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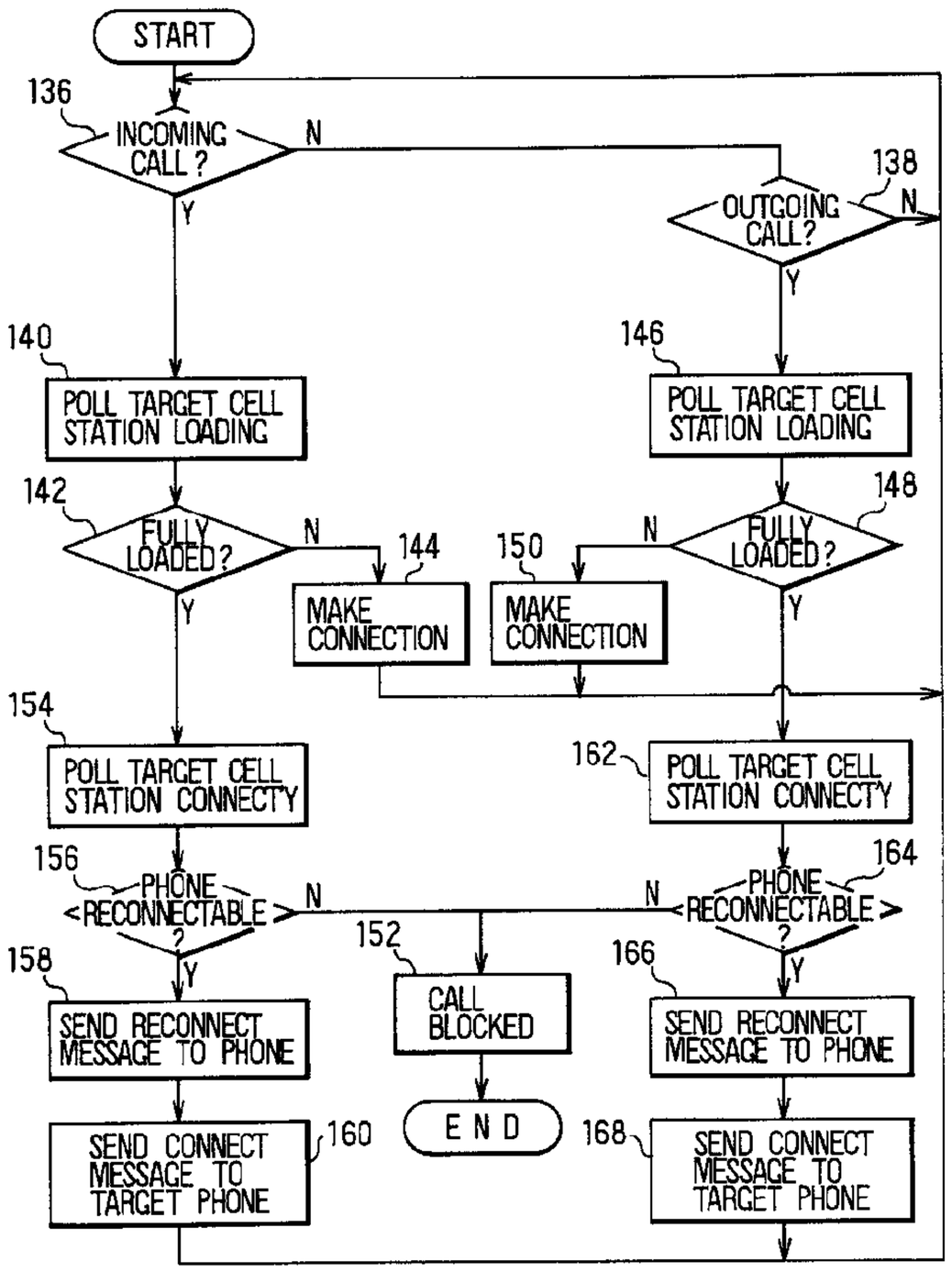

(57) Abrégé/Abstract:
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ABSTRACT OF THE DISCLOSURE

In a distributed communication system such as a personal handyphone system, when a new call must be connected through a cell station, the PNC unit associated with the cell station checks to see if the cell station is fully loaded. If so, portable telephones currently having calls connected through that cell station are checked to see if they can reconnect to a different cell station. If so, they are directed to reconnect, thereby freeing a space on the target cell station so that the new call can be connected. This technique is useful for incoming calls from a wireline network, outgoing calls from a portable telephone, and handoffs of a roaming portable telephone.

PAGING TECHNIQUE FOR PERSONAL COMMUNICATIONS SYSTEMS AND APPARATUS FOR IMPLEMENTING THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is related to paging in distributed communications systems. More particularly, this invention is related to techniques and systems for paging in portable personal communications systems which are characterized by a limited number of communication channels between mobile and base units, such as personal handyphone (PHS) and micro-cellular systems.

2. Description of Related Art

Portable personal communication systems have enjoyed a dramatic increase in popularity in recent years, and the trend is sure to continue. With their ability to place conventional telephone calls from virtually anywhere in a geographically diverse environment, their high quality of service and their compact size, such systems provide their users with convenience, flexibility and ease of use unparalleled by other communication systems.

Portable personal telephone networks such as the one shown in FIG. 1 typically include three main parts: a number of portable telephones 10 (hereinafter "Personal Communication System" or "PCS units"), several cell stations 12 each disposed

within a respective coverage zone 14, and a PCS network controller 16 (hereinafter "PNC"). The PCS units 10 communicate exclusively with the cell stations 12, and the cell stations 12 communicate with the PCS units 10 and the PNC 16.

The Federal Communications Commission (hereinafter "FCC") has allocated 666 RF channels for communications between PCS units 10 and cell stations 12. Of these channels, 312 in each band are used for voice and data transmission (hereinafter, these channels will simply be called "voice channels") and the remaining 21 are reserved for use as setup channels, the significance of which will be described below.

In practice, a multiplexing technique is used so that each RF channel can be used to service three PCS units 10 simultaneously; however, in the following discussion, for simplicity we will assume that each RF channel is dedicated to a single PCS unit 10.

One of the biggest advantages of PHS systems is their ability to use relatively inexpensive parts and their consequent low cost. Thus, it is advantageous for the cell stations to handle as few channels as possible, since the cost and complexity of a cell station increases with the number of channels it services.

The PNC 16 is the system's link to the conventional telephone network. When a PCS unit 10 originates or receives a call, a radio link is established between the PCS unit 10 and the cell station 12, and a data link (typically an ISDN

connection) is established between the cell station 12 and the PNC 16. In this way, the PNC 16 establishes a path between the PCS 10 and the conventional wireline telephone network.

The process of establishing a call with a PCS unit 10 will now be described in detail. When the PCS unit 10 is turned on, it scans a group of setup channels whose frequencies have previously been stored in its memory and selects the RF channel corresponding to the best signal (e.g., the strongest signal) as shown in Step 100 of FIG. 2. It sets this RF channel as its operative setup channel in Step 102, receives a local identification code (hereinafter "LID") periodically sent by the cell station 12 transmitting on the operative setup channel in Step 104, and compares that LID to the LID of its last known position in Step 106.

If the two LIDs are different, the PCS unit 10 determines that it has moved to a new area since its last position registration and proceeds to register its new position with the current cell station 12 via the operative setup channel in Step 108. If the two LIDs are identical, the system loops through Steps 110 and 112 to wait for an incoming call from the registered cell station 10 (also known as paging) in Step 110 or for the user to place an outgoing call (also known as access) in Step 112. While waiting to execute the paging and access procedures, the PCS unit 10 checks to see if the signal from the operative setup channel has fallen below a predetermined threshold in Step 114 and if so, the PSC unit 10

executes the scanning procedure of Steps 100-104 again to establish a new operative setup channel.

When a user attempts to initiate access and place an outgoing call from the PCS unit 10, the PCS unit 10 sends a connection request signal, including the telephone number to be called, asking for a connection on a free voice channel to the operative cell station 12 as shown in Step 116. The cell station 12 sends a response signal notifying the PCS unit 10 of the assigned voice channel which is received by the PCS unit 10 in Step 118, the cell station establishes an ISDN link with the PNC 16 to connect to the wireline telephone network, and the call begins. The PCS unit 10 then places the outgoing call with the cell station 12 in Step 120 and loops through Step 122 waiting for the user to terminate the call, and at that point sends a disconnection request signal to the cell station 12 to free the allocated voice channel in Step 124 and returns to the paging-access loop of Steps 110 and 112.

In the complementary paging process, when the PNC 16 receives a call destined for a PCS unit 10 from the wireline telephone network, it sends a paging message containing the called number to all of its cell stations 12, and each cell station 12 broadcasts the called number on all of its setup channels. Since the PCS unit 10 is monitoring the operative setup channel, it recognizes its number in Step 110 and sends a connection request signal to the cell station 12 in Step 126. Then, the PCS unit 10 receives a response signal notifying the

PCS unit 10 of the assigned voice channel in Step 128, receives the incoming call on the assigned voice channel in Step 130, loops through Step 132 waiting for the user to terminate the call, and sends a disconnection request signal in Step 134 as in the case of the access process described above.

One other connection procedure, "handing off", is essential to PHS operation. As noted above, if while waiting for a paging or access procedure a PCS unit 10 determines that the signal strength of its operative setup channel has fallen to an unacceptably low level, it will scan the setup channels to find a better one. However, while a call is in progress, the cell station 12 may determine that the setup channel signal from the PCS unit 10 has fallen to an unacceptably low level. This is most often the result of movement of the PCS unit 10 away from the operative cell station 12, i.e., "roaming". In this case, the cell station 12 will notify the PNC 16 of the deterioration of the signal from the PCS unit 10.

The PNC 16 then sends a monitor request signal to other cell stations 12 adjacent to the operative cell station 12 instructing them to assess the strength of the setup channel signal from the PCS unit 10. The other cell stations 12 report their results, and the PNC 16 sends a command to the PCS unit 10 via the operative cell station 12 instructing it to make the other cell station 12 having the highest received signal strength its new operative cell station and to switch its voice channel accordingly.

The above system works well; however, it has practical disadvantages. For example, as noted above, it is advantageous for cell stations to use as few RF channels as possible. However, reducing the number of cell station channels increases the likelihood of call blocking, i.e., a situation where a PCS unit 10 attempting access to a cell station 12 or where a cell station 12 attempting to page a PCS unit 10 finds all voice channels occupied. If an access operation from a PCS unit 10 or a paging operation from a cell station 12 is blocked and the PCS unit 10 is not within the coverage zone of another cell station 12 which has a free channel, the call will be lost. Of course, this reduces the grade of service of the system, and most PHS systems attempt to keep the proportion of blocked calls during their busy hours under 1%.

FIGS. 3 and 4 show examples of call blocking in prior art systems. A paging group coverage area 18 is formed by respective individual coverage areas 20a, 20b and 20c of cell stations 12a, 12b and 12c in FIG. 3. Calls are established between PCS units 10a-10c and cell station 12a; thus, cell station 12a is fully loaded (in this Figure, light arrows from a PCS unit to a cell station indicate a PCS unit registration, while heavy arrows from a cell station to a PCS unit indicate a connected call). Further, a call is established between PCS unit 10d and cell station 12b, and PCS unit 10e makes a request to place an outgoing call with cell

station 12a. FIG. 4 shows a similar situation in which a call between PCS unit 10e and cell station 12b has previously been established; however, PCS unit 10e has roamed from the coverage area 20b to the coverage area 20a, and it requests that its call be handed off to cell station 12a.

In either situation, the call from PCS unit 10e will be blocked because cell station 12a is fully loaded. One way to avoid this problem while keeping the number of channels on each cell station 12 low is to add additional cell stations; however, this is expensive and there is a practical limit on how many cell stations can be placed in close proximity to one another while maintaining adequate frequency reuse conditions.

SUMMARY OF THE INVENTION

In view of the above-described problems of the prior art, one object of the present invention is to provide a technique for paging in distributed communication systems such as PHS systems which has a low percentage of blocked calls.

A further object of the present invention is to provide a distributed communication system paging technique which provides a high grade of service with cell stations having a small number of channels.

Another object of the present invention is to provide a distributed communication system paging technique which provides a high grade of service with a small number of cell stations.

A still further object of the present invention is to provide a distributed communication system paging technique which uses a personal communication system network controller to monitor cell station loading and to direct calls with personal communication system units to selected cell stations in order to minimize call blocking.

Still another object of the present invention is to provide a distributed communication system paging technique which minimizes the blocking of outgoing calls from a personal communication system unit and which minimizes the blocking of incoming calls to a personal communication system unit.

A yet further object of the present invention is to provide a distributed communication system paging technique which minimizes call blocking when a call with a roaming personal communication system traversing cell station coverage boundaries is handed off.

In a first aspect of the present invention, the above objects are achieved by providing a personal communication system in which, when a new call must be connected through a cell station, the PCS unit associated with the cell station checks to see if the cell station is fully loaded. If so, portable telephones currently having calls connected through that cell station are checked to see if they can reconnect to a different cell station. If so, they are directed to reconnect, thereby freeing a space on the target cell station so that the new call can be connected. This

technique may be used for incoming calls from a wireline network, outgoing calls from a portable telephone, and handoffs of a roaming portable telephone.

In accordance with the present invention, there is provided a distributed communication system paging method, comprising: receiving a call connection request; determining whether a cell station through which said call connection request is to be routed is fully loaded; when said cell station is determined to be fully loaded, reconnecting a reconnectable portable unit having a call connected through said cell station to a different cell station; and connecting a call through said cell station responsive to said call connection request; said reconnecting step comprising sending a connectivity poll command to portable units having calls connected through said cell station, and receiving a zone report from each of said portable units in response thereto, said reconnectable portable unit being one of said portable units having calls connected through said cell station, and being chosen to be reconnected based on its zone report.

In accordance with the present invention, there is provided a personal communication system network controller comprising: call connection request receiving means for receiving a call connection request; cell station loading monitoring means for determining loading of a cell station through which a call corresponding to said call connection request is to be connected; portable unit connectivity monitoring means for determining connectivity of portable units having calls connected through said cell station; and reconnection means for directing reconnection of a reconnectable portable unit determined by said portable unit connectivity monitoring means to be reconnectable to a

different cell station; wherein said reconnection means comprises connectivity poll command sending means for sending a connectivity poll command to portable units having calls connected through said cell station, and receiving a zone report from each of said portable units, said reconnectable portable unit being one of said portable units having calls connected through said cell station, and being chosen based on its zone report.

In accordance with the present invention, there is provided a personal communication system comprising: a network controller: a plurality of cell stations connected to said network controller; and a plurality of portable phones each connectable to one of said cell stations; wherein said network controller is for monitoring connection states between said cell stations and said portable phones to control the connection states thereof and for intermediating incoming calls, outgoing calls and roaming connection requests through the cell station and said portable phones, said network controller providing through a given cell station, a reconnect message to each portable phone connected to said given cell station when said given cell station is fully loaded and connection is requested thereto by a portable phone presently unconnected thereto, by polling said each portable phone for reconnection determination purposes, and; said plurality of cell stations are each for connecting to the portable phones via wireless links, transmitting connection requests from the portable phones to the network controller, and reconnecting the portable phones responsive to reception of a reconnect message from said network controller; and said plurality of portable phones are each for providing a connection request to cell stations to which said phone is communicable other than a cell station to which said phone is presently connected, and for reconnecting to one of said cell stations

which is connectable to reduce the full loading of the cell station to which said phone is presently connected when said portable phone generates a report indicative of its reconnectablity to at least one of said cell stations, and as result receives said reconnect message.

Other objects and features of the invention will appear in the course of the description thereof, which follows.

BRIEF DESCRIPTION OF THE DRAWINGS

Additional objects and advantages of the present invention will be more readily apparent from the following detailed description of preferred embodiments thereof when taken together with the accompanying drawings in which:

FIGURE 1 is a conceptual diagram of a typical portable telephone network according to the prior art;

FIGURE 2 is a flowchart showing the handling of incoming and outgoing calls in a personal communication system unit according to the prior art;

FIGURE 3 and 4 are conceptual diagrams showing call blocking in prior art system;

FIGURE 5 is a flowchart showing the processing in a PCS network controller according to a preferred embodiment of the present invention;

FIGURE 6 is a graph showing the sequence of transactions between the PCS controller, cell station and PCS units according to the preferred embodiment;

FIGURE 7 is a conceptual diagram showing reconnection of PCS units according to the preferred embodiment; and

FIGURE 8 is a conceptual diagram showing a multiple reconnectability condition according to the preferred embodiment.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EXEMPLARY EMBODIMENTS

FIG. 5 is a flowchart showing the processing in a PCS network controller (PNC) performing a portable telephone paging technique according to a preferred embodiment of the present invention. It is well-known in the art that PNCs are usually controlled by one or more microprocessors, and this technique is preferably implemented as a program in such a microprocessor or microprocessors.

The PNC cycles through a wait loop formed by Steps 136 and 138 waiting for a telephone call transaction. When the PNC determines that it has received an incoming call from the wireline network in Step 136, it sends a loading poll command signal to the cell station where the PCS unit to which the incoming call is directed has registered in Step 140, and in Step 142 the PNC determines whether the cell station's response indicates that it is fully loaded (remember that control operations are performed using the setup channels separate from the voice channels, and such polling may therefore be performed

even with a cell station whose voice channels are fully loaded). If the cell station is not fully loaded, the PNC proceeds to make the connection with the PCS unit to establish a telephone session in Step 144.

Similarly, when the PCS determines that it has received a request to make an outgoing call to the wireline network from a PCS unit in Step 138, it sends a loading poll command signal to the cell station where the PCS unit from which the outgoing call request was made has registered in Step 146, and in Step 148 the PNC determines whether the cell station's response indicates that it is fully loaded. If the cell station is not fully loaded, the PNC proceeds to connect the PCS unit to the wireline network to establish a telephone session in Step 150.

The processing described so far is substantially the same as in prior art systems. However, in the prior art, if the PNC determines that the relevant cell station is fully loaded in Step 142 or Step 148, it simply goes to Step 152 and determines that the call is blocked, thereby presenting the caller (the wireline subscriber for an incoming call or the PCS unit user for an outgoing call) with a denial of service. In contrast, this embodiment of the present invention makes additional efforts to establish the call.

More specifically, if the PNC determines that the cell station is fully loaded in the case of an incoming call, it sends a connectivity poll command to all other PCS units

currently connected to the fully-loaded cell station in Step 154 and in Step 156 determines whether one of these other PCS units can reconnect from its current cell station to a different cell station. If one of the other PCS units indicates that it is reconnectable, the PNC sends a reconnect command to it via its current cell station in Step 158, thereby freeing up a voice channel on the cell station currently associated with the target PCS unit. Finally, in Step 160, the PNC unit connects the incoming call from the wireline network to the target PCS unit, thereby establishing a telephone session. Only when the PNS determines in Step 164 that no other PCS unit connected to the cell station is reconnectable does it give up and go to Step 152 to declare that the call is blocked.

Similarly, if the PNC determines that the cell station is fully loaded in the case of an outgoing call, it sends a connectivity poll command to all other PCS unit currently connected to the fully-loaded cell station in Step 162 and in Step 164 determines whether one of these other PCS units can reconnect from its current cell station to a different cell station. If one of the other PCS units indicates that it is reconnectable, the PNC sends a reconnect command to it via its current cell station in Step 166, thereby freeing up a voice channel on the cell station currently associated with the target PCS unit. Finally, in Step 168, the PNC unit connects the incoming call from the wireline network

to the target PCS unit, thereby establishing a telephone session. On the other hand, if the PNC determines in Step 164 that no other PCS unit connected to the cell station is reconnectable, it goes to Step 152 to declare that the call is blocked.

FIG. 6 shows the transactions between the PNC, cell station and PCS units necessary to accomplish these operations with the arrangement of units in FIG. 4. At time t1, the PNC 16 receives an incoming call from the wireline network, and it sends a loading poll command to the cell station associated with the target PCS unit 10e at time t2. The cell station 12a reports that it is fully loaded at time t3, and at time t4 the PNC sends a connectivity poll command to the PCS units 10a - 10c. At time t5, the PCS unit 10c reports to the PNC 16 that it can reconnect. The PNC 16 sends it a reconnect command at time t6, and it obligingly reconnects to cell station 12c at time t7. A voice channel on cell station 12a having been thereby freed, the PNC 16 sends a connect command to the PCS unit 10e at time t8, and the PCS unit 10e connects at time t9 to establish the calling session.

The complementary sequence of events for an outgoing call is almost identical with the exception that at time t1, the PNC 16 receives an outgoing call request from the PCS unit 10e. Also, the sequence of events for handing off a roaming PCS unit are analogous to those for handling an outgoing call request.

The end result of this process is shown in FIG. 7, where in comparison to FIG. 4 one sees that PCS unit 10e is connected to cell station 12a because PCS unit 10c has reconnected to cell station 12c.

The advantages of the present invention in comparison to the prior art can also be understood in mathematical terms. Assume that the probability of any one of the three PCS units connected to a fully loaded cell station not being reconnectable is P(R). Then, the probability of all three PCS units not being reconnectable is roughly $P(R)^3$ and, conversely, the probability of at least one PCS unit being reconnectable and the additional call therefore not being blocked is about $1-P(R)^3$. Thus, the present invention offers approximately a $1-P(R)^3$ chance of connecting a call to a fully loaded cell station, whereas prior art systems offer none.

The exact improvement in call connection performance will depend on a number of factors such as RF coverage area patterns, base station density, network traffic characteristics and handset location; however, the above figures are a working approximation, and computer simulations comparing this technique to prior art systems show about a 20-50% increase in performance using the present invention.

To implement the above-described embodiment of the present invention, the PNC, cell stations and PCS units must have additional capabilities not found in prior art systems. For the PNC, these include the ability to issue loading poll

commands to cell stations and to analyze responses thereto; the ability to issue connectivity poll commands to PCS units and to analyze responses thereto; and the ability to send reconnect commands to PCS units. For cell stations, these include the ability to respond to loading poll commands and the ability to report PCS unit outgoing call request to the PNC. For the PCS unit, these include the ability to respond to connectivity poll commands and reconnect commands.

The present discussion has dealt only with the situation where one PCS unit indicates that it is reconnectable in Step 156 or Step 164 of FIG. 5. There may be cases, however, where more than one PCS unit is reconnectable. Consider, for example, FIG. 8, where in response to the connectivity poll command from the PNC 16 (not shown in this Figure) in Step 154 or 162, PCS unit 10c would again reply in Step 164 that it is reconnectable (to cell station 12c); however, PCS unit 10a would additionally reply in Step 164 that it is reconnectable (to cell station 12b). In this case, the PNC 16 must make a decision as to which PCS unit, 10a or 10c, should be directed to reconnect. The decision may be based on a number of criteria. For example:

-- the PCS unit whose reply was received first may be selected;

-- the PCS unit with the weakest reply signal at the cell station may be selected, since it is probably the

farthest away from the cell station and therefore is likely to be handed off soon, anyway;

-- the PCS unit that has been connected to the cell station for the longest time may be selected, since frequent reconnections of a PCS unit may noticeably degrade the quality of the call from the user's standpoint; and

-- of all cell stations to which the reconnectable PCS units can reconnect, a PCS unit which is reconnectable to the cell station having the lightest present loading is selected, since doing so will minimize the likelihood that reconnection creates yet another fully loaded cell station.

Numerous variations on these criteria are of course possible. For example, in the case of choosing one of two PCS units reconnectable equally lightly loaded cell stations, one of the other criteria may be used as a tiebreaker.

Although the present invention has been fully described in connection with the preferred embodiment thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications will become apparent to those skilled in the art.

For example, the preferred embodiment of the present invention has been described in a PHS environment; however, it may be adapted to other distributed communication systems, such as micro-cellular systems and conventional cellular systems.

Further, in the above-described embodiment, the PNC determines which PCS units are reconnectable in Steps 156 and

164 of FIG. 5 and sends a reconnect command to one of them in Steps 158 and 166, respectively; however, the PCS units need not reply to the PNC as to their reconnectability. Instead, they can simply reconnect to other cell stations, in which case the PNC unit can determine whether any voice channels have been freed up as a result of its connectivity poll command by issuing another loading poll to the cell station as in Steps 140 and 146.

Also in Steps 156 and 164, the PNC may wait for all PCS units registered at the cell station of interest to respond to the connectivity poll command before proceeding; however, it is preferable that the PNC only wait for a predetermined time period and, optionally, accept the first positive reconnectability response before continuing processing. In this way, nonresponsive PCS units are deemed to be non-reconnectable; thus, operation of the paging technique according to this embodiment of the present invention is transparent to PCS units which do not have the capability of handling connectivity poll commands and the like.

Also, in this case, a PCS unit which is not reconnectable need not respond to the PNC -- it will, by its silence, be deemed to be non-reconnectable, and only reconnectable PNC units need respond to the connectivity poll command.

The present invention has been described only in terms of a single step search for reconnectable PCS units.

That is, only the connectivity of PCS units connected to the cell station to which the target PCS unit has registered will be examined. However, the invention is not so limited. For example, assume cell station 12c in FIG. 4 is fully loaded. In such a case, the above-described embodiment would find that there are no reconnectable PCS units in Step 156 or Step 164 and determine that the call is blocked in Step 152. However, since PCS 10c unit is within the coverage zone 20c of cell station 12c, the reconnectability of PCS units connected to cell station 12c might be examined. If one of those PCS units is reconnectable, reconnecting it would free a voice channel on cell station 12c, thereby permitting PCS unit 10c to reconnect and freeing a voice channel on cell station 12a. This would permit connection of the call to PCS unit 10e.

As will be readily apparent, this technique can be extended to any number of steps in order to effect reconnection. As above, various criteria may be used to choose one of several possible candidates for reconnection. Moreover, those skilled in the art will appreciate that heuristic search techniques can be used to find the most optimal reconnection sequence. Optimality of a reconnection sequence may be determined on the basis of, e.g., the number of reconnections involved, loading characteristics of the cell stations involved, etc.

Moreover, the technique need not be used exclusively for redistributing connected calls in fully loaded cell

stations. For example, the invention may be used simply to manage overall cell station loading characteristics and maintain relative uniformity of loading in cell stations associated with a particular PNC. In fact, the invention may even be used for selective routing of calls among multiple PNC units. Further, it may be used to see if the target PCS unit, or the PCS unit to which an incoming call is directed, may itself be reconnectable to a different cell station.

Such changes and modifications are to be understood as being included within the scope of the present invention as defined by the appended claims.

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CLAIMS:

1. A distributed communication system paging method, comprising:

receiving a call connection request;

determining whether a cell station through which said call connection request is to be routed is fully loaded;

when said cell station is determined to be fully loaded, reconnecting a reconnectable portable unit having a call connected through said cell station to a different cell station; and

connecting a call through said cell station responsive to said call connection request;

said reconnecting step comprising sending a connectivity poll command to portable units having calls connected through said cell station, and receiving a zone report from each of said portable units in response thereto, said reconnectable portable unit being one of said portable units having calls connected through said cell station, and being chosen to be reconnected based on its zone report.

2. The method of claim 1, wherein said call connection request is an incoming call request from a wireline network.

3. The method of claim 1, wherein said call connection request is an outgoing call request from a portable unit registered with said cell station.

4. The method of claim 1, wherein said call connection request is a handoff of a roaming portable unit.

5. The method of claim 1, wherein said determining step comprises the steps of:

issuing a loading poll command to said cell station; and

determining whether a response from said cell station indicates that said cell station is fully loaded.

6. The method of claim 1, wherein said reconnecting step comprises the step of sending a connectivity poll command to portable units having calls connected through said cell station, said reconnectable portable unit being one of said portable units having calls connected through said cell station.

7. The method of claim 6, wherein said reconnecting step further comprises the steps of:

receiving a response from said reconnectable portable unit which indicates that said reconnectable portable unit can connect to a different cell station; and

sending said reconnectable portable unit a reconnect command to cause said reconnectable portable unit to said different cell station.

8. A personal communication system network controller comprising:

call connection request receiving means for receiving a call connection request;

cell station loading monitoring means for determining loading of a cell station through which a call corresponding to said call connection request is to be connected;

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portable unit connectivity monitoring means for determining connectivity of portable units having calls connected through said cell station; and

reconnection means for directing reconnection of a reconnectable portable unit determined by said portable unit connectivity monitoring means to be reconnectable to a different cell station;

wherein said reconnection means comprises connectivity poll command sending means for sending a connectivity poll command to portable units having calls connected through said cell station, and receiving a zone report from each of said portable units, said reconnectable portable unit being one of said portable units having calls connected through said cell station, and being chosen based on its zone report.

9. The system of claim 8, wherein said cell station loading monitoring means comprises:

loading poll command issuing means for issuing a loading poll command to said cell station; and

response determination means for determining whether a response from said cell station indicates that said cell station is fully loaded.

10. The system of claim 8, wherein said reconnection means comprises connectivity poll command sending means for sending a connectivity poll command to portable units having calls connected through said cell station, said reconnectable portable unit being one of said portable units having calls connected through said cell station.

11. The system of claim 10, wherein said reconnection means further comprises:

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connectivity response receiving means for receiving a response from said reconnectable portable unit which indicates that said reconnectable portable unit can connect to a different cell station; and

reconnect command sending means for sending said reconnectable portable unit a reconnect command to cause said reconnectable portable unit to said different cell station.

12. A personal communication system comprising:

a network controller:

a plurality of cell stations connected to said network controller; and

a plurality of portable phones each connectable to one of said cell stations;

wherein said network controller is for monitoring connection states between said cell stations and said portable phones to control the connection states thereof and for intermediating incoming calls, outgoing calls and roaming connection requests through the cell station and said portable phones, said network controller providing through a given cell station, a reconnect message to each portable phone connected to said given cell station when said given cell station is fully loaded and connection is requested thereto by a portable phone presently unconnected thereto, by polling said each portable phone for reconnection determination purposes, and;

said plurality of cell stations are each for connecting to the portable phones via wireless links, transmitting connection requests from the portable phones to the network controller, and reconnecting the portable phones

responsive to reception of a reconnect message from said network controller; and

said plurality of portable phones are each for providing a connection request to cell stations to which said phone is communicable other than a cell station to which said phone is presently connected, and for reconnecting to one of said cell stations which is connectable to reduce the full loading of the cell station to which said phone is presently connected when said portable phone generates a report indicative of its reconnectablity to at least one of said cell stations, and as result receives said reconnect message.

13. The system of claim 12, wherein each of said plurality of cell stations is connected to said network controller via a wired ISDN line.

14. The system of claim 12, wherein:

each of said cell stations is connectable to a limited number of portable phones;

each of said portable phones is further for requesting connected to a fully loaded cell station when said phone cannot connect to any other cell station; and

said network controller includes means for reconnecting a portable phone connected to said fully loaded cell station to another cell station so that said portable phone which cannot connect to any other cell station can connect to said fully loaded cell station.

15. A system in accordance with claim 14, wherein said portable phone which cannot connect to any other cell station is a roaming portable phone to be connected to the full loaded cell station.

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16. A system in accordance with claim 12, wherein said network controller includes means for providing a reconnect message to portable phones connected to a fully loaded cell station responsive to an incoming call from said external network for a portable phone connectable to said fully loaded cell.

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OTTAWA, CANADA

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FIG. 1
PRIOR ART

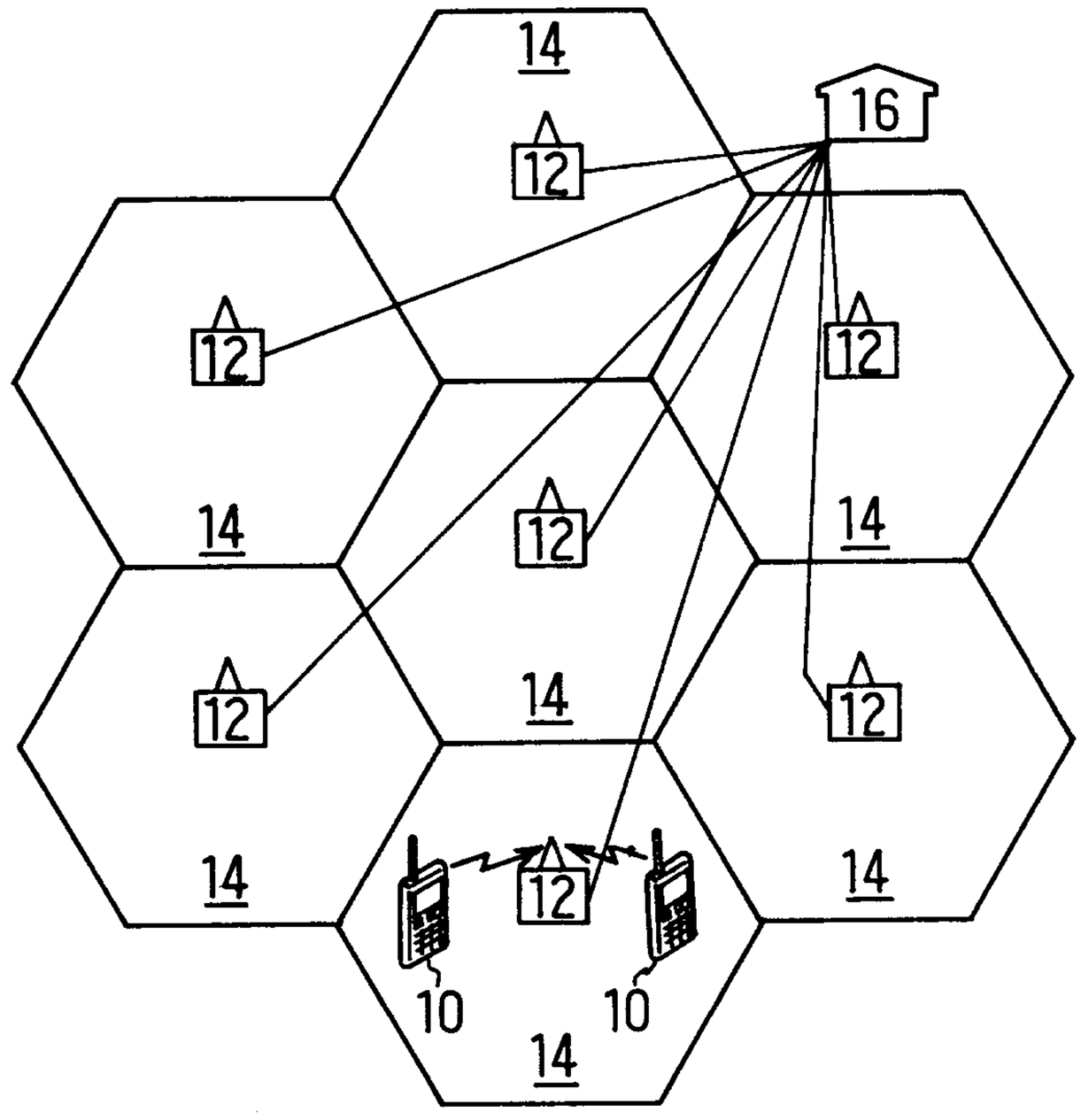

FIG. 3
PRIOR ART

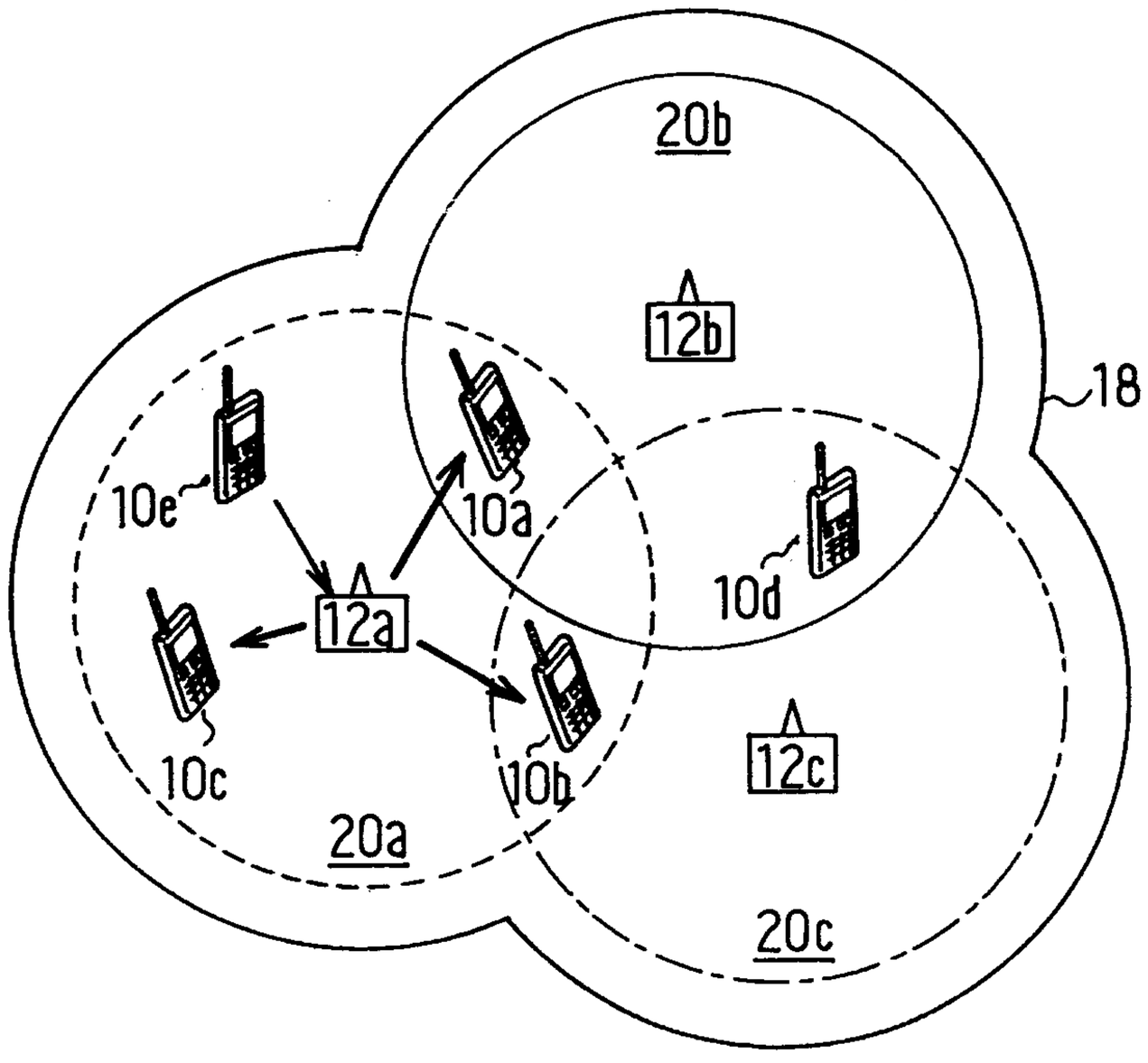

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FIG. 2
PRIOR ART

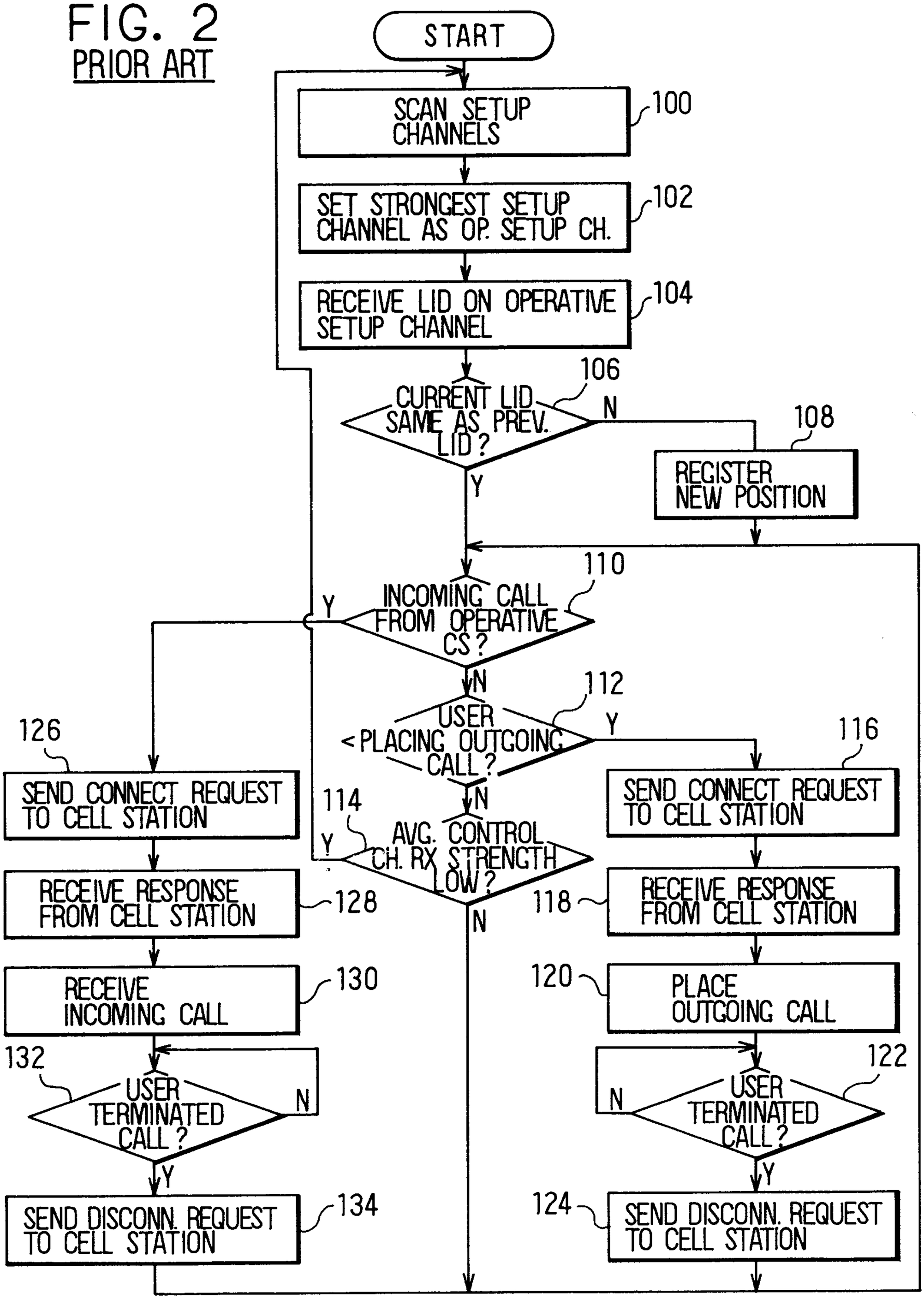

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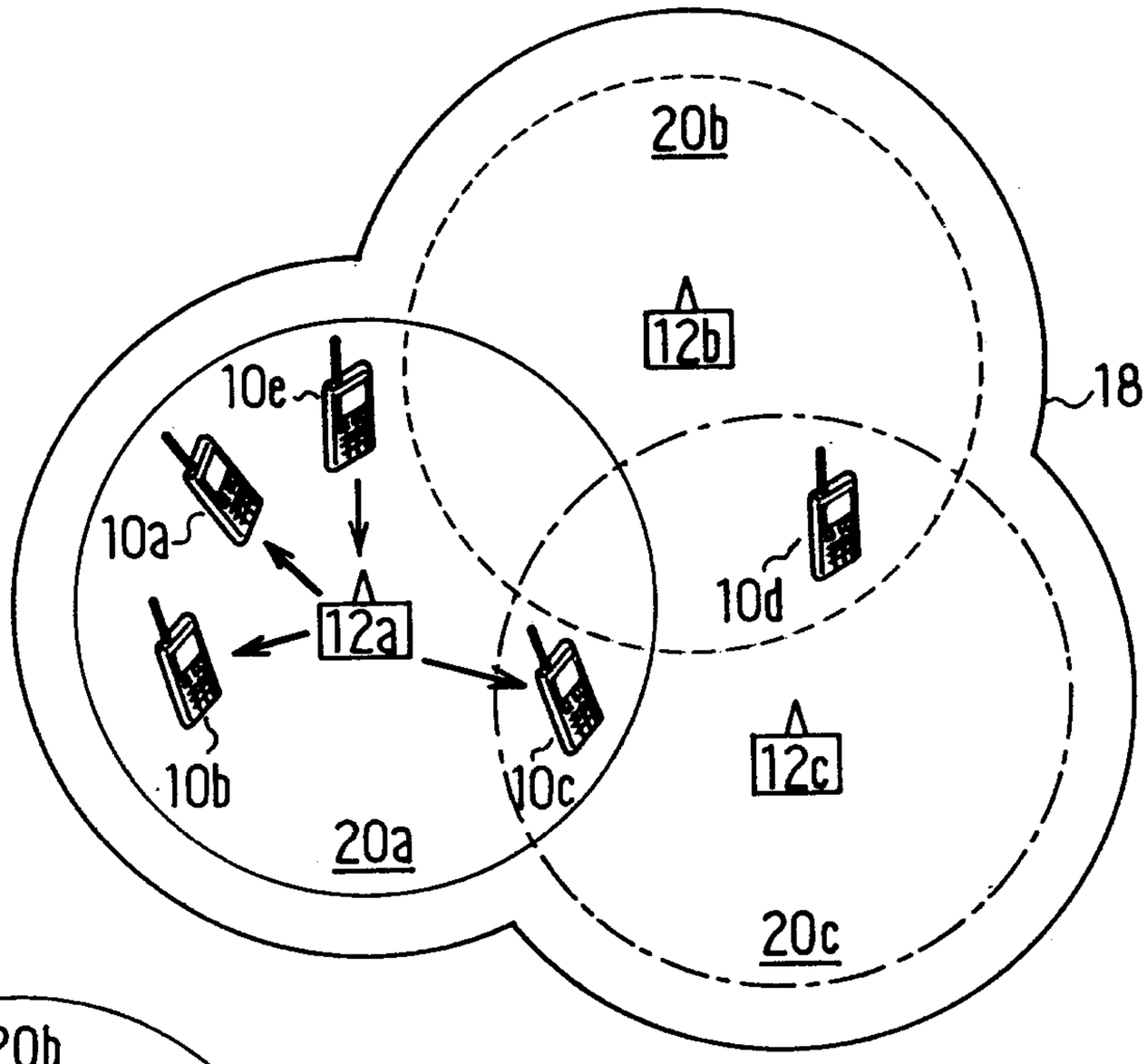
FIG. 4
PRIOR ART



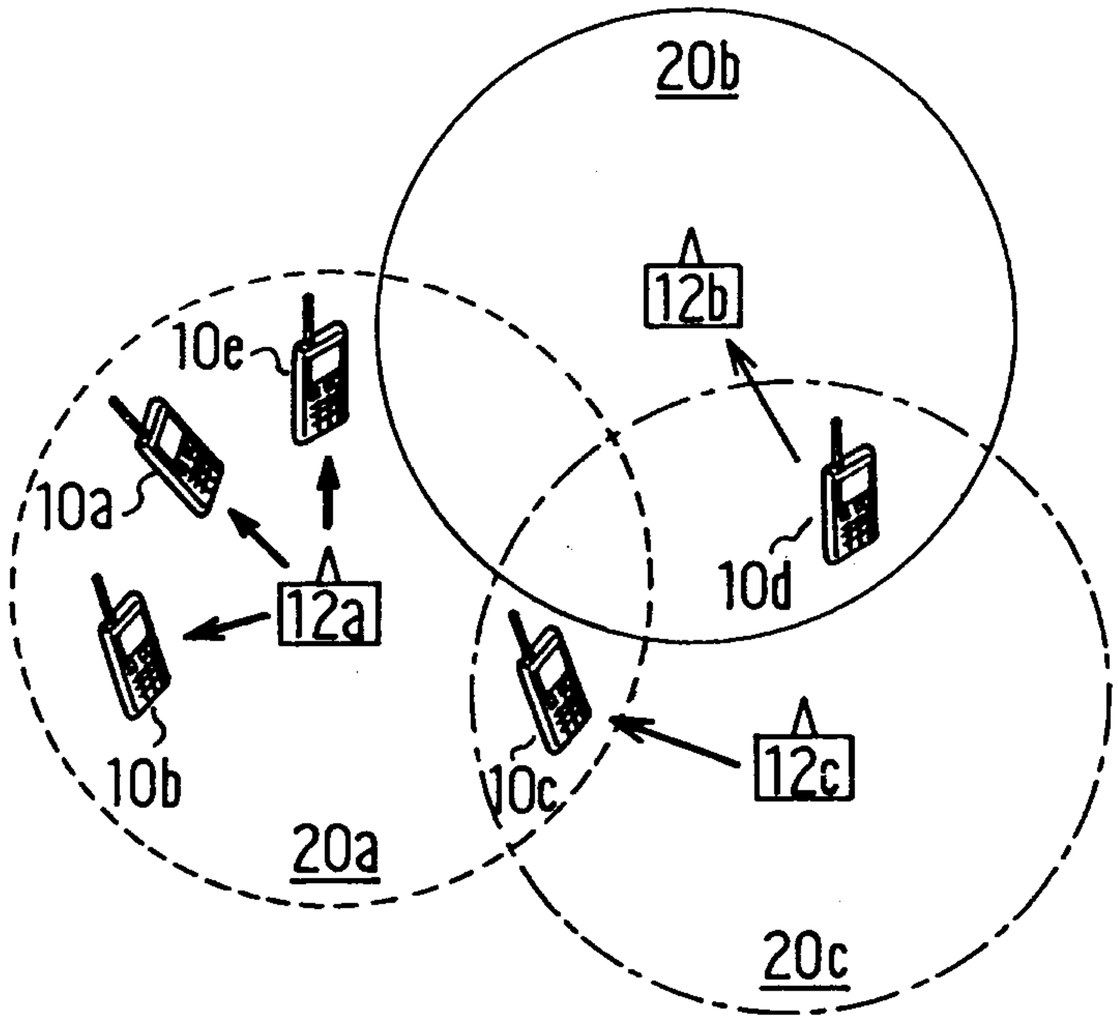


FIG. 7

FIG. 8

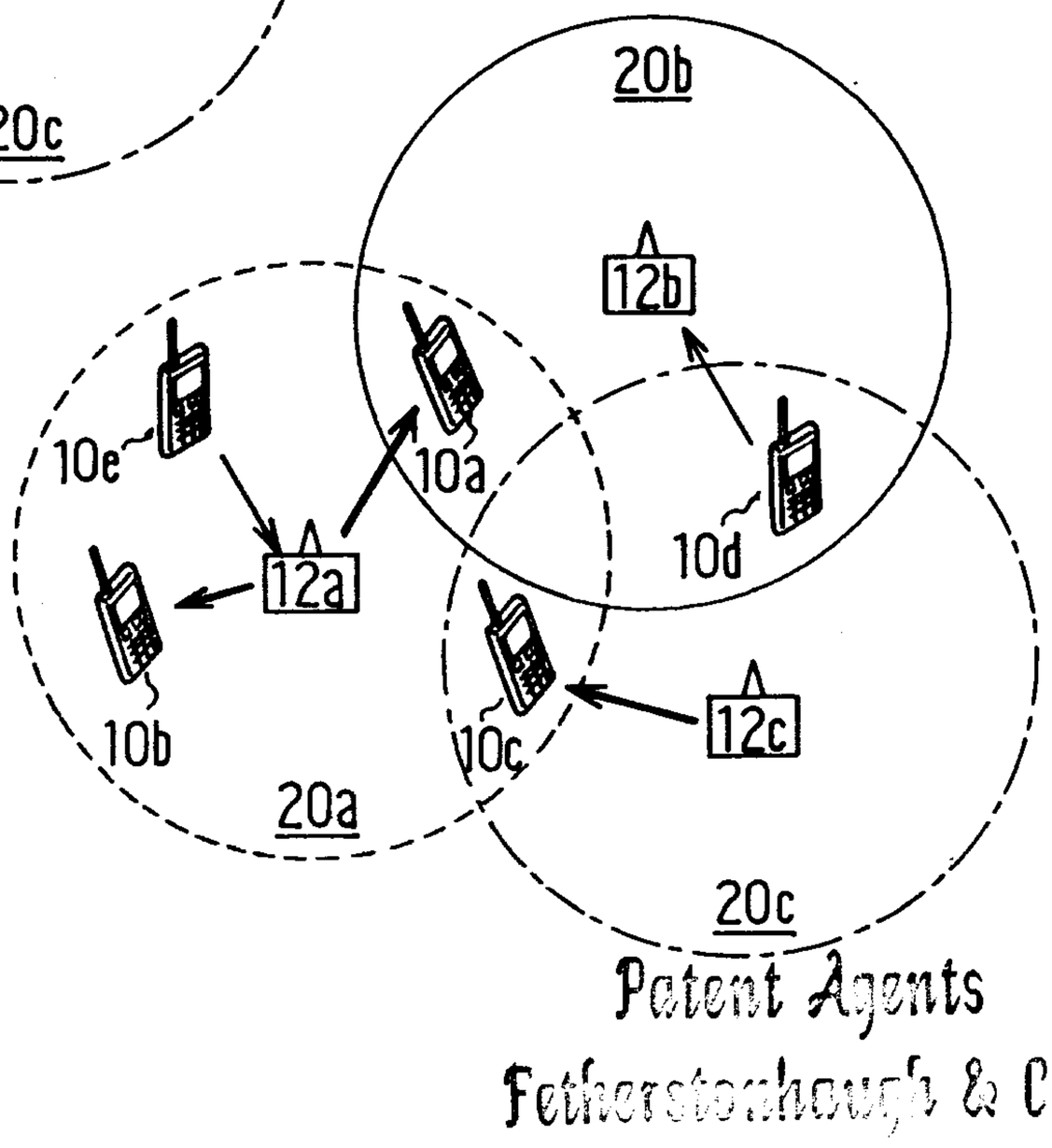


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FIG. 5

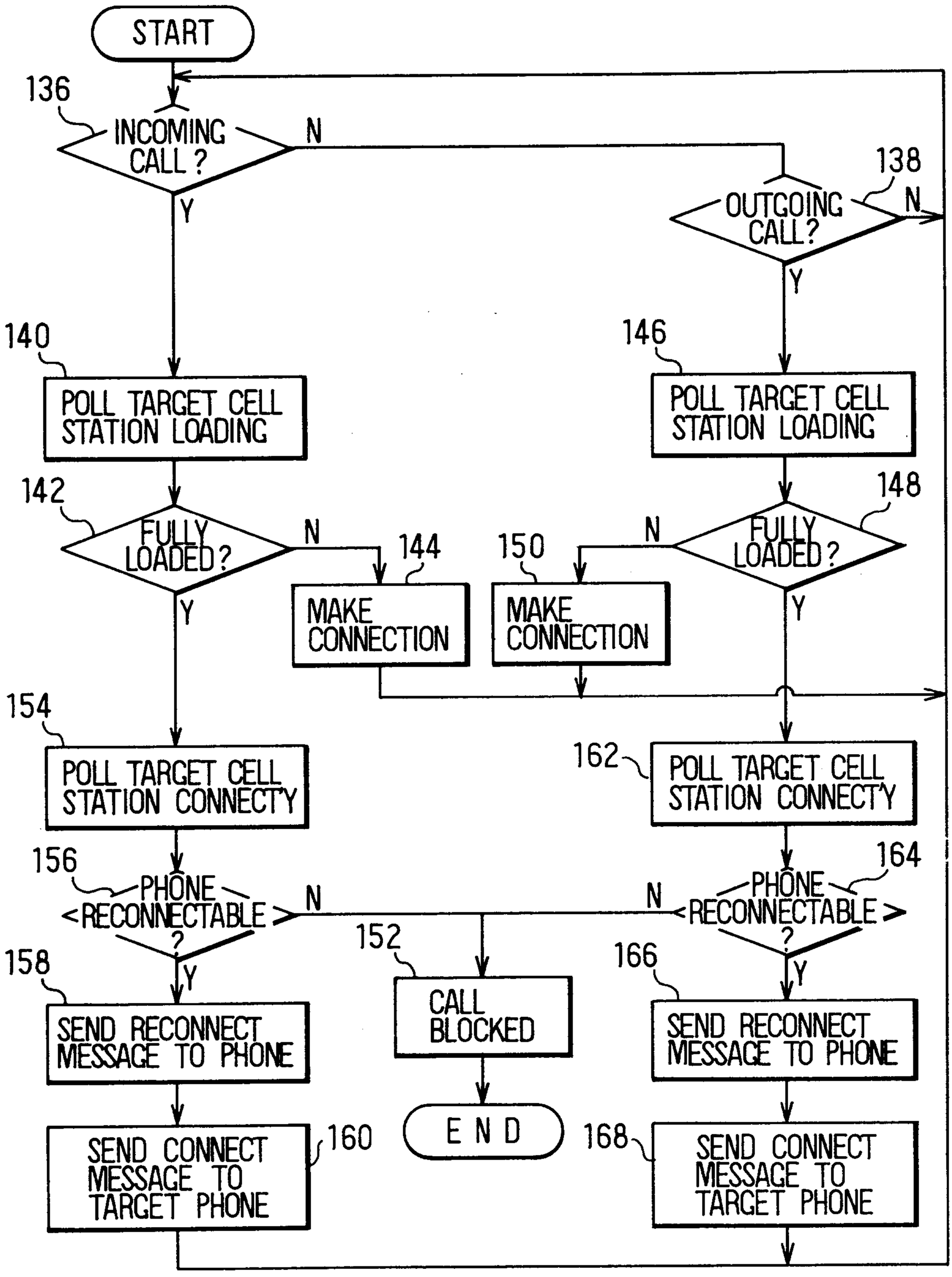

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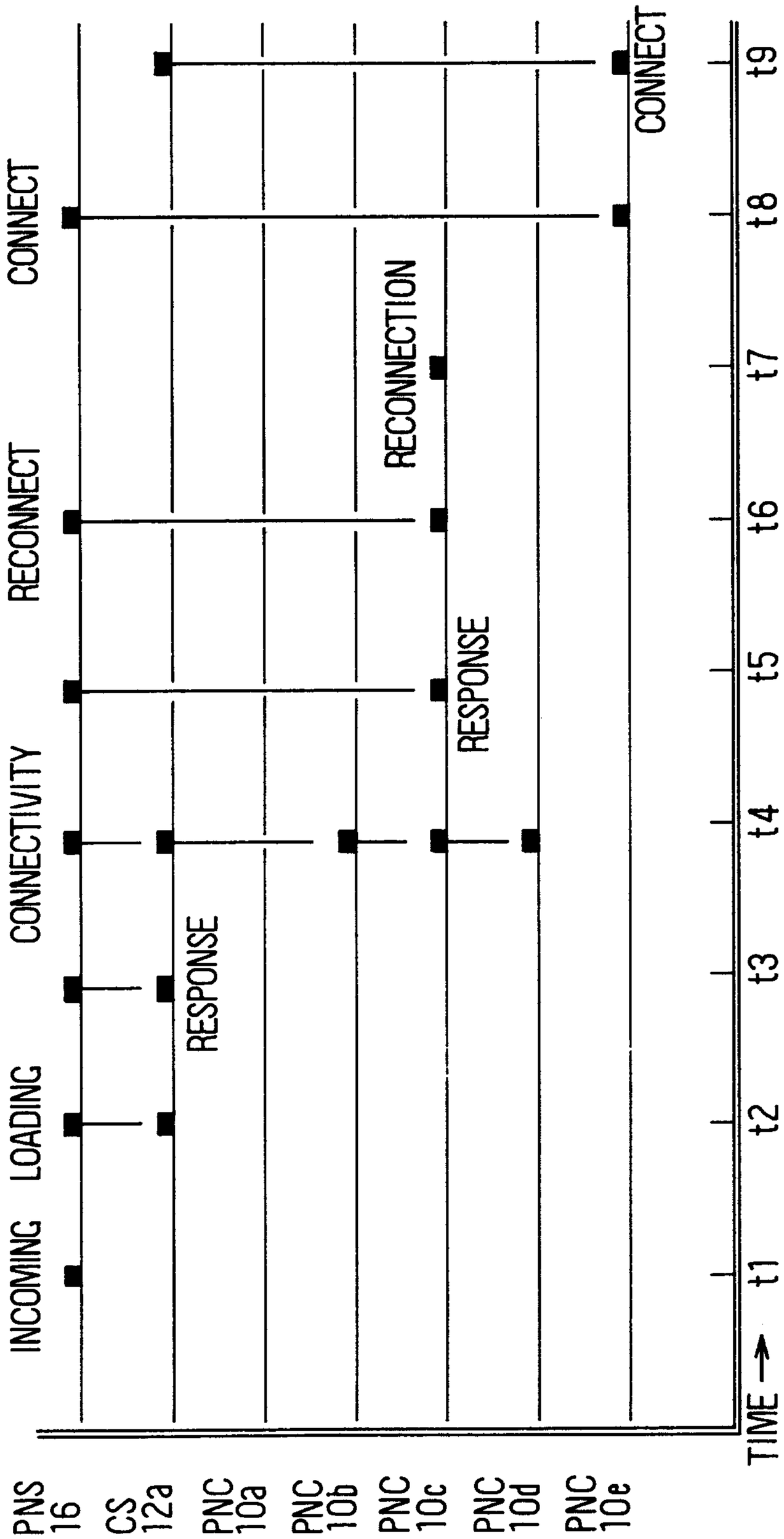
FIG. 6



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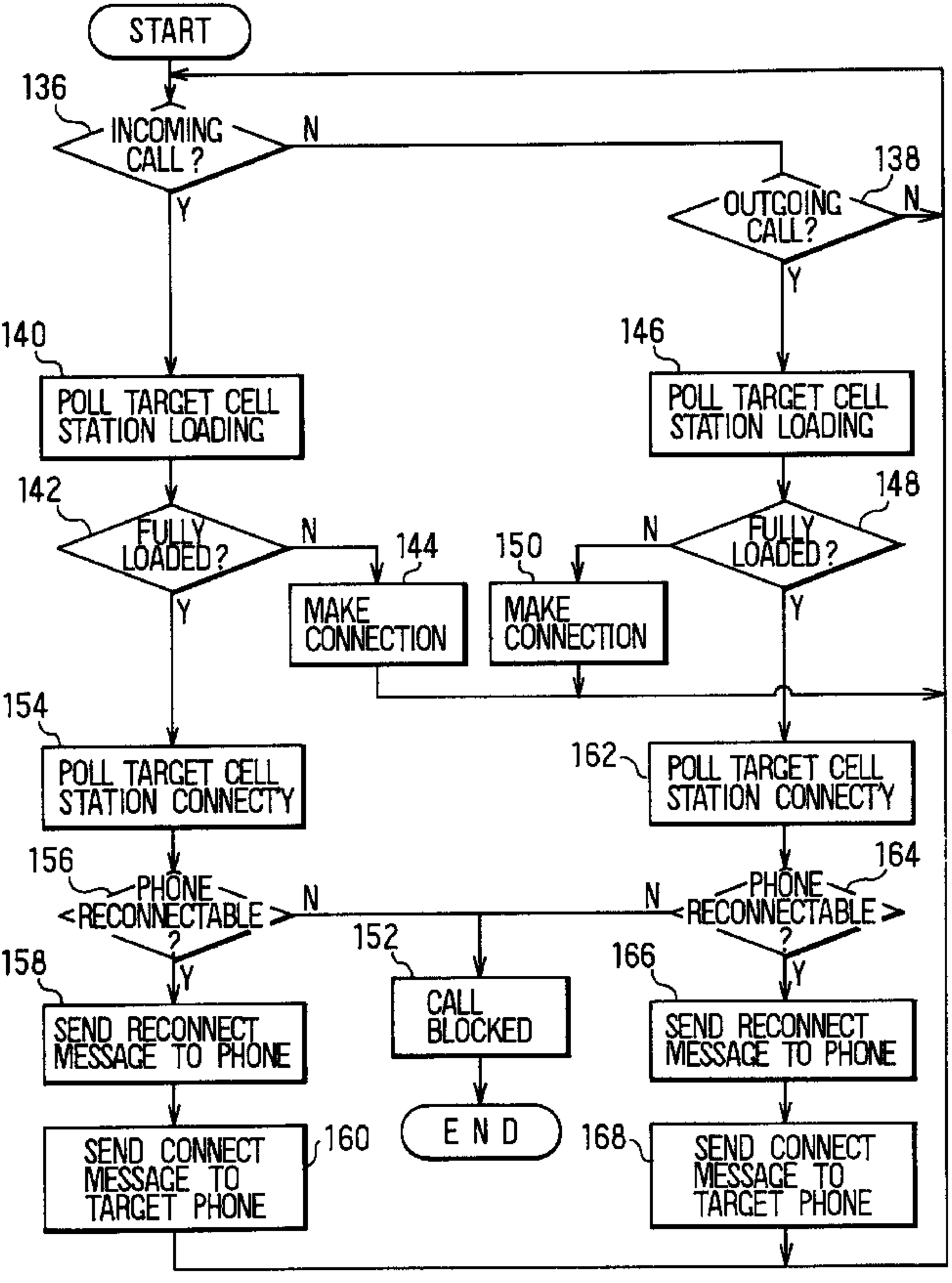
START
136
INCOMING CALL?
N
Y
138
OUTGOING CALL?
N
Y
140
POLL TARGET CELL STATION LOADING
146
POLL TARGET CELL STATION LOADING
142
FULLY LOADED?
N
Y
144
MAKE CONNECTION
150
MAKE CONNECTION
148
FULLY LOADED?
N
Y
154
POLL TARGET CELL STATION CONNECTY
162
POLL TARGET CELL STATION CONNECTY
156
PHONE <RECONNECTABLE>?
N
Y
152
CALL BLOCKED
END
164
PHONE <RECONNECTABLE>?
N
Y
158
SEND RECONNECT MESSAGE TO PHONE
166
SEND RECONNECT MESSAGE TO PHONE
160
SEND CONNECT MESSAGE TO TARGET PHONE
168
SEND CONNECT MESSAGE TO TARGET PHONE