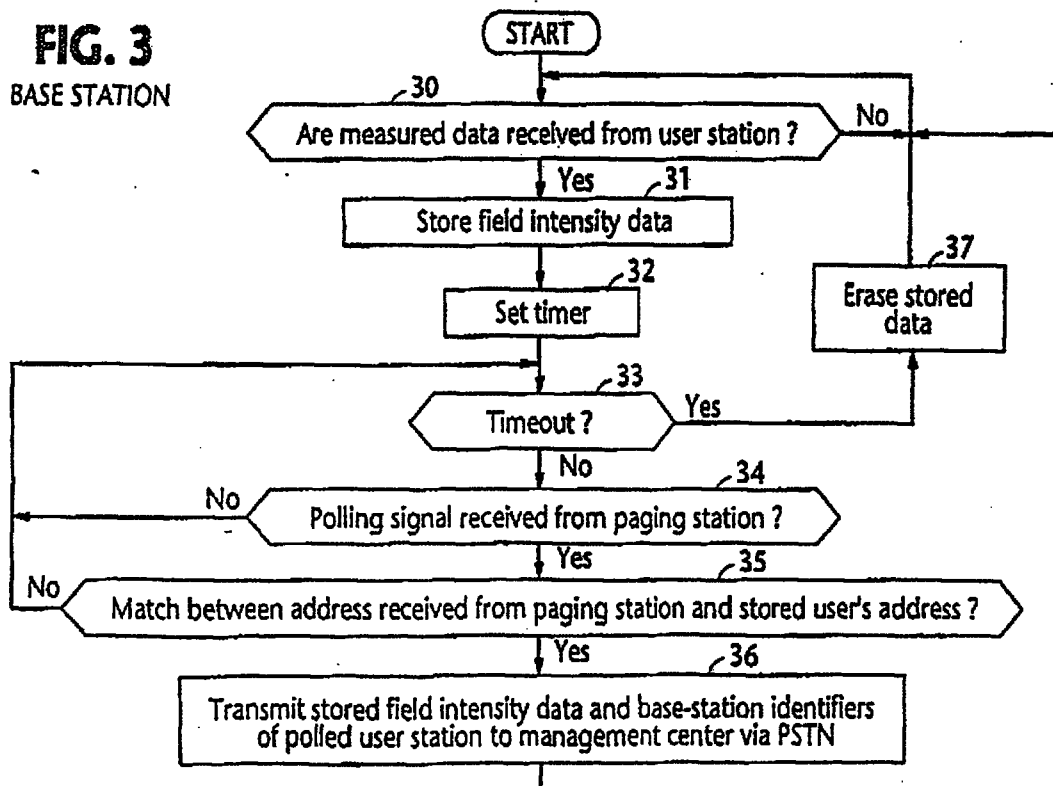


FIG. 1

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FIG. 2
USER STATION**FIG. 3**
BASE STATION

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FIG. 4
USER STATION

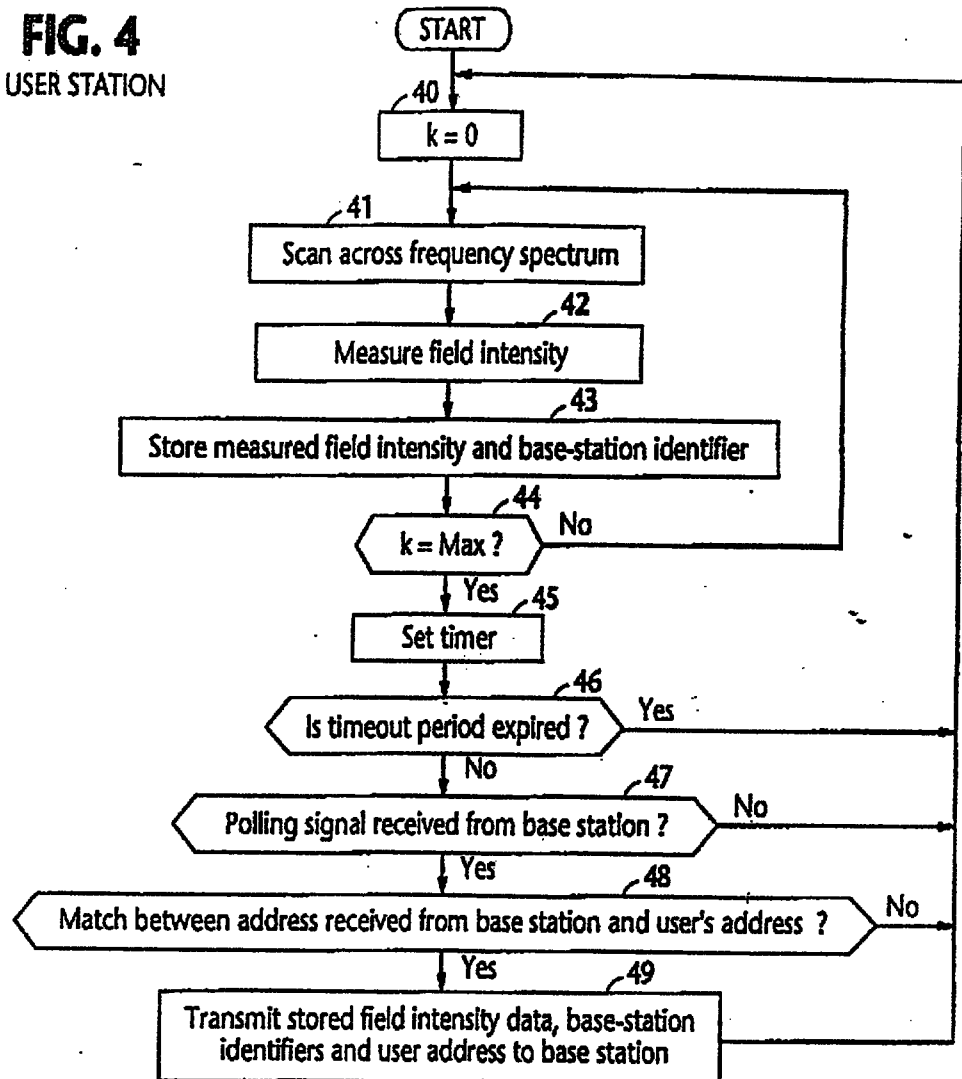
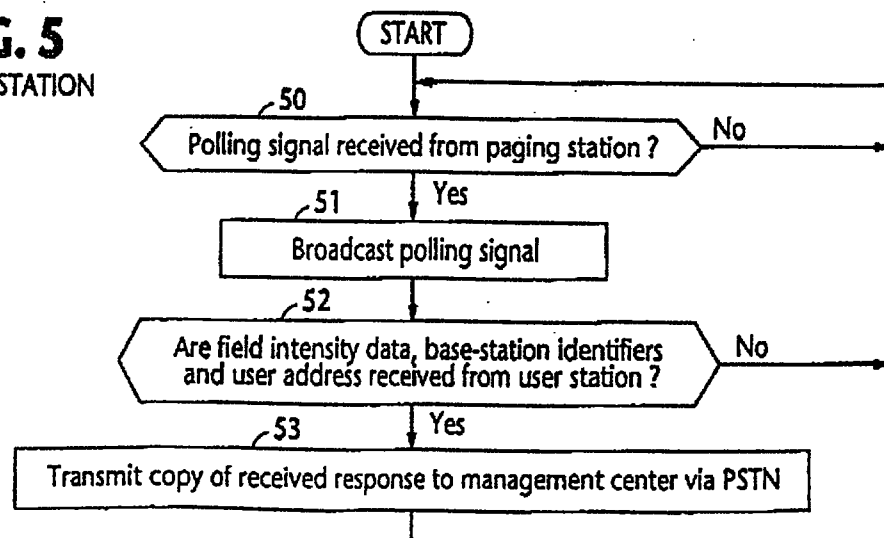


FIG. 5
BASE STATION



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REPLACEMENT SHEET

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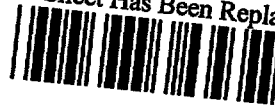
PERSON LOCATION SYSTEM

ABSTRACT

A person location system comprises radio base stations (4-8) and a radio central station (1), all stations being connected to a public switched telephone network. The base stations (4-8) respectively cover small areas, or "microcells", in one of which is located a user station, and the central station (1) covers an area containing all of the microcells. The central station (1) receives a polling signal containing the user's address via the telephone network and broadcasts a copy of the polling signal. A management center (10) is connected to the telephone network for transmitting the polling signal to the central station (1) when a location demand arises. Each base station (4-8) is responsive to the polling signal from the central station for returning field intensity data of the user station through the telephone network to the management center if the polling signal identifies the user station.

Fig. 1

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PERSON LOCATION SYSTEM

BACKGROUND TO THE INVENTION

Field of the Invention

The present invention relates to a person location system comprising a plurality of base stations which are respectively located at the sites of microcells with radius of about 100 meters.

Description of the Related Art

In a proposed person location system, a plurality of radio base stations are located to serve microcells and users are always carrying a hand-held transmitter for periodically transmitting a signal identifying the user. Each base station monitors the field intensity of the transmitted signal and informs it to a management center via a dedicated network of radio or wire-line circuits. However, such a dedicated network would be complex and costly if implemented solely with dedicated wire-line circuits, or if implemented with radio circuits since a switched network would be required for routing signals from the base stations.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a person location system which enables low-cost implementation.

According to one aspect of the invention there is disclosed a person location system comprising:

a plurality of radio base stations, connected to a public switched telephone network, for respectively covering microcells, each of said base stations being uniquely identified by an identifier and having a memory;

a user station located in one of said microcells and uniquely identified by a user's address, said user station detecting field intensities of signals transmitted from surrounding radio base stations and transmitting a field intensity signal containing detected field intensities, identifiers of the surrounding base stations and said user's address to one of the surrounding base stations;

a radio central station for covering an area containing all of said microcells, the radio central station being connected to said public switched telephone network for receiving a polling signal containing said user's address via the public switched telephone network and broadcasting a copy of the polling signal within said area, said radio central station serving as a transmitting station of a radio paging system for transmitting said polling signal and a radio paging signal having a message for radio pagers owned by subscribers of the radio paging system; and

a management center connected to said public switched telephone network for transmitting said polling signal through a switched connection established by said public switched telephone network to said central station,

each of said base stations receiving the field intensity signal from said user station and storing the received field intensity signal into said memory, each of the base stations being responsive to said polling signal for notifying the field intensities and the identifiers contained in the stored field intensity signal through a switched connection established by said public switched telephone network to said management center if the user's address in said polling signal matches the user's address in said field intensity signal,

said management center determining the location of said user station based on the field intensities and the identifiers notified by the base station.

According to yet another aspect of the invention there is disclosed A location system comprising:

a plurality of radio base stations, connected to a public switched telephone network, for respectively covering microcells, each of said base stations being uniquely identified by an identifier;

a user station located in one of said microcells and uniquely identified by a user's address, said user station having a memory and detecting at intervals, field intensities of signals transmitted from surrounding base stations and storing the detected field intensities

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into said memory and being responsive to a polling signal containing said user's address, said user station for transmitting a field intensity signal containing the stored field intensities and identifiers of the surrounding base stations to one of the surrounding base stations;

a management center connected to said public switched telephone network for transmitting said polling signal through a switched connection established by said public switched telephone network; and

a radio central station for covering an area containing said microcells, the radio central station being connected to said public switched telephone network for receiving said polling signal via said switched connection from said management center and broadcasting a copy of the polling signal within said area, said radio central station serving as a transmitting station of a radio paging system for transmitting said polling signal and a radio paging signal having a message for radio pagers owned by subscribers of the radio paging system,

each of said base stations receiving the field intensity signal transmitted from said user station and being responsive to said polling signal for notifying the field intensities and the identifiers contained in the field intensity signal to said management center through a switched connection established by said public switched telephone network,

said management center determining the location of said user station from the field intensities and the identifiers notified by the base station.

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BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be described in further detail with reference to the accompanying drawings, in which:

Fig. 1 is a block diagram of a person location system according to the present invention;

Fig. 2 is a flowchart of operations performed by the user station according to a first embodiment of the present invention;

Fig. 3 is a flowchart of operations performed by the base station according to the first embodiment of the present invention;

Fig. 4 is a flowchart of operations performed by the user station according to a second embodiment of the present invention; and

Fig. 5 is a flowchart of operations performed by the base station according to the second embodiment.

DETAILED DESCRIPTION

Referring to Fig. 1, a first embodiment of a person location system of the present invention comprises cell-site base stations 4-8 which are located in respective small zones or "microcells" each with a radius of about 100 meters. Base stations 4-8 are connected to a public switched telephone network (PSTN) 3 through respective exchange lines 4a-8a. At the center of a larger area 2 that covers all microcells of base stations 4-8 there is located a radio paging station 1, which is connected to the PSTN 3 through exchange line 1a. Each user of the system carries a hand-held radio transceiver, or user station 9, which is uniquely identified by a user's address. The user station 9 periodically scans across the spectrum of frequencies used by all the base stations, and measures the field intensity of each signal transmitted from surrounding base stations. The management center 10 transmits a polling signal containing the user's address of a desired user station through the PSTN to the paging station

**CLAIMS:****1. A person location system comprising:**

a plurality of radio base stations, connected to a public switched telephone network, for respectively covering microcells, each of said base stations being uniquely identified by an identifier and having a memory;

a user station located in one of said microcells and uniquely identified by a user's address, said user station detecting field intensities of signals transmitted from surrounding radio base stations and transmitting a field intensity signal containing detected field intensities, identifiers of the surrounding base stations and said user's address to one of the surrounding base stations;

a radio central station for covering an area containing all of said microcells, the radio central station being connected to said public switched telephone network for receiving a polling signal containing said user's address via the public switched telephone network and broadcasting a copy of the polling signal within said area, said radio central station serving as a transmitting station of a radio paging system for transmitting said polling signal and a radio paging signal having a message for radio pagers owned by subscribers of the radio paging system; and

a management center connected to said public switched telephone network for transmitting said polling signal through a switched connection established by said public switched telephone network to said central station,

each of said base stations receiving the field intensity signal from said user station and storing the received field intensity signal into said memory, each of the base stations being responsive to said polling signal for notifying the field intensities and the identifiers contained in the stored field intensity signal through a switched connection established by said public switched telephone network to said management center if the user's address in said polling signal matches the user's address in said field intensity signal,

said management center determining the location of said user station based on the field intensities and the identifiers notified by the base station.

2. A person location system as claimed in claim 2, wherein each of said base stations comprises means for erasing the stored field intensity signal if a prescribed timeout period expires after the reception of the field intensity signal from the user station.

3. A person location system as claimed in claim 1, wherein each of said base stations serves mobile telephone units.

4. A location system comprising:

a plurality of radio base stations, connected to a public switched telephone network, for respectively covering microcells, each of said base stations being uniquely identified by an identifier;



a user station located in one of said microcells and uniquely identified by a user's address, said user station having a memory and detecting at intervals, field intensities of signals transmitted from surrounding base stations and storing the detected field intensities into said memory and being responsive to a polling signal containing said user's address, said user station for transmitting a field intensity signal containing the stored field intensities and identifiers of the surrounding base stations to one of the surrounding base stations;

a management center connected to said public switched telephone network for transmitting said polling signal through a switched connection established by said public switched telephone network; and

a radio central station for covering an area containing said microcells, the radio central station being connected to said public switched telephone network for receiving said polling signal via said switched connection from said management center and broadcasting a copy of the polling signal within said area, said radio central station serving as a transmitting station of a radio paging system for transmitting said polling signal and a radio paging signal having a message for radio pagers owned by subscribers of the radio paging system,

each of said base stations receiving the field intensity signal transmitted from said user station and being responsive to said polling signal for notifying the field intensities and the identifiers contained in the field intensity signal to said management center through a switched connection established by said public switched telephone network,

said management center determining the location of said user station from the field intensities and the identifiers notified by the base station.

5. A person location system as claimed in claim 4, wherein each of said base stations comprises means responsive to said polling signal supplied from said central station for broadcasting a copy of the polling signal.

6. A person location system as claimed in claim 5, wherein said field intensity signal additionally contains the address of the user station.

7. A location system as claimed in claim 5, wherein each of said base stations serves mobile telephone units.

PERSON LOCATION SYSTEM

ABSTRACT

A person location system comprises radio base stations (4-8) and a radio central station (1), all stations being connected to a public switched telephone network. The base stations (4-8) respectively cover small areas, or "microcells", in one of which is located a user station, and the central station (1) covers an area containing all of the microcells. The central station (1) receives a polling signal containing the user's address via the telephone network and broadcasts a copy of the polling signal. A management center (10) is connected to the telephone network for transmitting the polling signal to the central station (1) when a location demand arises. Each base station (4-8) is responsive to the polling signal from the central station for returning field intensity data of the user station through the telephone network to the management center if the polling signal identifies the user station.

Fig. 1