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(54) Title: GLOBAL SATELLITE COMMUNICATION SYSTEM WITH GEOGRAPHIC PROTOCOL CONVERSION
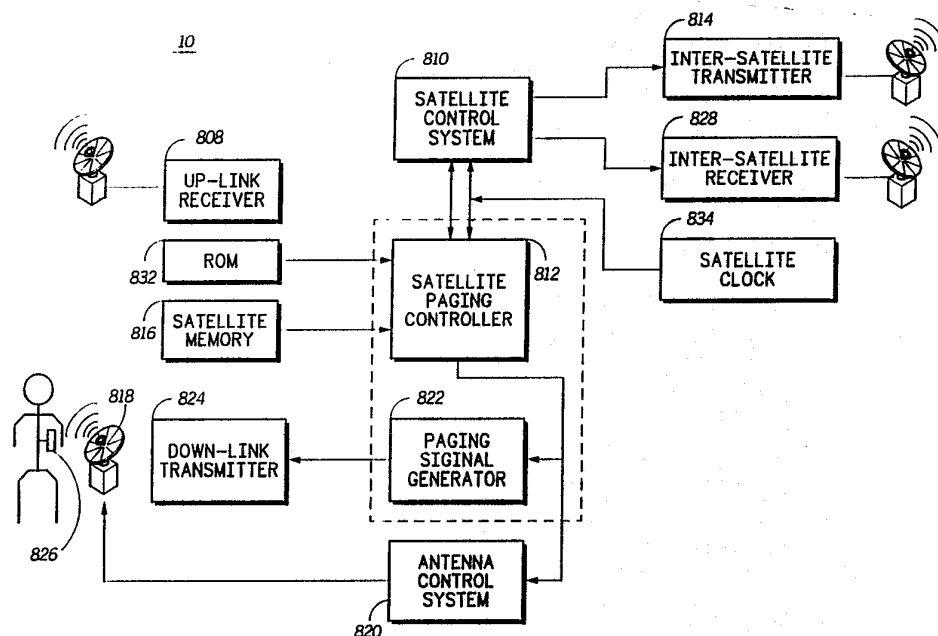
(57) Abstract

A satellite paging system is described for providing geographic protocol conversion for data packet delivery to communication receivers (826) located in a plurality of geographic areas (14). The system includes a transmitter (16) for transmitting data packets formatted in a first predetermined data format to the communication satellite (12). The satellite (12) includes a receiver (808) for receiving the data packets and a programmable encoder (822) coupled to the receiver for encoding the received data packets into encoded data packets in a second predetermined data format corresponding to the signalling requirements of each geographic delivery area. A satellite transmitter (824) coupled to the programmable encoder (822) then transmits the encoded data packets in the second predetermined data format to a portable communication receiver (826), operable in the second predetermined data format in the geographic delivery area (14).

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GLOBAL SATELLITE COMMUNICATION SYSTEM
WITH GEOGRAPHIC PROTOCOL CONVERSION

5   BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION:

      The present invention relates to global satellite
communication systems and more particularly to a global
10   satellite communication system providing signaling protocol
conversion based on geographic coverage provided.

DESCRIPTION OF THE PRIOR ART:

15   Numerous nationwide communication systems, such as
nationwide paging systems, have been proposed and a number
of such systems are currently in operation around the
world. While these systems fulfill the need to deliver
information on a limited nationwide basis, they fall short
20   of providing true nationwide information delivery. This is
due to the fact that such nationwide systems were limited
only to those service areas where the nationwide system
service provider had a communication system infrastructure
in place, which was generally only in the major
25   metropolitan areas. Such nationwide systems have provided
a centralized message input, or collection, point to which
all messages to be handled by the system were directed.
The messages were then distributed by landline or by
satellite to each of the cities in the network. The
30   messages, as they were received in each of the network
cities, were then processed as a conventional message for
transmission throughout the local systems. Because the
messages were transmitted throughout the nationwide system,
problems with message throughput are expected as the number
35   of subscribers belonging to the system increases.
      Networking such nationwide systems to provide
information delivery on a global basis reaching far beyond

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the immediate boundaries of the nationwide system service
provider is a goal of many of these systems. However, such
systems would at best, only provide limited global system
coverage in the manner described for the present nationwide
5   systems. It would also be anticipated that the problems
with message throughput would become even more severe when
the messages are distributed throughout the global system,
and transmitted in each of the cities making up the global
system.
10   One solution to the problem of limited nationwide
paging coverage, and complete global paging coverage, is by
means of a satellite based communication system, in which
the satellite, or satellites, would be active in
transmitting the messages directly to the ground based
15   communication receivers. The success of such a satellite
based communication system would depend directly on how
many users can be covered by the system to help defray the
very high costs associated with satellite systems. In
addition, the acceptance of a global communication system
20   would depend on the utility the system offers the end-
users.
Acceptance of a satellite based communication system
is complicated by the fact that there are several
"standard" paging protocols in use around the world. These
25   paging protocols include such digital signaling formats as
the Golay Sequential Code (GSC) and POCSAG signaling
formats, and such analog tone signaling formats as the
Motorola 5/6-tone signaling format and the ZVEI and CCIR 6-
tone signaling formats. Many other signaling formats are
30   in use, as well, around the world. New signaling
standards, such as the ERMES European paging standard will
also be in place in the future. To facilitate a global
satellite paging system, the system would have to provide
service in a number of signaling formats in order to gain
35   the broad acceptance required to make such a system cost
effective. By providing information delivery in a number
of signaling formats, messages may be inputted into the

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system anywhere in the world and would be effectively
delivered directly to the end-user anywhere in the world,
without requiring the end-user to have a pager capable of
decoding a particular signaling format dedicated to the

5   global satellite based communication system.

In addition to the problems associated with processing
multiple signaling formats, the assignments of operating
frequencies for pagers operating in the global system is
subject to national and regional conventions regulated by

10 the International Telecommunications Union (ITU) and
national regulatory agencies, such as the Federal
Communications Commission (FCC), as the communication
satellite sweeps over the earth. This would require the
satellite paging system to adhere to the local laws and

15 regulations in a particular nation or region in order that
service be provided on a global basis. Such a satellite
based communication system must be capable of selectively
transmitting over limited geographic areas on a number of
different operating frequencies.

20 Pagers operating within the system which allow the
end-user to roam, or travel, from place-to-place throughout
the world would also need to be frequency-agile, in order
for the pager to maintain communication with the satellite
transmissions throughout the world. However, because the

25 satellites are capable of delivering messages in a variety
of signaling formats, the requirement of the pager to
process different signaling formats is eliminated.

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SUMMARY OF THE INVENTION

It is an object of the present invention to provide a communication system providing global communication coverage.

It is a further object of the present invention to provide a global communication system which is satellite based.

It is a further object of the present invention to provide a satellite based communication system providing improved message throughput.

It is a further object of the present invention to provide a satellite based communication system providing geographical signaling protocol conversion.

In a first embodiment of the present invention, a global satellite paging system is described which provides geographic protocol conversion for data packet delivery to paging receivers having different signaling requirements in a plurality of geographic areas. Data packets are transmitted to the satellite in a first predetermined signaling format which provides high message throughput. Within the satellite the data packets received in the first predetermined signaling format are converted to a second predetermined signaling format which corresponds to that required for message transmission to paging receivers located in each geographic area traversed by the satellite.

In a second embodiment of the present invention, the data packets are transmitted to an earth based satellite station in a first predetermined signaling format which provides high message throughput. The data packets are converted at the earth based satellite station from the first predetermined data format to a second predetermined data format which corresponds to that required for message transmission to paging receivers located in each geographic area traversed by the satellite.

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For either embodiment of the present invention, both synchronously and non-synchronously orbiting satellites can be employed.

5   **BRIEF DESCRIPTION OF THE DRAWINGS**

The features of the invention which are believed to be novel are set forth with particularity in the appended claims. The invention itself, together with its further
10   objects and advantages thereof, may be best understood by reference to the following description when taken in conjunction with the accompanying drawings, in the several figures of which like reference numerals identify identical elements, in which, and wherein:
15   Figures 1A and 1B are pictorial representations of a synchronous satellite configuration for a satellite based communication system providing geographical protocol conversion of the present invention.
Figure 2 is a pictorial representation of a non-
20   synchronous satellite configuration for a satellite based communication system providing geographical protocol conversion of the present invention.
Figure 3 is a diagram depicting a global telecommunication network used to receive and process
25   messages for the satellite based communication system of the present invention.
Figure 4 is a diagram illustrating the ground station to satellite communication for the non-synchronous satellite based communication system of the present
30   invention.
Figure 5 is a diagram illustrating the intersatellite communication for the non-synchronous satellite based communication system of the present invention.
Figures 6A and 6B are timing diagrams illustrating
35   formats for entering messages into the satellite based communication system of the present invention.

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Figure 7 is a timing diagram illustrating the format for satellite routing in the satellite based communication system of the present invention.

Figure 8A shows a simplified block diagram depicting the flow of the message information through the satellite based communication system of the present invention.

Figure 8B is an electrical block diagram illustrating the apparatus of the trunk station for the satellite based communication system of the present invention.

Figure 8C is an electrical block diagram illustrating the apparatus of the satellites for the satellite based communication system of the present invention.

Figure 9 is a flow chart illustrating the message flow for the satellite based communication system of the present invention.

Figure 10 is an electrical block diagram of a portable communication receiver for use in the satellite based communication system of the present invention.

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DESCRIPTION OF THE PREFERRED EMBODIMENTS

With respect to the figures, FIGs. 1 through 10
5   illustrate the preferred embodiment of a satellite based
communication system providing geographical protocol
conversion. Reference is directed to FIGs. 1A and 1B which
show a first embodiment for a configuration of the global
satellite communication system providing geographical
10   protocol conversion of the present invention. As shown in
FIG. 1A, one or more satellites 10 (only one of which is
shown) are positioned in synchronous orbits for
transmitting communication signals to the earth using an
antenna 12 with a steerable beam. The steerable beam
15   antenna is used to focus a transmitted radio frequency
signal on a small geographical area, such as indicated by
the beam footprint of area 14 of FIG. 1A. Such focusing of
the transmitted signal produces sufficient ground level
signal strength to provide adequate performance of ground
20   based communication receiving equipment, such as paging
receivers or pagers, operating within the boundaries of
area 14. Wide area coverage is obtained in the system by
moving, or steering, the beam to point at different
geographical areas 14 on the earth as shown in FIG. 1B. In
25   the system of FIG. 1A, the satellite can also change the
signaling protocol and/or the down link frequency when
serving customers in different geographical areas. As for
example, the down link signal would be transmitted at a
frequency of 1.5 Gigahertz (GHz) using the POCSAG signaling
30   format for pagers located in the geographical areas
indicated by the letter B for the geographic areas within
Europe in FIG. 1B. The down-link signal would be
transmitted at a frequency of 900 Megahertz (MHz) using the
Golay Sequential Code (GSC) signaling format for pagers
35   located in the geographical areas indicated by the letter A
for North and Central America. It will be appreciated, the
choice of down link frequency is not arbitrary, but is

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controlled by the various national regulatory agencies in
each country or geographic area covered by the beam
footprint, as such, actual transmitter frequencies may vary
widely as operating frequencies are assigned within the
5 satellite based communication system.

   Entry of the messages into the satellite based
communication system is through the public switched
telephone network (PSTN) which directs the messages to a
ground station 16, or gateway, for transmission of
10 information to the synchronous satellite 10 by way of
uplink antenna 18, as shown in FIG. 1A. In the preferred
embodiment of the present invention, three synchronous
communication satellites at an altitude of approximately
35,000 KM would provide total global coverage with ground
15 stations, such as gateway 16, suitably located around the
world to communicate with a corresponding synchronous
satellite. The format of the information being transmitted
to and from the satellite to provide the geographical
protocol conversion of the present invention will be
20 described in detail shortly.

   When multiple synchronous satellites are employed in
the satellite communication system of the present
invention, message information received at any of the
ground stations is transferred to the corresponding
25 satellites. However, it will be appreciated, some of the
message information transferred to the particular satellite
may be directed to pagers which are located in geographical
areas not covered by the particular satellite receiving the
message information. In this instance, intersatellite
30 communications is provided between each of the synchronous
satellites in orbit which allow the transfer of message
information to the appropriate satellite which will
ultimately deliver the messages to the pagers in a
particular geographical area. Intersatellite
35 communications will be described in further detail later in
the specification.

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Referring to FIG. 2, a second embodiment of a satellite configuration for a global satellite based communication system is shown. In this configuration, a plurality of satellites are shown in non-synchronous, low

5   earth orbits. The satellites are placed in a number of orbiting planes. The orbiting planes (3 through 8), as shown, are highly inclined in nature and provide paging coverage for the entire earth. With this system, as with the synchronous satellite based communication system of

10   FIG. 1, users located anywhere on a land mass, on the water or in the air at an altitude less than that of the orbiting satellites may be paged by anyone having access to the public switched telephone network.

In the preferred embodiment of the non-synchronous

15   satellite based communication system of the present invention, eleven satellites are placed in each of seven orbiting planes at an altitude of 413.53 nautical miles (765.86 kilometers) to provide complete global coverage, with each satellite in this orbit completely circling the

20   globe approximately once every 100 minutes. It will be appreciated by one of ordinary skill in the art that the number of satellites required in the system of FIG. 2, the altitude and the orbit time are a function of how highly inclined are the orbiting planes. Lower inclined orbiting

25   plane configurations would require more satellites than more highly inclined orbiting plane configurations. It will also be appreciated the number of satellites described in the preferred embodiment of the satellite based communication system is by way of example only, and other

30   satellite configurations including a greater number, or a fewer number could be utilized depending upon the particular system requirements.

Each satellite in either the synchronous or non-synchronous satellite based communication system contains a

35   satellite control systems unit, suitable antennas 11 (helical antennas for up/down links and for cross links, for example) and an unfolding array of solar cells 12 along

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with storage batteries (not shown) connected to the solar cells to provide power to the control systems unit, and a satellite paging controller to provide the necessary geographic protocol conversion. The satellite vehicles
5   themselves are low-earth orbiting satellites such as those commercially available for the non-synchronous satellite based communication system. The satellites in the non-synchronous as well as the synchronous systems, are put into orbit by a launching vehicle. When in orbit, the
10   solar cell array is opened and the switching unit thereby activated. The satellites are then individually brought on line via standard telemetry, tracking and control (TT&C) channels to form the satellite based communication system.

In operation, messages are entered into the satellite
15   based communication system from anywhere in the world through the public switched telephone network (PSTN). FIG. 3 depicts a typical interconnection of a portion of the global satellite network which may be used for entry of messages into the satellite based communication system of
20   the present invention. The global satellite network comprises local input nodes 20 and regional input and/or collection nodes 22 which act to concentrate and channel the messages into the satellite based communication system. The local input nodes 20 comprise terminals (not shown),
25   such as paging terminals, which are well known in the art, to receive and process the messages received through the public switched telephone network. The local input nodes 20 are generally located at the facilities of the local paging service providers participating in the global
30   satellite network, and as such, provide both the capability for controlling local paging services, and message handling and processing for the satellite based communication system as well. A large metropolitan area, such as indicated as Region B, can have multiple local input nodes 20,
35   representative of a number of local paging service providers which are participating in the global satellite network. Other geographic areas, such as indicated by

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Region A could represent local paging service providers located in major metropolitan areas located throughout a country, such as Canada.

 5   The messages directed to the global satellite network are routed from the local input node 20 to the regional input, or collection node 22. Regional collection node 22 acts to further concentrate the messages from each of the local input nodes 20 for a particular geographic area, such as the large metropolitan area, a state, a country, or even

10   a continent. The regional concentration of messages provides the most cost effective means for transmission of the messages to the trunk site 16. Because of the large volume of message traffic which must be handled to fulfill the economic requirements of a satellite based system, it

15   is important that the transmission time required to transmit the messages received throughout the global satellite network be minimized. Message throughput is improved in the system of the present invention by not encoding the messages received at the local inputs nodes

20   into the final signaling format prior to transmission to the trunk site. The messages are transmitted from the local input node 20 to the regional collection node 22, or from the local input node 20 to the trunk site 16 as raw data, such as BCD (binary coded decimal) or ASCII data. It

25   will be appreciated by one skilled in the art, substantial transmission time is saved by only transmitting the raw data using conventional data transmission techniques which are well known in the art, as compared to transmitting the data encoded into the final encoded signaling format, which

30   multiplies the data handling requirements by as much as a factor of two or more.

      Interconnection of the network between the local input nodes 20 and the regional input nodes 22, and the regional input nodes 22 to the trunk site 24 may be provided by any

35   of a number of well known methods, such as landlines, and microwave or satellite communications, depending on the distances involved and the volume of message traffic being

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handled from any given input node. It will be appreciated
that the structure of the global satellite network
described is by way of example only, and is representative
only of a system for concentrating and processing the
5   volume of information which is anticipated in a satellite
based communication system.

FIG. 4 shows a diagram of the relative positioning for
a number of non-synchronous satellites orbiting in any one
of the plurality of orbiting planes, as described for FIG
10   2. An up-link transmitter, or gateway, 16 is provided to
transmit the message data received from throughout the
system to each of the orbiting satellites 12 as they pass
substantially over the gateway 24. Since all satellites in
the global satellite based communication system are in
15   orbits which pass over the poles, as previously described
in FIG. 2, only a single gateway 16 is required to access
each of the satellites for control and for message delivery
from the gateway 16, as shown. It will be appreciated, the
position of the gateway shown is by way of example only,
20   and other geographic locations throughout northern North
America would be suitable for locating the gateway 16.

As shown in FIG. 5, messages received via the public
switched telephone network from a PSTN user are routed to
the trunk site 16, in a manner similar to that described
25   for FIG. 3. The message information is independently
beamed up to each satellite 12 in an orbiting plane as each
satellite 12 appears substantially overhead via beams J-1,
L-1, etc. Each satellite 12 in a particular orbiting plane
is also linked via intersatellite communication to the next
30   satellite and previous satellite, as indicated by example
by link I-1, link I, link I+1, and so on, for satellites
orbiting in plane N-1. This intersatellite communication
system provides a means for distributing messages received
by any particular satellite 12 in one orbiting plane to
35   each and any of the other satellites 12 located in the same
orbiting plane, or any other orbiting plane. In the latter
case, intersatellite communication is provided in the

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system between one or more satellites 12 in other orbiting
planes, as indicated by beam M1+ and M1-, and so forth for
satellites 12 orbiting in planes N and N-1. That is each
satellite 12 in a given orbiting plane is linked to a
5   previous satellite (beam M#-) and the next satellite (beam
M#+) in an adjacent orbiting plane, thereby providing a
means for distributing the received global message
information throughout the entire satellite system. The
intersatellite links are implemented via data transmission
10   on a communications channel, such as a microwave beam or
via a laser beam. Existing technologies currently provide
for such data transmission. It will be appreciated, that
while the previous description described intersatellite
communication for a satellite system utilizing non-
15   synchronous satellites, a similar system is can be used
with synchronous satellites.

As previously described in FIG 2, each satellite in
the non-synchronous satellite system of the present
invention completely circles the globe every 100 minutes.
20   Since each orbiting plane is occupied by eleven satellites
in the preferred embodiment of the present invention, a new
satellite appears substantially over any geographic area
approximately once every nine minutes from any one orbiting
plane. Since there are seven satellite orbits provided in
25   the non-synchronous satellite system of the present
invention, a new satellite from one of the seven satellite
orbits appears substantially over the gateway 16, once
every one minute and eighteen seconds. As a result, global
message information and control information is transmitted
30   from the gateway 16 to one of the eleven satellites in one
of the seven orbiting planes which regularly appears over
the gateway 16. Thereafter, the global message information
is processed on-board the receiving satellite, as will be
explained in further detail later, for further distribution
35   of the information to the other satellites located around
the world, or is transmitted by the receiving satellite to

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those communication receivers falling in the present track
of the receiving satellite.

As previously described, global message information
entered into the satellite based communication system of
5   the present invention is forwarded from the local inputs
nodes 20 to the gateway 16 without being processed into a
particular signaling format. In one embodiment of the
present invention, the global message information is
processed into the appropriate signaling format for the
10   pager to which the information is directed, prior to the
transmission from the gateway 16 to the overhead receiving
satellite. In an alternate embodiment of the present
invention, the global message information is transmitted
from the gateway 16 to the overhead receiving satellite
15   without processing into the final signaling format. In
this instance, the final processing into the appropriate
signaling format occurs within the particular satellite
which is to ultimately deliver the message. The operation
of both embodiments of the present invention will become
20   more apparent in the description to follow.

FIG. 6A, shows one possible format for the entry of
information by a message originator through the public
switched telephone network. It will be noted, FIG. 6A
shows a format that is very similar to that used for
25   international telephone service. That is, the format
contains a country code 100, an exchange or location code
102, and a pager I.D. number 104 followed by the message
106. This format would be used when the message originator
knows the particular country code 100 and location code 102
30   information for the pager to which the message is intended.
The country code 100 and the location code 102 information
is processed at the trunk station to determine satellite
routing information which will be described in detail
shortly. The routing information defines which satellite
35   in the synchronous or non-synchronous satellite systems
will be in position to deliver the message at the earliest
time. The country code 100, location code 102, pager I.D.

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number 104, message portion 106 and the orbiting
information are transmitted from the trunk station to the
satellite currently overhead. Once received, the routing
information is processed, as will be described shortly, to

5   forward the message to the delivery satellite anywhere
around the globe. The message delivery satellite uses the
country code 100 and location code 102 information to
determine the appropriate down link frequency and signaling
protocol for message delivery. In one embodiment of the

10   present invention, the information transmitted from the
trunk station to the satellites is not encoded, except for
that required to guarantee reception at the satellite
overhead. The I.D. Number 104 and the message 106, which
were received in an ASCII data format, are encoded by the

15   delivery satellite into the appropriate signalling format
for the geographic delivery area, such as the POCSAG or GSC
signaling formats. At the appropriate time, when the
delivery satellite passes over the geographic area
determined by the country code 100 and the location code

20   102 information, the message is beamed down to deliver the
message to the intended pager.

        FIG. 6B shows an alternate format for message entry,
wherein the country code 100 and location code 102
information is automatically provided by the system based

25   on the current location of the pager to which the message
is being directed. In this embodiment, the current
location of each pager in the system is tracked in the
terminal associated with the local paging system to which
the pager is assigned. When the user is in the home, or

30   local system area, messages entered through the local input
node, are directed for transmission on the local non-
satellite system. However, when the user plans to leave
the local area, such as for a business trip from Chicago to
Singapore, the user would call in to the paging service

35   provider to indicate the destination, and departure and
arrival times. The system thereafter automatically adds
the country code 100 and the location code 102, to the

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pager I.D. number 104 and the message 106 entered by the
message originator.   The system thereafter automatically
routes the message through the satellite system, as
previously described, to the proper geographic area, adding

5   the appropriate country code 100 and location code 102,
when the user is away from the local system, and omits the
country code 100 and the location code 102 when the user is
within the area of the local system.   In this the second
embodiment for message input, the required coding changes

10   are transparent to the call originator, while the message
may be delivered anywhere in the world.

As previously described, satellite routing information
is added at the trunk station prior to the up-link
transmission to the satellites overhead.   The format of the

15   satellite routing codeword are shown in FIG. 7 It will be
appreciated the format of the codeword shown is for example
only, as other codeword formats may be provided depending
upon the number of satellites and orbits provided within
the satellite system.   As the messages are received at the

20   trunk station, the country code and location code are
evaluated to determine which satellite will be in a
position to deliver the message at the earliest possible
time.   The routing code provides an orbit number 108 and
satellite number 110 of the satellite that will be

25   scheduled to deliver the message.   The delivery satellite
selection is based upon a number of factors, such as
whether the system is synchronous or non-synchronous, and
the time to transmit the messages to the satellites and to
route the messages through the satellite system.   The

30   messages are transmitted from the trunk station to the
receiving satellite currently overhead in data packets
containing a predetermined number of messages.   After the
data packet has been received by the receiving satellite,
the routing code for each of the predetermined number of

35   messages is processed to determine the routing through the
intersatellite communication system for each message.
Depending on the grouping of messages for the various

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geographic areas, it will be appreciated there can be
numerous routes initiated by the receiving satellite.

In an alternate embodiment of the present invention,
the routing code, rather than being determined at the trunk
5   station, is determined by the receiving satellite. This
embodiment reduces the amount of information which must be
transmitted from the trunk station to the satellites, but
as it will be appreciated, increases the complexity of the
processing required by each satellite.

10   FIG. 8A shows a simplified block diagram depicting the
flow of the message information through the satellite based
communication system. The paging messages received at the
local input nodes via the public switched telephone network
are received by the trunk station. The messages are
15   processed, as previously described, by the ground station
equipment described in FIG. 8B. The processed messages are
transmitted to the satellites in data packets via an up-
link channel as each new satellite appears substantially
overhead, as in the case of a non-synchronous satellite
20   system. The received data packets are processed by the
satellite equipment described in FIG. 8C. This processing
includes such steps as the selection of the transmission
frequency, and encoding of the message information into the
signaling protocol required for the geographic delivery
25   area. At the appropriate time, the satellite beams down
the messages using a down-link channel set to the proper
frequency for the geographic area. The messages after they
have been beamed down, are received by pagers operable in
the satellite system, whereupon the user is alerted for
30   having received the message.

Figure 8B is a block diagram illustrating the
apparatus of the trunk station 16 for the satellite based
communication system of the present invention providing
geographical protocol conversion. Messages transmitted
35   through the global satellite network are received at the
trunk station 16 by the ground station paging terminal 802
through one or more inputs. As previously described, the

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message information delivered to the inputs may be
delivered via landline, or microwave or satellite
communication, or any combination thereof. The ground
station paging terminal 802 receives the message

5   information in a manner well known in the art, temporarily
storing the information in ground station memory 803 in an
active message file, or queue. Ground station memory 803
provides non-volatile storage of the received message
information, such as provided by a hard disk memory. As

10   previously described the country code and location code
information added by the terminal at the local input node,
is processed and the appropriate routing code for each
message received is determined and added to the
corresponding message data stored in the active message

15   queue. The routing information is determined from
satellite network information stored in read only memory
(ROM) 805 and the known current position of each of the
satellites around the world.

The format of the information of the active message

20   queue is essentially the same as when originally entered
into the system, in a BCD or ASCII format together with the
added codewords for satellite routing, as previously
described. At the appropriate time, as determined from the
high precision system clock 830 which couples to the ground

25   station paging terminal 802, the active message queue is
recovered from ground station memory 803 by the ground
station paging controller 802, and is transmitted by up-
link transmitter 804 as a message data packet having a
predetermined number of messages using directional antenna

30   18 and conventional telemetry techniques to the satellite
appearing substantially overhead. In addition to the
transmission of the active message queue to each satellite
as they appear substantially overhead, a ground station
controller 806 generates control data for transmission via

35   the up-link transmitter 804 for controlling the operation
of the satellite and its on-board systems. It will be
appreciated, the message data packet size is determined by

19

the time the satellite remains substantially overhead and
is in a position to receive information, and the time
remaining after the satellite control information has been
transmitted.

5   Figure 8C is a block diagram illustrating the
apparatus for each of the satellites of the present
invention. The control information and data packets
transmitted from up-link transmitter 804 are received by
the satellite 10 by up-link receiver 808. The control
10   information is processed in a manner well known to one
skilled in the art by the satellite control system 810,
controlling such satellite parameters as satellite
orientation and altitude. The message information is
processed by the satellite paging controller 812. When the
15   routing code is included in the message data packet, the
paging satellite controller 812 determines which of the
nearest satellites will be used in routing the message
information not intended for transmission by the receiving
satellite. The intersatellite message routing is
20   determined from satellite network information stored in the
satellite read only memory (ROM) 832. The message
information intended for transmission by the other
satellites can be transmitted to the appropriate nearest
satellite using intersatellite transmitter 814, or may be
25   temporarily stored in satellite memory 816 until all the
received message information has been processed, after
which the data may be transmitted in batches to the
appropriate nearest satellites.

          The message information intended to be transmitted by
30   the receiving satellite is further processed by satellite
paging controller 812 for country code and location code to
determine when the transmission of the message information
will occur. The message information is then temporarily
stored in memory 816 until the appropriate transmission
35   time is reached. The transmission time is determined from
the satellite control system 810 which receives timing
information from satellite clock 834 to determined the

20

satellites current position around the world. The
satellite control system 810 generates periodic position
signals which are coupled to satellite paging controller
812, thereby allowing the satellite paging controller to
5 determine the protocol requirements for each geographical
area from protocol information stored in satellite ROM 832.
As the satellite travels over each geographic area during
which down-link transmissions are to be made, the satellite
paging controller 812 controls the down-link antenna 818
10 direction via antenna control system 820. Any message
information which is stored in memory 816 will be recovered
at the appropriate time by satellite paging controller 812
from satellite memory 816 and supplied to paging signal
generator 822. The paging signal generator 822 provides a
15 programmable encoding means for encoding the message
information which was received in the first predetermined
signaling format, as previously described, and encodes the
message information into a second predetermined signaling
format corresponding to the signaling protocol utilized in
20 each geographic area to which the satellite antenna is
directed. Satellite paging controller 812 also controls
the transmission frequency of down-link transmitter 824
thereby allowing the message information encoded in the
signaling protocol for the particular geographic area to be
25 transmitted on the down-link frequency appropriate for the
particular geographic area. The transmitted message
information can then be received by the paging receiver 826
anywhere within the coverage area of the antenna beam.

       When message information is routed from one satellite
30 to the next, the routed message information is received by
intersatellite receiver 828. Satellite paging controller
processes the received message information to determined if
the received information is intended to be transmitted from
the receiving satellite, or if the message information is
35 to be routed to the next satellite in the present orbit, or
in an adjacent orbit. Message information intended to be
transmitted by the receiving satellite is stored as

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previously described and transmitted at the appropriate
time as previously described. Message information not
intended to be transmitted by the receiving satellite is
routed to the next satellite also as previously described.

5   While only a single intersatellite transmitter and receiver
are shown in FIG. 8C, it will be appreciated multiple
transmitters and receivers will be required to provide
intersatellite communication between satellites is a given
orbit and with satellites in different orbits.

10   FIG. 9 is a flow chart of the message processing for
the satellite based communication system providing
geographical protocol conversion of the present invention.
When a message is received at any of the local input nodes,
at block 902, the local terminal determines the present

15   status of the pager for which the message is intended, i.e.
whether the pager is currently assigned to receive the
messages through the local paging system, or through the
satellite based communication system. When the message is
to be delivered through the satellite based communication

20   system, at block 904, a country codeword and a location
codeword are assigned and are added to the message, when
such automatic assignment is provided, or the location
codeword entered with the message is processed to determine
the assigned country codeword and location codeword. The

25   message information is then forwarded to the trunk site for
transmission to the satellites.

         When the trunk site receives the message information,
the country codeword and location codeword are processed to
identify the satellite routing information, at block 906.

30   The satellite routing information is determined from the
present location of each of the satellites in orbit, and
the time required required to deliver the message
information to the appropriate satellite for down-link
transmission using the system clock.

35   The message information is next transmitted as a data
packet to the next satellite appearing substantially
overhead the trunk site. The receiving satellite processes

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the routing information, at block 908, to determine whether
the message is to be delivered from the receiving
satellite, or any other satellite. When the message is
received at the appropriate satellite for down-link
5   transmission, the message is queued, at block 910, for
subsequent transmission. When the transmission time is
reached, at block 912, which indicates the satellite is
over the correct geographical area, the down-link
transmitter frequency is set and the programmable encoder
10   is set for the signaling protocol required for the
particular geographical area, at block 914. The message
information is encoded into the correct signaling protocol,
and transmitted via the down-link transmitter, at block
916, to the pager for which the message is intended, which
15   is now located in the current transmission area.

FIG. 10 shows an electrical block diagram of a
portable communication receiver for use in the satellite
based communication system of the present invention. Data
packets containing paging addresses and message directed to
20   pagers located in particular geographic areas are beamed
down to the pagers in the second predetermined signaling
format, corresponding to the signaling format to which the
pager decoder is responsive. The data packets are
intercepted by the pager antenna 1000 for reception by
25   receiver 1002. Receiver 1002 is a conventional FM receiver
operating, preferably in the 900 MHz to 2.0 GHz frequency
range. The choice of operating frequency is controlled by
the ITU and national regulatory agencies as previously
described, and is controlled by channel frequency
30   synthesizer 1004 in a manner well known in the art. The
output of receiver 1002 is a stream of binary data
corresponding to the received data packet information. The
stream of binary data is applied to the input of signaling
decoder 1006, where the data is processed in a manner well
35   known in the art. Since the data packets received may be
transmitted in any of a plurality of signaling formats,
such as the Golay Sequential Code (GSC) or POCSAG signaling

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formats, data decoder 1010 is adaptive to decode either
signaling format. One such adaptive decoder is described
in U.S. Patent No. 4,518,961 to Davis et al, entitled
"Universal Paging Device with Power Conservation" which
5   assigned to the assignee of the present invention and which
is incorporated by reference herein. The decoder may also
adapt to the proper signaling format based on a received
codeword from the satellite, such as the country code or
location code codewords previously described. When an
10   address is received in the transmitted data packet which
corresponds to an address stored in code plug memory 1008,
the signaling decoder 1006 generates a control signal
enabling the operation of the data decoder 1010. The
received message is processed by the data decoder 1010
15   which converts the message information received in the
predetermined signaling format, to BCD or ASCII data which
is then stored in the message memory 1012. Upon completion
of the processing of the message information, the user is
sensibly alerted by an alerting means (not shown) which
20   couples to the signaling decoder 1006, such as by an
audible tone, or a tactile vibration to indicate a message
has been received. Upon being alerted, the user can read
the stored message by means of user controls 1014. The
user controls 1014 also provide the user such additional
25   capability as to reset the audible or tactile alert, place
the receiver in a deferred page mode, erase the message,
and protect the message in a manner well known in the art.
The message read from message memory 1012 is supplied to
display controller 1016 which provides the necessary
30   conversion from the BCD or ASCII data to that required for
display of the message on display 1018. Display 1018 is
preferably an LCD display, such as a dot matrix LCD display
capable of displaying alphanumeric message information.
The recovery of message information from the message
35   memory 1012 and display of the recalled message information
is well known in the art.

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In normal operation, the receiver is assigned to a home channel for normal operation using a conventional paging system. Or in those instances where no conventional paging system exists, the receiver may be assigned to a

5   home operating frequency for the delivery of messages from the satellite. The choice of the home channel for normal operation is determined by information periodically transmitted on the home channel in a manner well known in the art. However, once the pager user leaves the immediate

10 geographic area covered by the home channel

A global satellite based communication system providing geographic protocol conversion has been described. In this system messages intended for delivery to a pager located anywhere on earth are transmitted to

15 satellites operating in synchronous or non-synchronous orbits in a first signaling format which provides high message throughput. The messages are then transmitted by the satellites using a down-link frequency and conventional signaling protocols to earth based receivers corresponding

20 to each geographical area over which the satellites pass.

While a specific embodiment of this invention has been shown and described, further modifications and improvements will occur to those skilled in the art. All modifications which retain the basic underlying principles disclosed and

25 claimed herein are within the scope and spirit of the present invention.

25

We claim:

1.   A satellite paging system providing geographic
protocol conversion for data packet delivery to a plurality
5   of geographic areas, said satellite based communication
system comprising:
transmission means, for transmitting data packets to
the communication satellite, the data packets being
transmitted in a first predetermined data format;
10   a satellite having,
satellite receiving means, for receiving the
transmitted data packets transmitted in the first
predetermined data format;
programmable encoding means, coupled to said
15   receiving means, for encoding the received data packets
transmitted in the first predetermined data format into
encoded data packets in a second predetermined data format
corresponding to the signaling requirements of each
geographic delivery area;
20   satellite transmitting means, coupled to said
encoding means, for transmitting the encoded data packets
in the second predetermined data format; and
a portable communication receiver, operable in the
second predetermined data format in the geographic delivery
25   area, for receiving the encoded data packets transmitted in
the second predetermined data format,
whereby data packets transmitted to said satellite in
the first predetermined data format are converted within
said satellite to the second predetermined data format
30   conforming to the signaling requirements for transmission
to said portable communication receiver in the geographic
delivery area.

26

2.   The global satellite paging system according to claim 1, further comprising:

memory means, for storing a table correlating correlating the required second predetermined data format to each geographical delivery area; and

controller means, coupled to said programmable encoding means and to said memory means, for controlling the encoding of the data packets received in the first predetermined data format into data packets encoded in the second predetermined signaling format based on the current geographical delivery area.

3.   The global satellite paging system according to claim 2, wherein said satellite transmitter means is capable of transmitting on a plurality of frequencies, and said memory means further stores a table correlating transmitter frequency to the geographic location information, and wherein said controller means is further responsive to the geographic location information to transmit the data packets on one or more of the plurality of frequencies for each of the plurality of geographic delivery areas.

4.   The global satellite paging system according to claim 1 wherein the data transmitted in the first predetermined data format is ASCII encoded data.

5.   The global satellite paging system according to claim 1 wherein the data transmitted in the second predetermined data format is encoded in the POCSAG signaling format.

6.   The global satellite paging system according to claim 1 wherein the data transmitted in the second predetermined data format is encoded in the Golay Sequential Code signaling format.

7.   The global satellite paging system according to claim 1, wherein said satellite orbits in a synchronous orbit.

5   8.   The global satellite paging system according to claim 7, wherein the satellite paging system includes a plurality of satellites orbiting in synchronous orbits, and each of said satellites further comprising inter-satellite communication means for forwarding the data packet received

10   in the first predetermined data format to an adjacent satellite.

28

9.   A satellite paging system providing geographic
protocol conversion for data packet delivery to a plurality
of geographic areas, said satellite based communication
system comprising:

5   earth based satellite station, having
          receiving means, for receiving information data
packets transmitted in a first predetermined data format;
          programmable encoding means, coupled to said
receiving means, for encoding the received information data
10   packets transmitted in the first predetermined data format
into data packets encoded in a second predetermined data
format corresponding to the signaling requirements of each
geographic delivery area;
          transmission means, for transmitting data
15   packets to the communication satellite, the data packets
being transmitted in the second predetermined data format;
          a satellite having,
          satellite receiving means; for receiving the
transmitted data packets transmitted in the first
20   predetermined data format;
          satellite transmitting means, coupled to said
encoding means, for transmitting the encoded data packets
in the second predetermined data format; and
          a portable communication receiver, operable in the
25   second predetermined data format in the geographic delivery
area, for receiving the encoded data packets transmitted in
the second predetermined data format,
          whereby data packets received at said earth based
satellite station in the first predetermined data format
30   are transmitted to said satellite in the second
predetermined data format conforming to the signaling
requirements for transmission to said portable
communication receiver in the geographic delivery area.
          10.   The global satellite paging system according to
35   claim 9, further comprising:

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memory means, for storing a table correlating
correlating the required second predetermined data format
to each geographical delivery area; and

controller means, coupled to said programmable
5   encoding means and to said memory means, for controlling
the encoding of the data packets received in the first
predetermined data format into data packets encoded in the
second predetermined signaling format based on the current
geographical delivery area.
10·

11.   The global satellite paging system according to
claim 10, wherein said satellite transmitter means is
capable of transmitting on a plurality of frequencies, and
said memory means further stores a table correlating
15   transmitter frequency to the geographic location
information, and wherein said controller means is further
responsive to the geographic location information to
transmit the data packets on one or more of the plurality
of frequencies for each of the plurality of geographic
20   delivery areas.

12.   The global satellite paging system according to
claim 9 wherein the data transmitted in the first
predetermined data format is ASCII encoded data

25

13.   The global satellite paging system according to
claim 9 wherein the data transmitted in the second
predetermined data format is encoded in the POCSAG
signaling format.

30

14.   The global satellite paging system according to
claim 9 wherein the data transmitted in the second
predetermined data format is encoded in the Golay
Sequential Code signaling format.

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15.   The global satellite paging system according to claim 9, wherein said satellite orbits in a synchronous orbit.

5   16.   The global satellite paging system according to claim 15, wherein the satellite paging system includes a plurality of satellites orbiting in synchronous orbits, and each of said satellites further comprising inter-satellite communication means for forwarding the data packet received

10 · in the first predetermined data format to an adjacent satellite.

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17. A communication satellite providing geographic
protocol conversion for data packet delivery to portable
communication receivers located in a plurality of
geographic areas, comprising:

5   satellite receiving means; for receiving data packets
transmitted in a first predetermined data format;
        programmable decoding means, coupled to said satellite
receiving means, for decoding the received data packets
transmitted in the first predetermined data format to

10   provide decoded data packets;
        programmable encoding means, coupled to said decoding
means, for encoding the decoded data packets into data
packets encoded in a second predetermined signaling format
corresponding to the signaling requirements of each

15   geographic delivery area; and
        satellite transmitting means, coupled to said encoding
means, for transmitting the data packets encoded in the
second predetermined signaling format;
        whereby packetized data received by the satellite in a

20   first predetermined signaling format is converted within
the satellite to a second predetermined signaling format
for data packet retransmission conforming to the signaling
requirements for transmission to the portable communication
receivers in the geographic delivery area.

25

        18. The global satellite paging system according to
claim 17, further comprising:
        memory means, for storing a table correlating
correlating the required second predetermined data format

30   to each geographical delivery area; and
        controller means, coupled to said programmable
encoding means and to said memory means, for controlling
the encoding of the data packets received in the first
predetermined data format into data packets encoded in the

35   second predetermined signaling format based on the current
geographical delivery area.

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19.   The global satellite paging system according to claim
17, further comprising:
     satellite timing means, for generating timing
information signals;
5   memory means, for storing a table correlating the
timing information signals to the plurality of geographic
delivery areas, said memory means further for storing a
table correlating the required second predetermined data
format to each geographical delivery area; and
10 ·   controller means, coupled to said programmable
encoding means and to said memory means, and responsive to
the timing information signals, for determining the current
geographical delivery area, said controller means further
for controlling the encoding of the data packets received
15   in the first predetermined data format into data packets
encoded in the second predetermined signaling format based
on the current geographical delivery area.

     20.   The global satellite paging system according to
20   claim 18, wherein said satellite transmitter means is
capable of transmitting on a plurality of frequencies, and
said memory means further stores a table correlating
transmitter frequency to the geographic location
information, and wherein said controller means is further
25   responsive to the geographic location information to
transmit the data packets on one or more of the plurality
of frequencies for each of the plurality of geographic
delivery areas.
     21.   The global satellite paging system according to
30   claim 19, wherein said satellite transmitter means is
capable of transmitting on a plurality of frequencies, and
said memory means further stores a table correlating
transmitter frequency to the geographic location
information, and wherein said controller means is further
35   responsive to the geographic location information to
transmit the data packets on one or more of the plurality

of frequencies for each of the plurality of geographic
delivery areas.

        22.   The global satellite paging system according to
5   claim 17 wherein the data transmitted in the first
predetermined data format is ASCII encoded data.

        23.   The global satellite paging system according to
claim 17 wherein the data transmitted in the second
10 predetermined data format is encoded in the POCSAG
signaling format.

        24.   The global satellite paging system according to
claim 17 wherein the data transmitted in the second
15 predetermined data format is encoded in the Golay
Sequential Code signaling format.

        25.   The global satellite paging system according to
claim 17, wherein the satellite paging system includes a
20 plurality of satellites.

        26.   The global satellite paging system according to
claim 25, wherein said plurality of satellites orbit in
synchronous orbits.

25

        27.   The global satellite paging system according to
claim 26, wherein each of said satellites further
comprising inter-satellite communication means for
forwarding the data packet received in the first
30 predetermined data format to an adjacent satellite.

        28.   The global satellite paging system according to
claim 25, wherein said plurality of satellite orbit in non-
synchronous orbits.

35

        29.   The global satellite paging system according to
claim 28, wherein each of said satellites further

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comprising inter-satellite communication means for
forwarding the data packet received in the first
predetermined data format to an adjacent satellite.

35

30.   A global satellite paging system providing
geographic protocol conversion for data packet delivery to
a plurality of geographic areas, each of the plurality of
geographical areas requiring data packet transmission in

5   one of a plurality of different signaling formats, said
satellite based communication system comprising:
        earth based satellite station, having
                receiving means, for receiving information data
packets transmitted in a first predetermined data format;

10·   programmable encoding means, coupled to said
receiving means, for encoding the received information data
packets transmitted in the first predetermined data format
into data packets encoded in a second predetermined data
format corresponding to the signaling requirements for each

15   geographic delivery area;
                transmission means, for transmitting the encoded
data packets to a predetermined one of the plurality of
communication satellites, the data packets being
transmitted in the second predetermined data format;

20   a plurality of satellites orbiting in the plurality of
predetermined orbital planes, each having
                satellite receiving means; for receiving the
transmitted data packets transmitted in the second
predetermined data format;

25   satellite transmitting means, coupled to said
satellite receiving means, for transmitting the encoded
data packets in the second predetermined data format; and
                a portable communication receiver, operable in the
second predetermined data format in the geographic delivery

30   area, for receiving the encoded data packets transmitted in
the second predetermined data format,

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whereby data packets received at said earth based
satellite station in a first predetermined data format are
converted to the second predetermined data format
conforming to the requirements for transmission to said
5   portable communication receiver in the geographic delivery
area.

31.   The global satellite paging system according to claim
30, further comprising:
10   satellite timing means, for generating timing
information signals;
        memory means, for storing a table correlating the
timing information signals to the plurality of geographic
delivery areas, said memory means further for storing a
15   table correlating the required second predetermined data
format to each geographical delivery area; and
        controller means, coupled to said programmable
encoding means and to said memory means, and responsive to
the timing information signals, for determining the current
20   geographical delivery area, said controller means further
for controlling the encoding of the data packets received
in the first predetermined data format into data packets
encoded in the second predetermined signaling format based
on the current geographical delivery area.
25

        32.   The global satellite paging system according to
claim 31, wherein said satellite transmitter means is
capable of transmitting on a plurality of frequencies, and
said memory means further stores a table correlating
30   transmitter frequency to the geographic location
information, and wherein said controller means is further
responsive to the geographic location information to
transmit the data packets on one or more of the plurality
of frequencies for each of the plurality of geographic
35   delivery areas.

33.   The global satellite paging system according to
claim 30 wherein the data transmitted in the first
predetermined data format is ASCII encoded data.

5   34.   The global satellite paging system according to
claim 30 wherein the data transmitted in the second
predetermined data format is encoded in the POCSAG
signaling format.

10 ·   35.   The global satellite paging system according to
claim 30 wherein the data transmitted in the second
predetermined data format is encoded in the Golay
Sequential Code signaling format.

15   36.   The global satellite paging system according to
claim 30, wherein said plurality of satellite orbit in non-
synchronous orbits.

         37.   The global satellite paging system according to
20   claim 36, wherein each of said satellites further
comprising inter-satellite communication means for
forwarding the data packet received in the first
predetermined data format to an adjacent satellite.

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38. A global satellite paging system providing
geographic protocol conversion for data packet delivery to
a plurality of geographic areas, each of the plurality of
geographical areas requiring data packet transmission in
5 one of a plurality of different signaling formats, said
satellite based communication system comprising:
          earth based satellite station, having
               receiving means, for receiving information data
packets transmitted in a first predetermined data format;
10 ·   transmission means, for transmitting the
received data packets to a predetermined one of the
plurality of communication satellites, the data packets
being transmitted in the first predetermined data format;
          a plurality of satellites orbiting in the plurality of
15 predetermined orbital planes, each having
               satellite receiving means; for receiving the
transmitted data packets transmitted in the first
predetermined data format;
               programmable encoding means, coupled to said
20 receiving means, for encoding the received data packets
transmitted in the first predetermined data format into
encoded data packets in a second predetermined data format
corresponding to the signaling requirements of each
geographic delivery area;
25   satellite transmitting means, coupled to said
satellite receiving means, for transmitting the encoded
data packets in the second predetermined data format; and
          a portable communication receiver, operable in the
second predetermined data format in the geographic delivery
30 area, for receiving the encoded data packets transmitted in
the second predetermined data format,

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whereby data packets transmitted to said satellite in the
first predetermined data format are converted within said
satellite to the second predetermined data format
conforming to the signaling requirements for transmission
5   to said portable communication receiver in the geographic
delivery area.

39.   The global satellite paging system according to
claim 38, further comprising:

satellite timing means, for generating timing
10   information signals;

memory means, for storing a table correlating the
timing information signals to the plurality of geographic
delivery areas, said memory means further for storing a
table correlating the required second predetermined data
15   format to each geographical delivery area; and

controller means, coupled to said programmable
encoding means and to said memory means, and responsive to
the timing information signals, for determining the current
geographical delivery area, said controller means further
20   for controlling the encoding of the data packets received
in the first predetermined data format into data packets
encoded in the second predetermined signaling format based
on the current geographical delivery area.

25   40.   The global satellite paging system according to
claim 39, wherein said satellite transmitter means is
capable of transmitting on a plurality of frequencies, and
said memory means further stores a table correlating
transmitter frequency to the geographic location
30   information, and wherein said controller means is further
responsive to the geographic location information to
transmit the data packets on one or more of the plurality
of frequencies for each of the plurality of geographic
delivery areas.

35

40

41. The global satellite paging system according to claim 38 wherein the data transmitted in the first predetermined data format is ASCII encoded data.

5   42. The global satellite paging system according to claim 38 wherein the data transmitted in the second predetermined data format is encoded in the POCSAG signaling format.

10   43. The global satellite paging system according to claim 38 wherein the data transmitted in the second predetermined data format is encoded in the Golay Sequential Code signaling format.

15   44. The global satellite paging system according to claim 38, wherein said plurality of satellite orbit in non-synchronous orbits.

        45. The global satellite paging system according to
20 claim 44, wherein each of said satellites further comprising inter-satellite communication means for forwarding the data packet received in the first predetermined data format to an adjacent satellite.

25   46. The global satellite paging system according to claim 38, wherein each of said plurality of satellites orbits in non-synchronous orbits.

        47. A method for providing geographic protocol
30 conversion for data packet delivery to ground based communication receivers located in a plurality of geographic areas from a satellite paging system, said method comprising the steps of:
            receiving the data for data packet delivery in a non-
35 encoded format;
            transmitting the non-encoded data from a ground based station to one or more satellites;

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encoding the data within the satellite into the signaling protocol based on the geographic delivery area; and

5   transmitting the encoded data packet to the ground based communication receivers in the geographic delivery area.

48. The method according to claim 47 further comprising the step of setting the transmitter operating
10   frequency corresponding the the geographic delivery area.
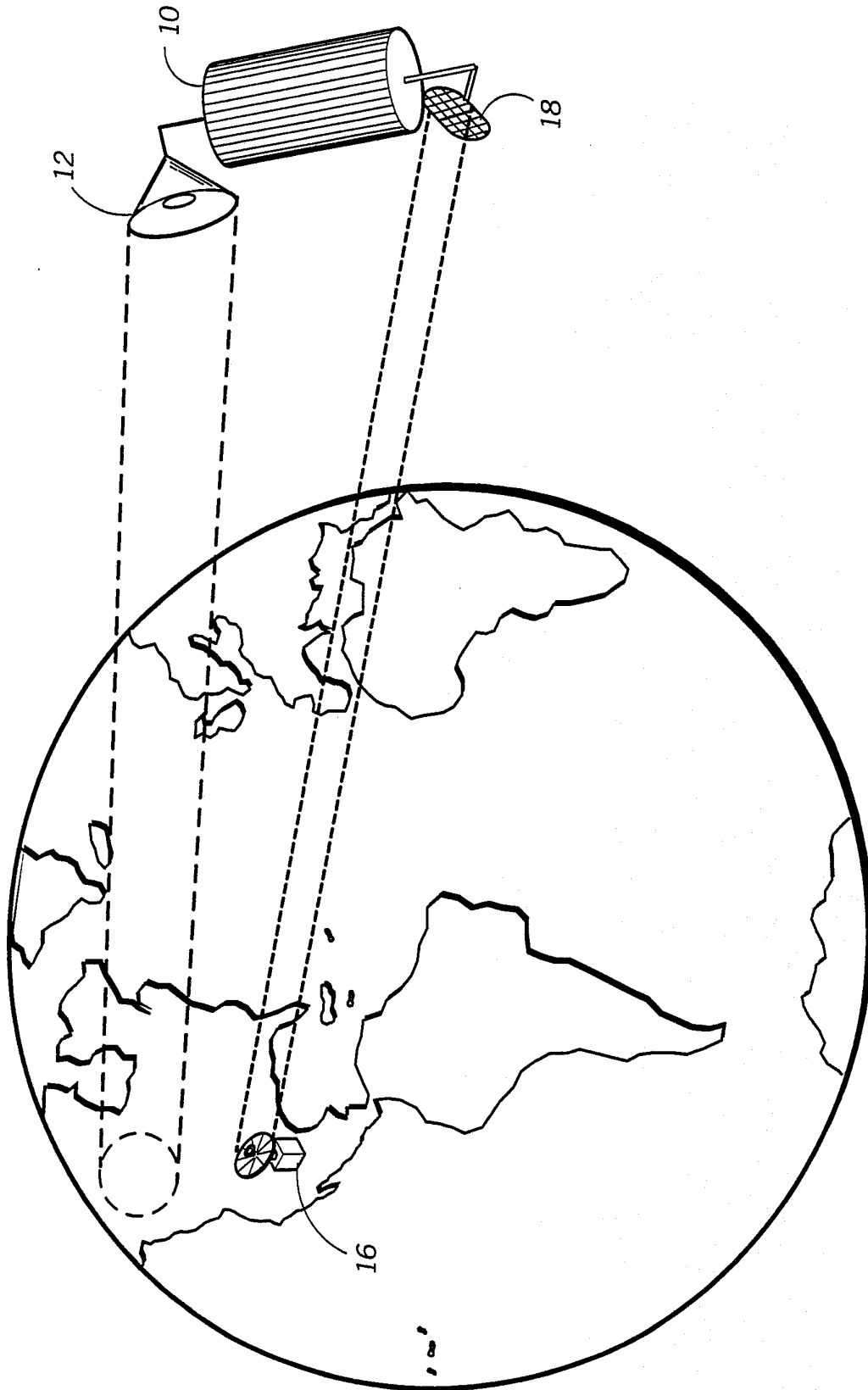
FIG.1A
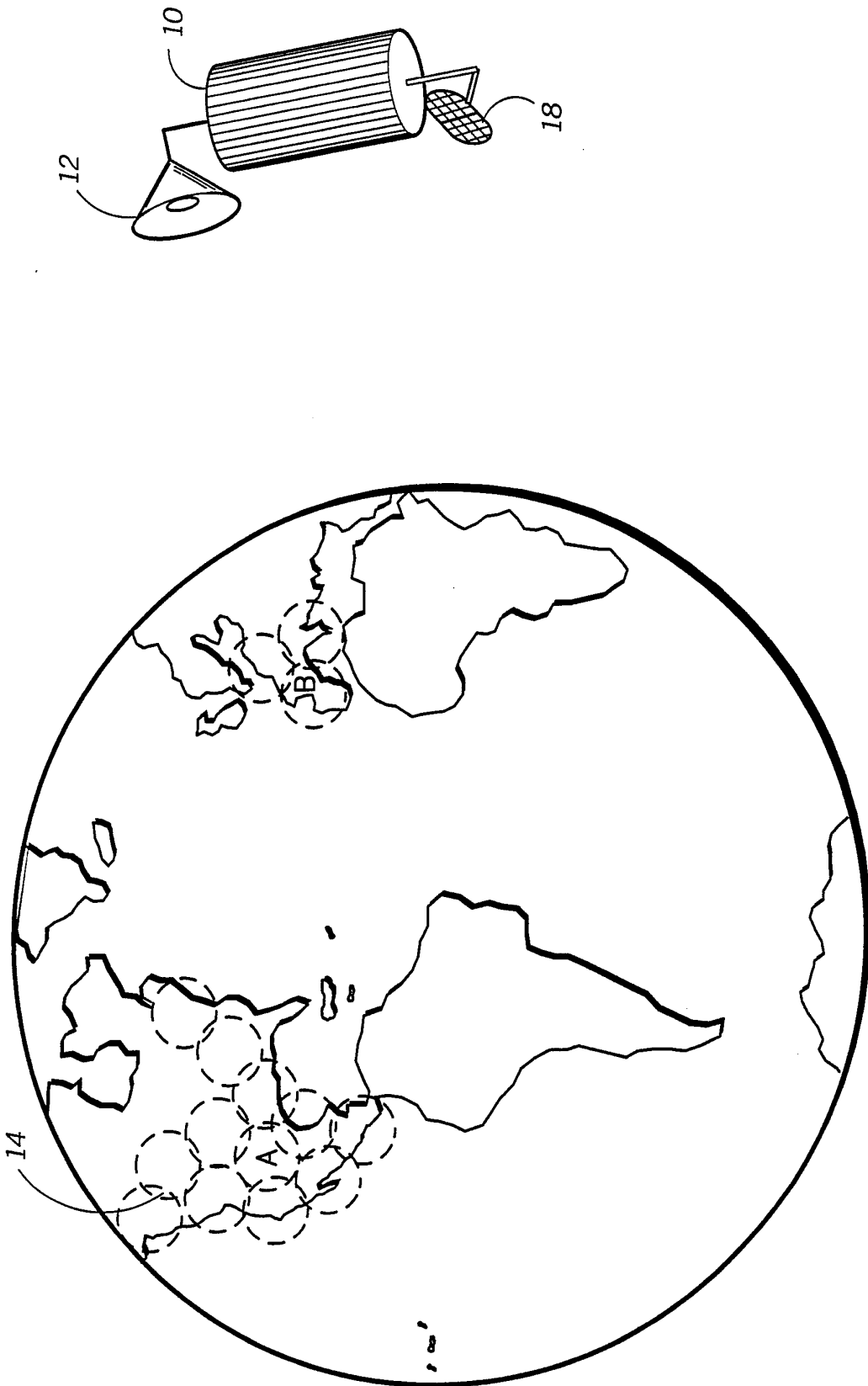
FIG.1B

FIG.2

FIG.3

FIG.4

FIG.5

100   102   104   106

| COUNTRY CODE | LOCATION CODE (EXCHANGE) | PAGER I.D. NUMBER | MESSAGE |

FIG.6A

104   106

| PAGER I.D. NUMBER | MESSAGE |

FIG.6B

BIT NUMBER   1   4   8   15

| ROUTING CODEWORD | ORBIT NUMBER | SATELLITE NUMBER | PARITY CHECK BITS |
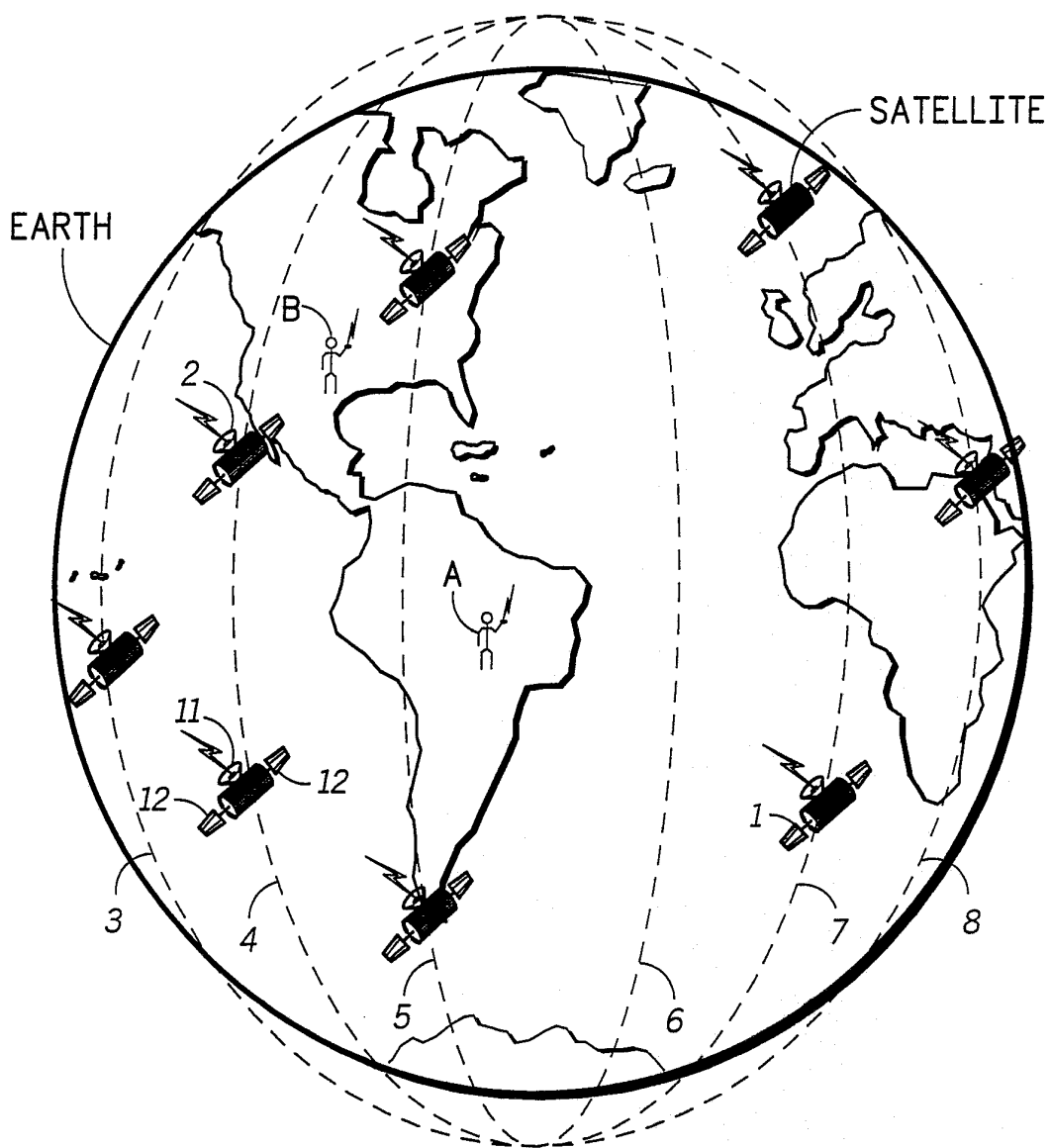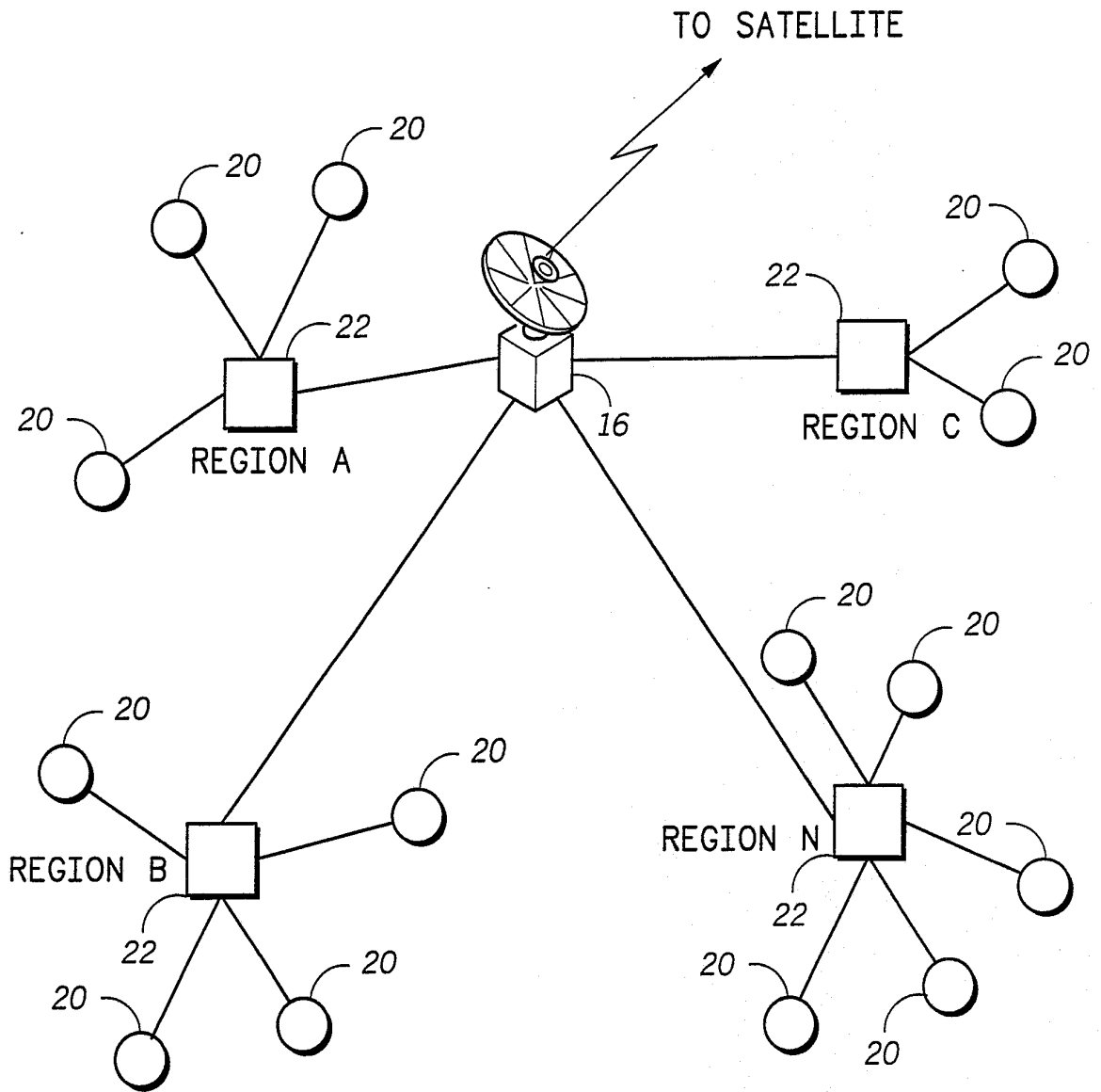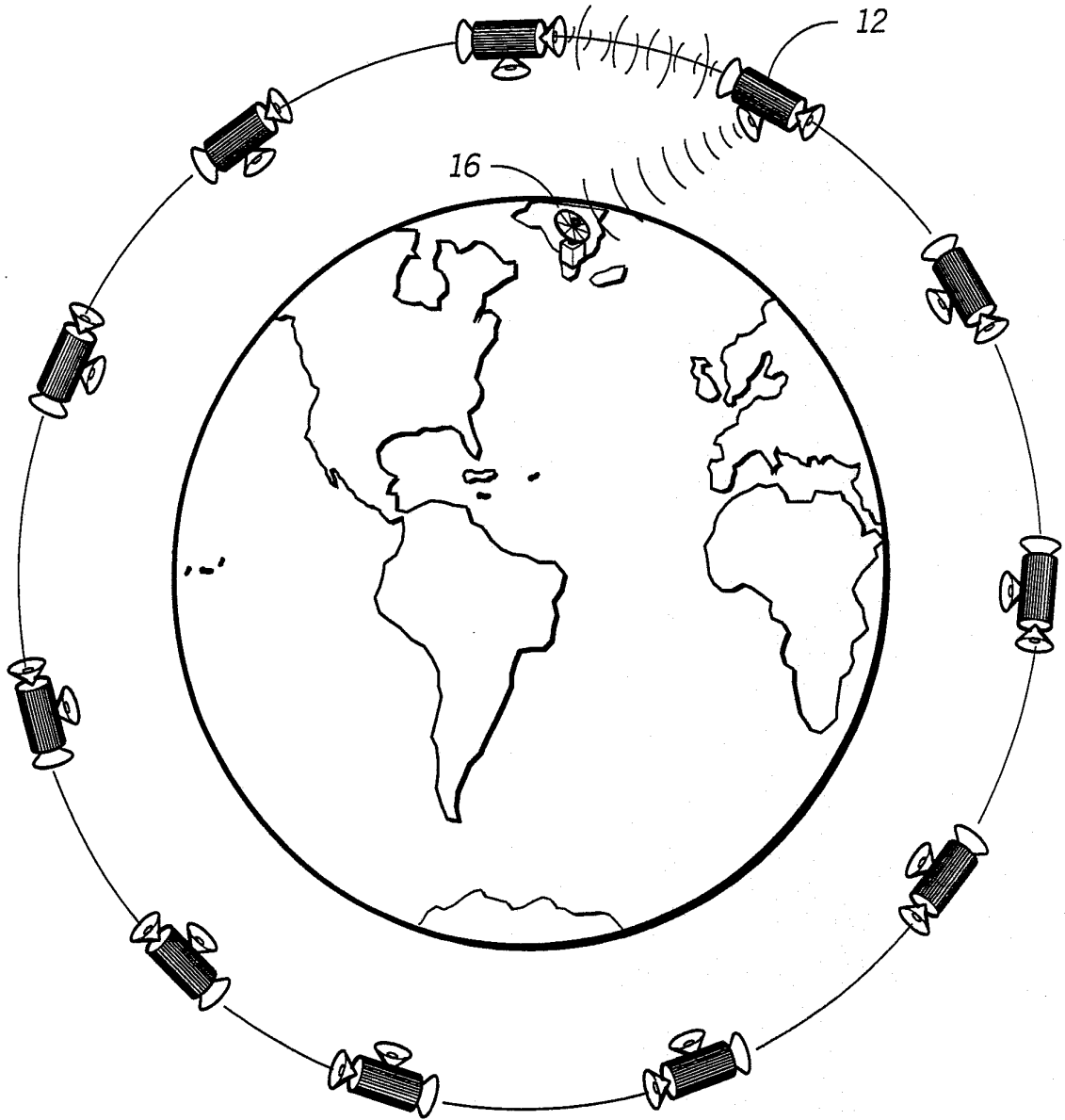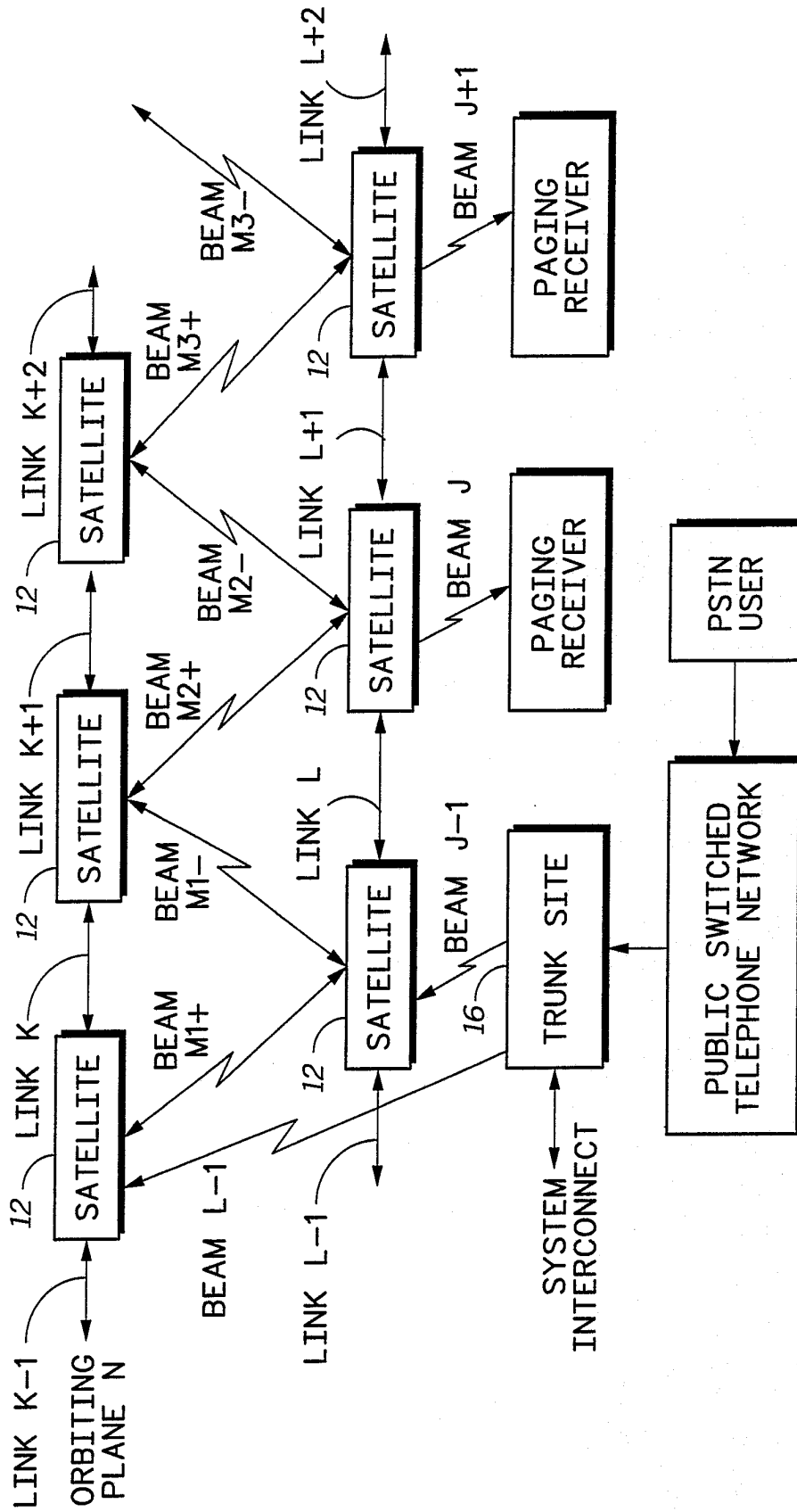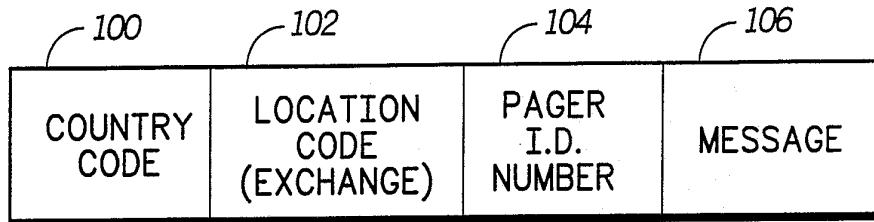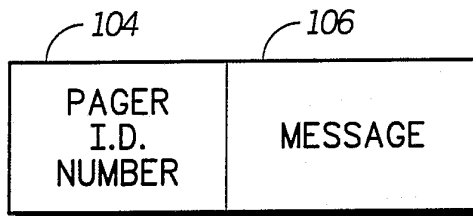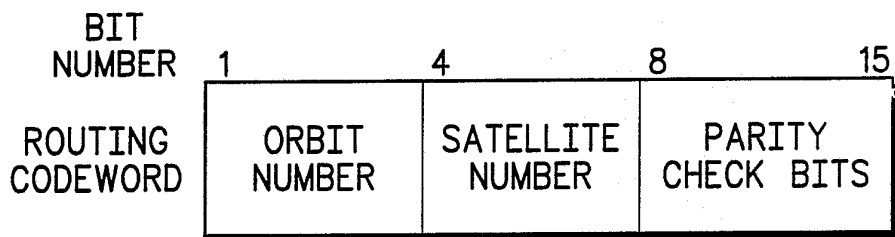
FIG.7

PAGING MESSSAGES
FROM GROUND-BASED
PAGING TERMIANLS

GROUND
STATION
EQUIPMENT

UP-LINK CHANNEL
TO SATELLITE

SATELLITE
EQUIPMENT

DOWN-LINK CHANNEL
TO USERS

PAGER
USER

FIG.8

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EARTH STATION
EQUIPMENT

ROM _805_

MEMORY _803_

GROUND
STATION
PAGING
TERMINAL _802_

GROUND
STATION
SATELLITE
CONTROLLER _806_

HIGH
PRECISION
SYSTEM
CLOCK _830_

UP—LINK
TRANSMITTER _804_

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INPUTS FROM
GROUND—BASED
COMMUNICATION
NETWORKS

FIG.8B

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FIG.8C

```
                    ┌──────────────────┐ 902
                    │ RECEIVE  PAGING  │
                    │     MESSAGE      │
                    └──────────────────┘
                             │
                             ▼
              ┌──────────────────────────┐ 904
              │       USE  LOCATION       │
              │   CODE  OR  PAGER  I.D.    │
              │    TO  GEOGRAPHICALLY      │
              │    LOCATE  END  USER       │
              └──────────────────────────┘
                             │
                             ▼
         ┌──────────────────────────┐ 906        ┌──────────────────┐
         │   USE SYSTEM CLOCK TO     │            │  HIGH PRECISION  │
         │   IDENTIFY SATELLITE      │◄───────────│  SYSTEM CLOCK    │
         │    FOR DOWN-LINK          │            └──────────────────┘
         │     TRANSMISSION          │
         └──────────────────────────┘
                             │
                             ▼
                    ┌──────────────────┐ 908
                    │   ROUTE PAGING    │
                    │   MESSAGE  TO     │
                    │   APPROPRIATE     │
                    │    SATELLITE      │
                    └──────────────────┘
                             │
                             ▼
                    ┌──────────────────┐ 910
                    │  QUEUE MESSAGE    │
                    │   IN SATELLITE    │
                    └──────────────────┘
                             │
          ┌──────────────────┤
          │                  ▼
          │              ╱───────╲ 912
          │     NO      ╱   TIME   ╲         ┌──────────────────┐
          └───────────◄ TO TRANSMIT ►◄───────│  HIGH PRECISION  │
                       ╲   QUEUE?   ╱         │  SYSTEM CLOCK    │
                        ╲─────────╱           └──────────────────┘
                             │YES
                             ▼
                    ┌──────────────────┐ 914
                    │  SET DOWN-LINK    │
                    │ FREQUENCY  AND    │
                    │    PROTOCOL       │
                    └──────────────────┘
                             │
                             ▼
                    ┌──────────────────┐ 916
                    │     TRANSMIT      │
                    │  QUEUED PAGING    │
                    │    SIGINALS       │
                    └──────────────────┘
```

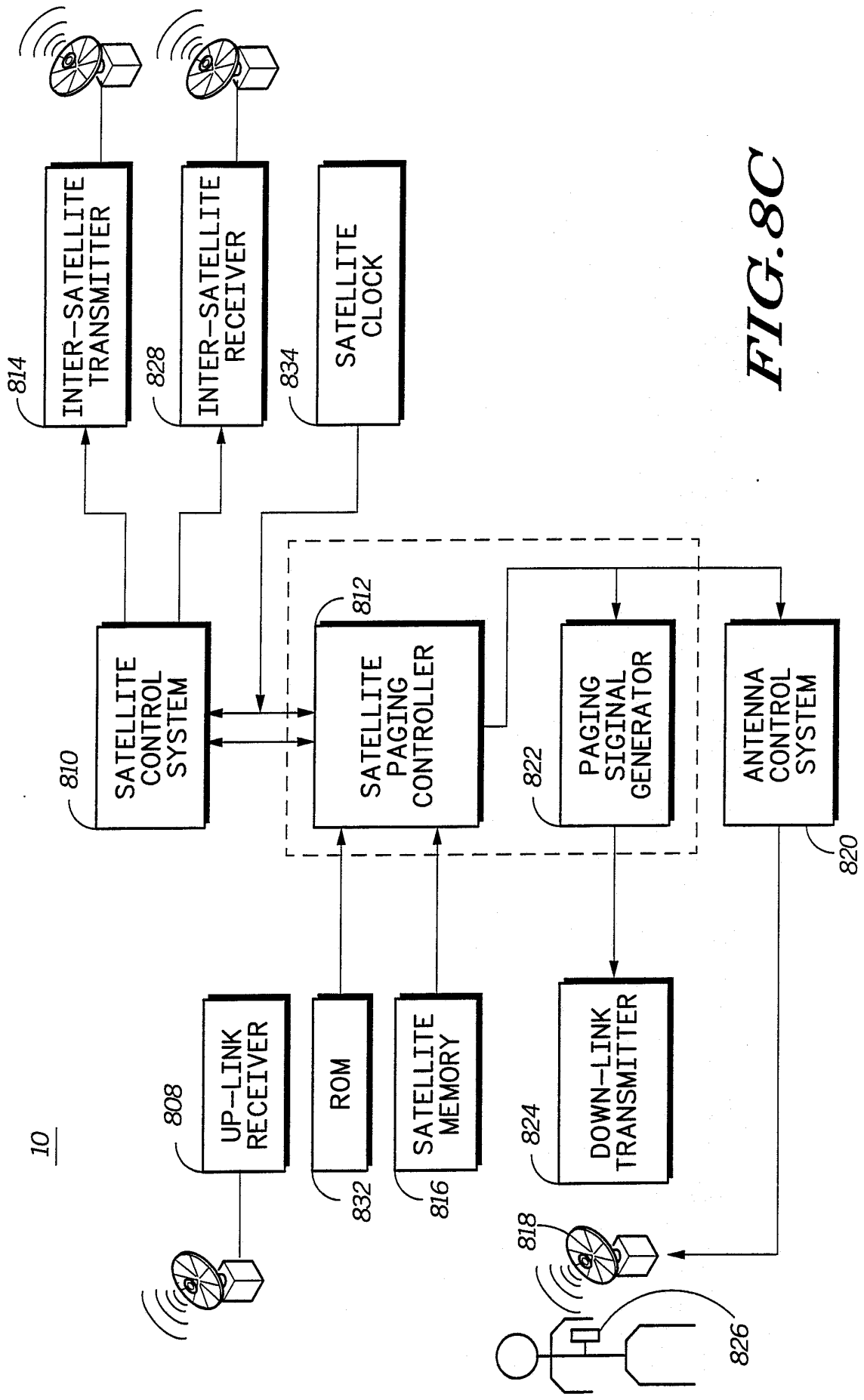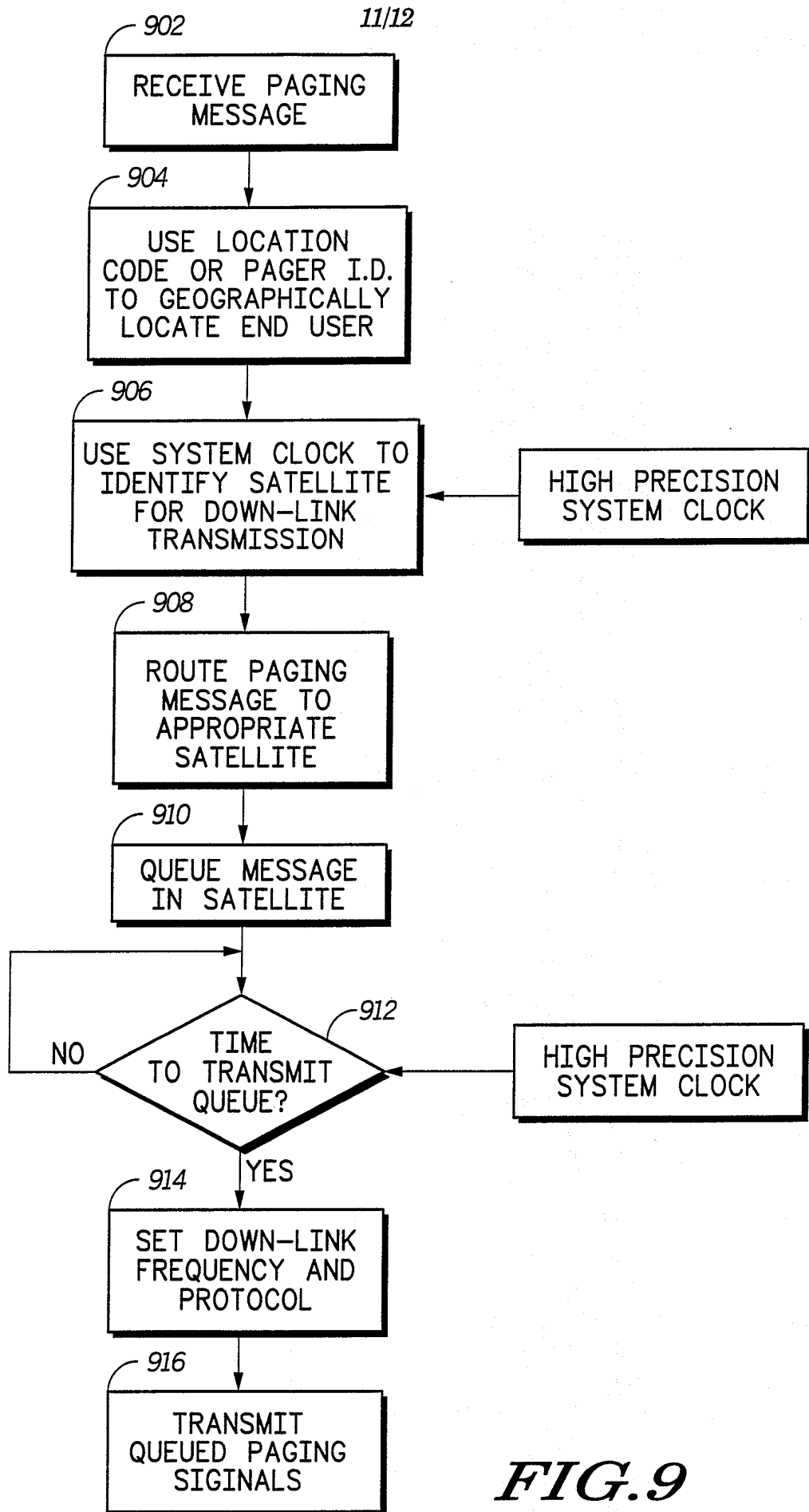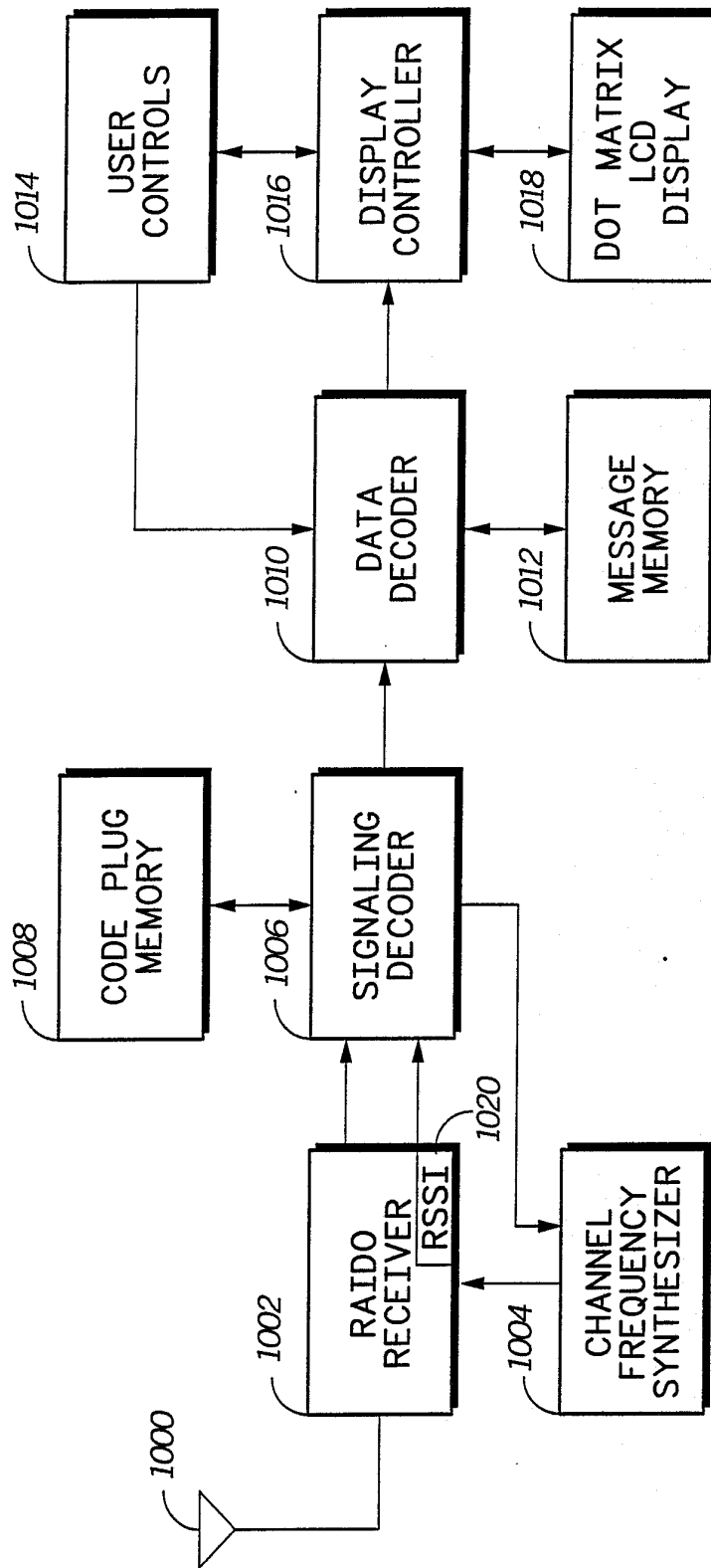*FIG.9*

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FIG.10

INTERNATIONAL SEARCH REPORT

International Application No   PCT/US90/05103

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) 3

Acccrding to International Patent Classification (IPC) or to both National Classification and IPC

IPC (5) :   H04B 7/185
U.S. Cl :   455/12,13

II. FIELDS SEARCHED

Minimum Documentation Searched 4

Classification System	Classification Symbols
U.S.	455/12,13,32,33; 340/825.44; 342/350,354,355,356

Documentation Searched other than Minimum Documentation
to the Extent that such Documents are Included in the Fields Searched 6

III. DOCUMENTS CONSIDERED TO BE RELEVANT 14

Category *	Citation of Document, 16 with indication, where appropriate, of the relevant passages 17	Relevant to Claim No. 18
A P	US,A 4,914,649 (SCHWENDEMAN ET AL) 03 April 1990 See the entire document.	1-48
A	US,A 4,775,974 (KOBAYAHII) 04 October 1988 See the entire document.	1-48

* Special categories of cited documents: 15

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search 2	Date of Mailing of this International Search Report 2
05 NOVEMBER 1990	05 FEB 1991
International Searching Authority 1	Signature of Authorized Officer 20
ISA/US	LISA D. CHAROVEL

Form PCT/ISA/210 (second sheet) (May 1986)