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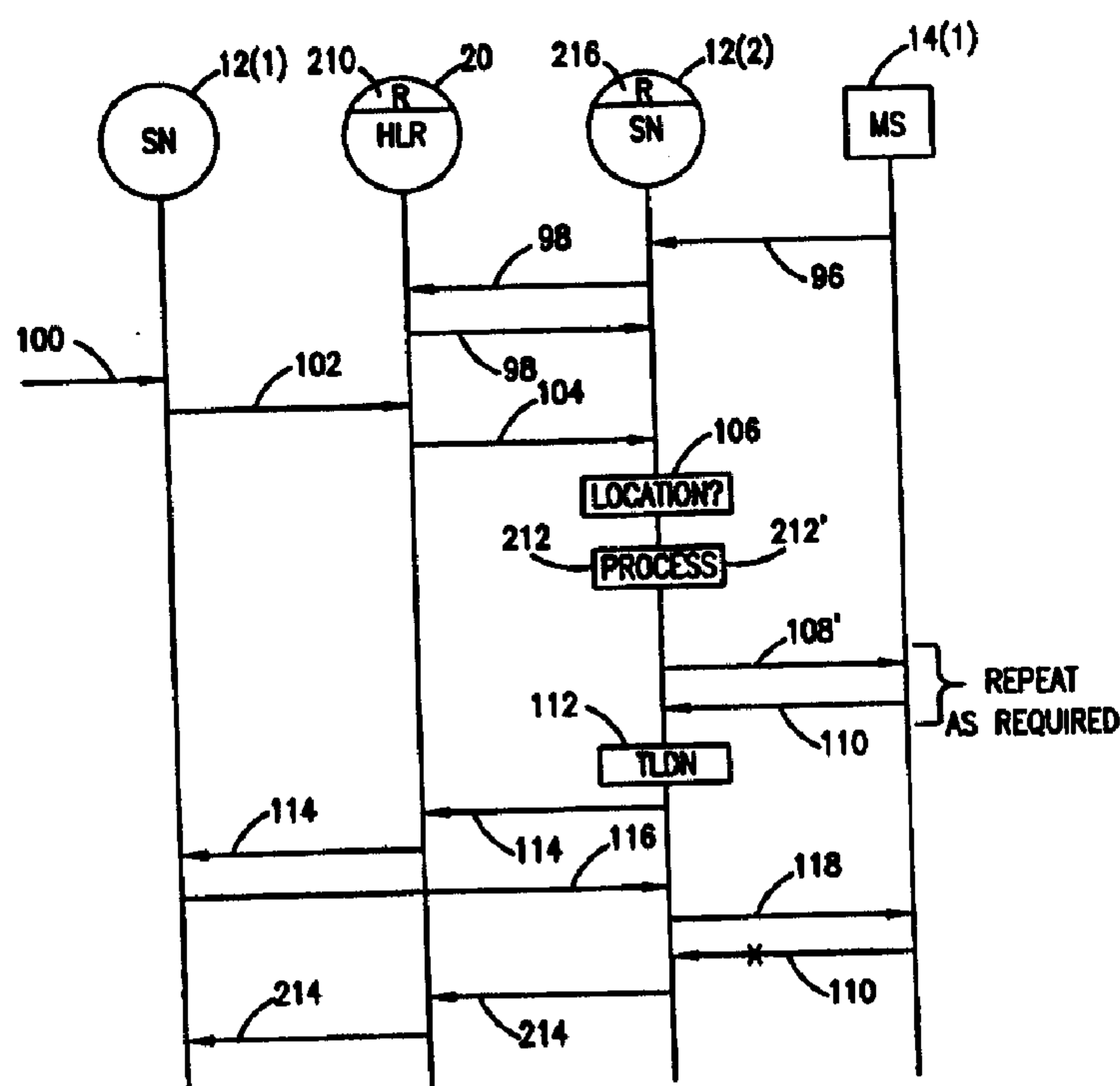
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(30) 1997/07/11 (08/891,507) US

(54) **SCHEMA DE RECHERCHE DE PERSONNE AMELIORE  
DESTINE A LA DELIVRANCE D'UN APPEL DANS UN  
RESEAU TELEPHONIQUE CELLULAIRE**

(54) **IMPROVED PAGING SCHEME FOR CALL DELIVERY WITHIN  
A CELLULAR TELEPHONE NETWORK**



(57) En réaction à la réception d'un appel entrant (100) au niveau d'un noeud de commutation de départ (12(1)), un message de demande de localisation (send routing) est envoyé au registre de localisation nominal destiné à la station mobile appelée. Un message de demande d'acheminement (provide roaming) (104) est ensuite envoyé du registre de localisation nominal au noeud de commutation (12(1)) identifié par le registre de localisation nominal comme étant en train de desservir la station mobile appelée (14(1)). Si la station mobile n'a pas le droit au service de réception dans les zones desservies par le noeud de commutation de desserte, un

(57) Responsive to receipt at an originating switching node (12(1)) of an incoming call (100), a location request (send routing) message is sent to the home location register for the called mobile station. A routing request (provide roaming) message (104) is then sent from the home location register to the switching node (12(1)) identified by the home location register as currently serving the called mobile station (14(1)). If the mobile station is not authorized to receive service in the areas serviced by the serving switching node a subscribed not found message (214) is returned to the originating switching node. Otherwise, the serving switching node



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message Subscriber not found (214) est renvoyé au noeud de commutation de départ. Sinon, le noeud de commutation de desserte recherche (108) la station mobile appelée seulement dans les zones qu'il dessert et qui sont également admises pour la fourniture de service de station mobile appelée. En réaction à un accusé réception de recherche (110), un numéro d'acheminement adéquat est affecté (112) et retransmis (114) au noeud de commutation de départ. Le numéro d'acheminement affecté est ensuite utilisé pour établir une communication longue distance (116) entre le noeud de commutation de départ et le contrôleur de la station de base en vue de la délivrance (118) de l'appel.

pages (108) for the called mobile station only in those areas it services which are also authorized to provided called mobile station service. Responsive to a paging acknowledgement (110), an appropriate routing number is assigned (112) and transmitted (114) back to the originating switching node. The assigned routing number is then used to establish a trunk connection (116) between the originating switching node and the base station controller for purposes of effectuating call delivery (118).



PCT

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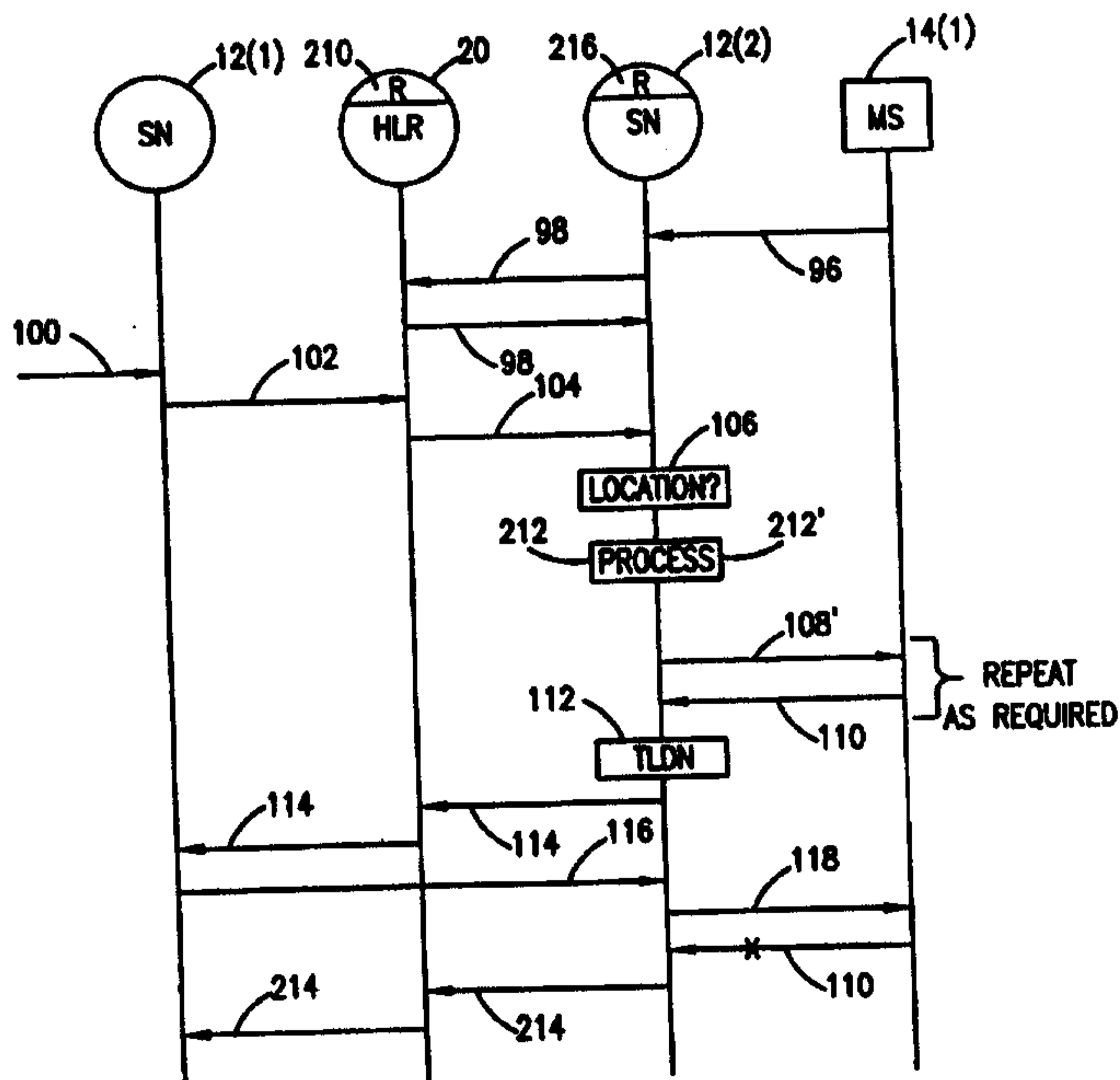
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<p>(21) International Application Number: PCT/SE98/01295 (22) International Filing Date: 30 June 1998 (30.06.98) (30) Priority Data: 08/891,507 11 July 1997 (11.07.97) US (71) Applicant: TELEFONAKTIEBOLAGET LM ERICSSON (publ) [SE/SE]; S-126 25 Stockholm (SE). (72) Inventor: NGUYEN, Viet; 6440 McLynn, Montreal, Quebec H3X 2R4 (CA). (74) Agent: ERICSSON RADIO SYSTEMS AB; Common Patent Dept., S-164 80 Stockholm (SE).</p>		<p>(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).</p> <p><b>Published</b> With international search report.</p>

(54) Title: IMPROVED PAGING SCHEME FOR CALL DELIVERY WITHIN A CELLULAR TELEPHONE NETWORK

(57) Abstract

Responsive to receipt at an originating switching node (12(1)) of an incoming call (100), a location request (send routing) message is sent to the home location register for the called mobile station. A routing request (provide roaming) message (104) is then sent from the home location register to the switching node (12(1)) identified by the home location register as currently serving the called mobile station (14(1)). If the mobile station is not authorized to receive service in the areas serviced by the serving switching node a subscribed not found message (214) is returned to the originating switching node. Otherwise, the serving switching node pages (108) for the called mobile station only in those areas it services which are also authorized to provided called mobile station service. Responsive to a paging acknowledgement (110), an appropriate routing number is assigned (112) and transmitted (114) back to the originating switching node. The assigned routing number is then used to establish a trunk connection (116) between the originating switching node and the base station controller for purposes of effectuating call delivery (118).



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**IMPROVED PAGING SCHEME  
FOR CALL DELIVERY WITHIN  
A CELLULAR TELEPHONE NETWORK**

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**BACKGROUND OF THE INVENTION**Technical Field of the Invention

The present invention relates to cellular telephone networks and, in particular, to the paging of a mobile station in connection with the termination of an incoming call.

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Description of Related Art

Operation of a cellular telephone network to handle an incoming call dialed to a cellular subscriber mobile station is well known. Responsive to receipt at an originating (or gateway) switching node of the incoming call dialed to a mobile station, a location request (send routing) message is sent to the home location register for the dialed mobile station. The home location register then identifies a switching node currently serving the dialed mobile station. A routing request (provide roaming) message is then sent from the home location register to the serving (or visited) switching node to prepare for delivery of the call. The serving switching node then pages for the mobile station within the network. Responsive to a paging acknowledgment, the mobile station is located and the serving switching node assigns an appropriate routing number (for example, a temporary location directory number or a roaming number) for that location. The routing number is then delivered to the originating switching node via the home location register where it is used to establish a trunk call connection between the originating switching node and the serving switching node. Delivery of the call to the mobile station from the serving switching node is then accomplished by establishing a connection with a base station currently serving the mobile station. A radio frequency communications link is then established between the base station and the mobile station to carry the call connection.

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Cellular telephone networks utilize a control channel to broadcast control signals within each of the included plurality of cells. In connection with the locating of a mobile station, a paging signal is transmitted over the control channel for certain ones of the cells. In order to provide the greatest likelihood of establishing location, the paging signal must be transmitted within every cell covering the service area of the network. The capacity of the control channel, however, is limited because its data transmission rate is relatively slow and it is used by the network to transmit many

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control related messages other than paging signals. Paging in every cell is then not an acceptable option as this would adversely affect control channel capacity. Procedures then must be established to utilize the limited capacity of the control channel as efficiently as possible, while at the same time ensuring an acceptable success rate for  
5 paging to facilitate call delivery.

One paging scheme that has been successfully utilized is to define a plurality of location areas (LA's) within the service area (SA) of the cellular telephone network. Each location area typically includes a plurality of individual cells. As mobile stations move about the service area, they register with the network each time they enter into  
10 a new location area. A record of this registration is kept, and selective paging is performed in each of the cells of the location area where the called mobile station last registered. If the paging signal is not acknowledged, the network next pages in a paging area (PA) which is larger than the location area in which the mobile station last registered, but smaller than the service area. Paging over the entire service area (i.e.,  
15 global) for a mobile station is performed, if at all, only in emergency situations.

It is known to offer cellular telephone service subscriptions that restrict the areas within which the subscriber is authorized to receive service. In a call delivery (restricted) service type subscription, subscribers are given the option of restricting the areas within which terminating calls may be delivered. With such a service, a mobile  
20 station is paged (typically on a location area basis) in connection with an incoming call delivery attempt. Responsive to a paging acknowledgment, the location of the mobile station is known and can be compared to a list of permitted call termination locations. If the mobile station is located within a permitted location, the call is delivered. Otherwise, the call is rejected. The use of conventional paging schemes in connection  
25 with this service, however, is inefficient and wasteful of limited paging resources because subscriber mobile stations may often be paged in cells where they are not authorized to receive cellular calling service.

In a long haul mobile switching center type subscription, service is offered in a small market where the use of a dedicated switching node is not justified. Excess  
30 capacity from a switching node in a neighboring market is then used to serve subscribers in the small market. With such a service, a mobile station is paged in connection with an incoming call delivery attempt in the location area for the serving switching node. This location area typically includes cells located outside of the small market service area. Furthermore, in many instances the small market subscribers are not even authorized to receive service outside of their own market. Again, the use of  
35 conventional paging schemes in connection with this service is inefficient and wasteful of limited paging resources because subscriber mobile stations may often be paged in

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cells where they either are not likely to be located, or are not authorized to receive cellular calling service.

What is needed then, especially in connection with the provision of any type of restricted service subscription, is a more efficient paging scheme that takes into account not only the location where a subscriber is likely to be found, but also the location where the subscriber is authorized to receive cellular calling service.

#### SUMMARY OF THE INVENTION

In general, a paging scheme is presented where mobile stations are paged, not conventionally in the locations where they are likely to be found, but rather in those locations where the mobile station is authorized to receive cellular calling service. Thus, in connection with the provision of a restricted service area subscription wherein a mobile station is authorized to receive cellular calls in only a certain portion of the cellular service area, the mobile station is paged in response to an incoming call only in that certain portion.

More particularly, responsive to receipt at an originating switching node of an incoming call, a location request (send routing) message is sent to the home location register for the called mobile station. A routing request (provide roaming) message is then sent from the home location register to the switching node identified by the home location register as currently serving the called mobile station. The serving switching node then pages for the called mobile station only in those areas it services which also comprise areas within which the called mobile station is authorized by its subscription to receive cellular calling service. Responsive to a paging acknowledgment, an appropriate routing number is assigned and transmitted back to the originating switching node. The assigned routing number is then used to establish a trunk connection between the originating switching node and the base station controller for purposes of effectuating call delivery.

In one embodiment of the invention, the certain areas within which the called mobile station is authorized by its subscription to receive cellular calling service are stored in the home location register and provided to the serving switching node along with a downloaded subscriber service profile. Responsive to a routing request message relating to an incoming call, the serving switching node determines which of those certain areas that it services, and then pages for the mobile station only in those determined areas. In the event the switching node services none of the determined areas, or no paging acknowledgment is received from the mobile station, a subscriber not available message is returned to the originating switching node.

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In another embodiment of the invention, certain directory B-number series are assigned to mobile stations having restricted service area subscriptions. Pursuant to this subscription, a mobile station in the certain directory B-number series is authorized to receive cellular calling service in only certain areas. Responsive to a routing request message relating to an incoming call, the serving switching node determines which of those certain areas specified by the B-number series that it services, and then pages for the mobile station only in those determined areas. In the event no paging acknowledgment is received from the mobile station, a subscriber not available message is returned to the originating switching node.

#### 10 BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the method and apparatus of the present invention may be acquired by reference to the following Detailed Description when taken in conjunction with the accompanying Drawings wherein:

FIGURE 1 is a schematic diagram of a cellular telephone network;

15 FIGURE 2 is a signal flow and node operation diagram illustrating the flow of signals in connection with the prior art termination of an incoming call;

FIGURE 3 is a cell diagram illustrating a plurality of cells grouped to form location areas;

20 FIGURE 4 is a signal flow and node operation diagram illustrating the flow of signals in connection with a specific example of the termination of an incoming call in accordance with the present invention;

FIGURES 5A-5E are diagrams illustrating various relationships between mobile station location and authorized service areas and their affect on mobile station paging; and

25 FIGURES 6A-6F are flow diagrams illustration operation of the paging scheme of the present invention.

#### DETAILED DESCRIPTION OF THE DRAWINGS

Reference is now made to FIGURE 1 wherein there is shown a schematic diagram of a cellular telephone network 10 including a plurality of interconnected switching nodes (SN) 12. Although only two switching nodes 12 are shown, it will be understood that the network 10 likely includes many more interconnected nodes. The first and second switching nodes 12(1) and 12(2) may comprise any one of a number of known telecommunications switching devices, including mobile switching centers (MSC's), as commonly used and known in the art for providing either digital or analog cellular telephone service to a plurality of mobile stations (MS) 14. The

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switching nodes 12 are interconnected with each other for communication via both voice trunks 18 (illustrated with broken lines) and signaling links 16 (illustrated with solid lines) providing a known ISUP (or R1 or R2) type connection. The voice trunks 18 provide voice and data communications paths used to carry subscriber communications between the switching nodes 12. The signaling links 16 carry command signals between the switching nodes 12. These signals may be used, for example, in setting up and tearing down voice and data communications links over the voice trunks 18 and controlling the provision of calling services to the mobile stations 14. The switching nodes 12 are also connected to a data base 20 comprising a home location register (HLR) by means of signaling links 22 providing a known Mobile Application Part (MAP) or IS-41 type connection. The data base 20 stores information concerning the mobile stations 14 comprising location information and service information.

In one implementation, the switching nodes 12 are further connected to at least one associated base station controller (BSC) 24 via both a signaling link 26 and a voice trunk 28. Only one base station controller 24 is shown connected to the switching node 12(1) in order to simplify the illustration. The voice trunk 28 provides a voice and data communications path used to carry subscriber communications between the switching node 12(1) and its base station controller 24. The signaling link 26 carries command signals between the node 12 and its associated base station controller 24. The signaling link 26 and trunk 28 are collectively commonly referred to in the art as the "A interface". The base station controller 24 is then connected to a plurality of base stations (BS) 30 which operate to effectuate radio frequency communications with proximately located mobile stations 14 over an air interface 32. The base station controller 24 functions in a well known manner to control this radio frequency communications operation. In another implementation, the switching node 12(2) is connected directly to the plurality of base stations (BS) 30. The functionality provided by the base station controller 24 in controlling the radio frequency communications operation is then instead performed by the switching node 12(2).

Although direct communications links (signaling and/or trunk) are illustrated in FIGURE 1, it is understood by those skilled in the art that the links are not necessarily direct between the illustrated nodes, and may instead pass through many other communications nodes (not shown) of the mobile network, and perhaps even utilize other communications networks (such as the public switched telephone network - PSTN). Illustration of the links in the "virtual" manner shown in FIGURE 1 is therefore by way of simplification of the drawing. The cellular telephone network 10 may comprise a Global System for Mobile (GSM) communications, an Advanced



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Mobile Phone System (AMPS), a digital Advanced Mobile Phone System (D-AMPS), a code division multiple access (CDMA) system, or the like.

Reference is now made in combination to FIGURES 1 and 2, wherein FIGURE 2 is a signal flow and node operation diagram illustrating the flow of signals in connection with a specific example of the prior art termination of an incoming call. A call 100 dialed to the directory number (B-number) of mobile station 14(1) originates from another cellular subscriber or the public switched telephone network (PSTN) and is received at the first (originating or gateway) switching node 12(1). Using the signaling link 22, the originating switching node 12(1) interrogates the home location register 20 with a location request (send routing) message 102. The location request (send routing) message 102 is processed by the home location register 20 to determine the location (i.e., second or serving switching node 12(2)) within the cellular network 10 of the called mobile station 14(1). Responsive to this interrogation, the home location register 20 signals the serving switching node 12(2) for the called mobile station 14(1) over signaling link 22 with a routing request (provide roaming) message 104 to prepare for the call. The serving switching node 12(2) then determines in action 106 whether the location (for example, location area) of the called mobile station 14(1) is known. This location may be identified, for example, based on information resulting from a most recent registration (not shown) of the called mobile station 14(1) as stored in a visitor location register (VLR) database 34 associated with the serving switching node 12(2). Preferably, the serving switching node 12(2) then pages 108 for the called mobile station 14(1) in the known location, and processes a page acknowledgment 110 to make a more precise (cell) location determination. In accordance with this determined location, the serving switching node 12(2) selects in action 112 an appropriate routing number (for example, a temporary location directory number (TLDN) or a roaming number) for that location (for example, taking in consideration LATA borders and other concerns). In this instance, the routing number is selected from a plurality of such numbers associated with the serving switching node 12(2). The selected routing number is then returned 114 to the originating switching node 12(1) via the home location register 20. The incoming call is then delivered (through connected) 116 over the voice trunk 18 using the routing number to the serving switching node 12(2) for attempted completion to the called mobile station 14(1). Completion of the call involves further routing 118 the incoming call to the currently serving base station 30, and then to the called mobile station 14(1) over the air interface 32.

Reference is now made to FIGURE 3 wherein there is shown a cell diagram 200 illustrating a plurality of cells 202 grouped to form location areas 204. For the

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sake of simplifying the illustration, only two location areas 204 are shown, it being understood, however, that the service area of a cellular telephone network like that shown in FIGURE 1 typically includes many more location areas. The first location area 204(1) includes cells 202(1)-202(5). The second location area 204(2) includes  
5 cells 202(6)-202(10).

Cellular telephone networks utilize instances of mobile station registration to ascertain mobile station location with an accuracy of about one location area 204. To determine mobile station location with a greater degree of accuracy, the system pages (108 of FIGURE 2) for the mobile station in each cell 202 of the location area 204  
10 within which that mobile station last registered. By processing a received paging acknowledgment (110 of FIGURE 2) from the mobile station, the network may ascertain mobile station location with an accuracy of about one cell 202.

Paging in this manner, however, can be inefficient and wasteful of limited available control channel communications resources because mobile stations are often  
15 paged in cells where the mobile station either is not likely to be located, or is not authorized to receive service. For example, in a call delivery (restricted) service type subscription, subscribers may restrict the areas within which terminating calls are to be delivered. It would be more efficient then to page for the mobile station only when it could possibly be located within a permitted location, and further to page only in  
20 those cells where mobile station operation is actually permitted. As another example, in a long haul mobile switching center type subscription, service is extended from a switching node to a small market where the allocation of a dedicated switching node is not justified. With respect to the small market subscribers that do not have roaming permission, it would be more efficient then to page for the mobile station only in those  
25 cells of the small market where service is authorized.

In connection with the implementation of a call delivery (restricted) service type subscription, a long haul mobile switching center type subscription, or some other type of restricted area service subscription, assume for exemplary purposes that a particular mobile station is authorized to receive incoming calls only when it is located  
30 within cells 202(3) and 202(5) of location area 204(1). As the particular mobile station moves about the service area, it would register with the network, and its current location within a certain one of the location areas 204 would be recorded in the home location register. When an incoming call is received for that particular mobile station, paging is conventionally performed in each cell 202 within the current location area  
35 204 where the called mobile station last registered. Following a paging acknowledgment identifying the cell 202 within which the paged mobile station is located, a comparison is made to determine whether the identified cell 202 matches

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any of the authorized cells 202(3) or 202(5). If so, the call setup for delivering the incoming call is completed. Otherwise, the call is rejected.

If it is now assumed that the particular mobile station is located at point "A" within cell 202(9) of location area 204(2), paging for the mobile station in each of the cells 202 of location area 204(2) is wasteful and inefficient as the restricted service subscription would not authorize completion of the incoming call to the mobile station at its current location. Similarly, if it is now assumed that the particular mobile station is located at point "B" within cell 202(5) of location area 204(1), paging for the mobile station in each of the cells 202(1)-202(5) of location area 204(1) is wasteful and inefficient as the restricted service subscription would not authorize completion of the incoming call to the mobile station in each of those cells. Instead, and in accordance with the present invention, paging for the mobile station is effectuated generally only within those location areas 204, and particularly only within those cells 202, within which termination of the incoming call is permitted.

Referring once again to FIGURE 1, in addition to storing the conventional cellular information relating to service provision, service profiles and mobile station position information (i.e., location area), the home location register 20 further stores in a register (R) 210 an identification of the particular areas (location areas 204 or cells 202) within which an associated mobile station is authorized to receive cellular calling service. This storage is associated with mobile station service provision, service profile and location information, and may be in the form of an authorization code from which the particular, service authorized, location area 204 and/or cell 202 identifications may be obtained through use of a look-up table or other known method. Alternatively, the storage may be in the form of a listing of the particular location areas 204 and/or cells 202 within which service is authorized.

As an alternative to storing an identification in the home location register 20 of the particular areas (location areas 204 or cells 202) within which an associated mobile station is authorized to receive cellular calling service (register 210), each switching node 12 is programmed in a register (R) 216 with an identification of one or more directory number series (NPA-NXX-XXXX) assigned to mobile stations 14 which are restricted for use in only certain areas. Associated with each such number series stored in the register 216 is an identification of the particular areas (location areas 204 or cells 202) within which mobile stations 14 in that series are authorized to receive cellular calling service.

Reference is now made in combination to FIGURES 1 and 4, wherein FIGURE 4 is a signal flow and node operation diagram illustrating the flow of signals in connection with a specific example of the termination of an incoming call in

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accordance with the present invention. When a mobile station 14(1) registers with the serving switching node 12(2), the service profile for that mobile station, including the register (R) 210 stored information identifying the particular areas (location areas 204 or cells 202) within which the called mobile station 14(1) is authorized to receive cellular calling service (if available), is downloaded 98 for use in providing cellular service. A call 100 dialed to the directory number (B-number) of mobile station 14(1) then originates from another cellular subscriber or the public switched telephone network (PSTN) and is received at the first (originating or gateway) switching node 12(1). Using the signaling link 22, the originating switching node 12(1) interrogates the home location register 20 with a location request (send routing) message 102. The location request (send routing) message 102 is processed by the home location register 20 to determine the location (i.e., second or serving switching node 12(2), or location area 204) within the cellular network 10 of the called mobile station 14(1). Responsive to this interrogation, the home location register 20 signals the serving switching node 12(2) for the called mobile station 14(1) over signaling link 22 with a routing request (provide roaming) message 104 to prepare for the call. The message 104 includes the B-number for the called mobile station 14(1). The serving switching node 12(2) then determines in action 106 whether the location (for example, within a location area 204) of the called mobile station 14(1) is known. This location may be determined, for example, based on information resulting from a most recent registration 96 of the called mobile station 14(1) as stored in a visitor location register (VLR) database 34 associated with the serving switching node 12(2).

In one embodiment of the present invention, the serving switching node 12(2) processes (action 212) the determined location information in view of the information obtained from the download 98 identifying the particular areas (location areas 204 or cells 202) within which the called mobile station 14(1) is authorized to receive cellular calling service (referred to as an "authorized area"). In another embodiment of the present invention, the serving switching node 12(2) analyzes the dialed B-number in connection with processing (action 212') the determined location information in view of the information obtained from the register 216 identifying restricted B-number series and the particular areas (location areas 204 or cells 202) within which mobile stations in those series are authorized to receive cellular calling service (also referred to as an "authorized area"). These processing actions 212 and 212' evaluate whether: (a) the location is unknown (FIGURE 5A); (b) the location is known and overlaps in part with an authorized area (FIGURE 5B); (c) the location is known and is within an authorized area (FIGURE 5C); (d) the location is known and includes in whole an

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authorized area (FIGURE 5D); and, (e) the location is known and is different from an authorized area (FIGURE 5E).

5 If (a) is satisfied, then the serving switching node 12(2) pages 108' for the called mobile station 14(1) in only those particular areas (location areas 204 or cells 202) associated with the serving switching node 12(2) within which the called mobile station 14(1) is authorized to receive cellular calling service. This is illustrated in FIGURE 5A where paging is performed in authorized area (1), but is not performed in area (2).

10 If (b) is satisfied, then the serving switching node 12(2) first pages 108' for the called mobile station 14(1) in only those particular areas (location areas 204 or cells 202) associated with the serving switching node 12(2) where the known location and area within which the called mobile station 14(1) is authorized to receive cellular calling service overlap. This is illustrated in FIGURE 5B where paging is first performed in authorized area (1), but not in any other areas (2-4). If this page fails, then the serving switching node 12(2) next (optionally) pages 108' for the called mobile station 14(1) in the remaining area within which the called mobile station 14(1) is authorized to receive cellular calling service overlap. This is also illustrated in FIGURE 5B where paging is performed in authorized area (2), but not in areas (3-4).

15 If (c) is satisfied, then the serving switching node 12(2) first pages 108' for the called mobile station 14(1) in only those particular areas (location areas 204 or cells 202) associated with the serving switching node 12(2) comprising the known location. This is illustrated in FIGURE 5C where paging is first performed in known location area (1), but not in any other areas (2-3). If this page fails, then the serving switching node 12(2) next (optionally) pages 108' for the called mobile station 14(1) in the area (encompassing the known location) within which the called mobile station 14(1) is authorized to receive cellular calling service overlap. This is also illustrated in FIGURE 5C where paging is performed in authorized area (2), but not in area (3). This case illustrates a scenario where the authorized area comprises, for example, a few location areas.

20 If (d) is satisfied, then the serving switching node 12(2) pages 108' for the called mobile station 14(1) in only those particular areas (location areas 204 or cells 202) associated with the serving switching node 12(2) within which the called mobile station 14(1) is authorized to receive cellular calling service. This is illustrated in FIGURE 5D where paging is performed in authorized area (1), but is not performed in areas (2-3). This case illustrates a scenario where the authorized area comprises, for example, a few cells located within a location area (see, FIGURE 3).

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If (e) is satisfied, then the serving switching node 12(2) pages 108' for the called mobile station 14(1) in only those particular areas (location areas 204 or cells 202) associated with the serving switching node 12(2) within which the called mobile station 14(1) is authorized to receive cellular calling service. This is illustrated in FIGURE 5E where paging is performed in authorized area (1), but is not performed in areas (2-3). As an alternative, the serving switching node 12(2) may choose not to page for the called mobile station 14(1) at all.

A page acknowledgment 110 received from the mobile station 14(1) in response to any of the pages 108' is processed to make a more precise location determination. In accordance with this determined location, the serving switching node 12(2) selects in action 112 an appropriate routing number (for example, a temporary location directory number (TLDN) or a roaming number) for that location (for example, taking in consideration LATA borders and other concerns). In this instance, the routing number is selected from a plurality of such numbers associated with the serving switching node 12(2). The selected routing number is then returned 114 to the originating switching node 12(1) via the home location register 20. The incoming call is then delivered (through connected) 116 over the voice trunk 18 using the routing number to the serving switching node 12(2) for attempted completion to the called mobile station 14(1). Completion of the call involves further routing 118 the incoming call to the currently serving base station 30, and then to the called mobile station 14(1) over the air interface 32.

If no page acknowledgment 110 is received (as indicated by the "X") to a page 108', and there are no more supplementary pages 108' to be made (see, e.g., FIGURES 5B and 5D), a subscriber not available message is returned 214 to the originating switching node 12(1) via the home location register 20. It should further be recognized that if the serving switching node 12(2) does not serve an authorized area, no page 108 or 108' is made, and a subscriber not available message is returned 214 to the originating switching node 12(1) via the home location register 20.

Reference is now made to FIGURES 6A-6F wherein there is shown a flow diagram illustration operation of the paging scheme of the present invention. In step 300, an incoming call is received. The home location register is then interrogated with a location request (send routing) message in step 302. The serving switching node is then signaled in step 304 with a routing request (provide roaming) message. A determination is then made in step 306 as whether the location of the called mobile station is known.

If the location is not known, the process moves to FIGURE 6B (step 308). Turning now to FIGURE 6B, paging is performed for the called mobile station only

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those particular areas (location areas or cells) where the called mobile station is authorized to receive cellular calling service (step 310). If the serving switching node does not serve an authorized area, the process advances to mark the subscriber as not found in step 314. A determination is next made in step 312 as to whether a paging acknowledgment (ACK) has been received from the called mobile station. If the determination made in step 312 is no, the subscriber is marked as not found (step 314). Otherwise, an appropriate routing number (for example, a temporary location directory number (TLDN) or a roaming number) is selected in step 316. The not found indication or selected routing number is then returned in step 318, and the incoming call is through connected using the returned routing number to the called mobile station in step 320.

Returning again to FIGURE 6A, if the location is known, the known location is compared to the authorized area in step 322. If the known location and authorized area overlap, the process moves to FIGURE 6C. Turning now to FIGURE 6C, paging is performed for the called mobile station only those particular areas (location areas or cells) where there is an overlap between the known location and those locations where the called mobile station is authorized to receive cellular calling service (step 324). If the serving switching node does not serve such an area, the process advances to mark the subscriber as not found in step 332. A determination is next made in step 326 as to whether a paging acknowledgment (ACK) has been received from the called mobile station. If the determination made in step 326 is no, paging is then (optionally) performed for the called mobile station in those particular areas (location areas or cells) where the called mobile station is authorized to receive cellular calling service (step 328). A determination is next made in step 330 as to whether a paging acknowledgment (ACK) has been received from the called mobile station. If the determination made in step 330 is no, the subscriber is marked as not found (step 332). Otherwise (steps 326 or 330), an appropriate routing number (for example, a temporary location directory number (TLDN) or a roaming number) is selected in step 334. The not found indication or selected routing number is then returned in step 336, and the incoming call is through connected using the returned routing number to the called mobile station in step 338.

Returning again to FIGURE 6A, if the known location is within the authorized area, the process moves to FIGURE 6D. Turning now to FIGURE 6D, paging is performed for the called mobile station only those particular areas (location areas or cells) of the known location of the called mobile station (step 344). If the serving switching node does not serve such an area, the process advances to mark the subscriber as not found in step 352. A determination is next made in step 346 as to

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whether a paging acknowledgment (ACK) has been received from the called mobile station. If the determination made in step 346 is no, paging is then (optionally) performed for the called mobile station in those particular areas (location areas or cells) including the known location where the called mobile station is authorized to receive cellular calling service of the known location of the called mobile station (step 348). A determination is next made in step 350 as to whether a paging acknowledgment (ACK) has been received from the called mobile station. If the determination made in step 350 is no, the subscriber is marked as not found (step 352). Otherwise (steps 346 or 350), an appropriate routing number (for example, a temporary location directory number (TLDN) or a roaming number) is selected in step 354. The not found indication or selected routing number is then returned in step 356, and the incoming call is through connected using the returned routing number to the called mobile station in step 358.

Returning again to FIGURE 6A, if the known location includes the authorized area, the process moves to FIGURE 6E. Turning now to FIGURE 6E, paging is performed for the called mobile station only those particular areas (location areas or cells) where the called mobile station is authorized to receive cellular calling service (step 370). If the serving switching node does not serve such an area, the process advances to mark the subscriber as not found in step 374. A determination is next made in step 372 as to whether a paging acknowledgment (ACK) has been received from the called mobile station. If the determination made in step 372 is no, the subscriber is marked as not found (step 374). Otherwise, an appropriate routing number (for example, a temporary location directory number (TLDN) or a roaming number) is selected in step 376. The not found indication or selected routing number is then returned in step 378, and the incoming call is through connected using the returned routing number to the called mobile station in step 380.

Returning again to FIGURE 6A, if the known location is different from the authorized area, the process moves to FIGURE 6F. Turning now to FIGURE 6F, paging is performed for the called mobile station only those particular areas (location areas or cells) where the called mobile station is authorized to receive cellular calling service (step 390). If the serving switching node does not serve such an area, the process advances to mark the subscriber as not found in step 394. A determination is next made in step 392 as to whether a paging acknowledgment (ACK) has been received from the called mobile station. If the determination made in step 392 is no, the subscriber is marked as not found (step 394). Otherwise, an appropriate routing number (for example, a temporary location directory number (TLDN) or a roaming number) is selected in step 396. The not found indication or selected routing number



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is then returned in step 398, and the incoming call is through connected using the returned routing number to the called mobile station in step 400.

5 Although preferred embodiments of the method and apparatus of the present invention have been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it will be understood that the invention is not limited to the embodiments disclosed, but is capable of numerous rearrangements, modifications and substitutions without departing from the spirit of the invention as set forth and defined by the following claims.

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**WHAT IS CLAIMED IS:**

1. With respect to a mobile station subscribed to a restricted area calling service wherein incoming call delivery is permitted only within certain ones of a plurality of cells defined within a service area, a method for paging for that mobile station in response to an incoming call comprising the step of paging for that mobile station initially only within those certain served ones of the plurality of cells defined within the service area for which the subscribed to restricted area calling service permits incoming call delivery.

2. The method as in claim 1 wherein the step of paging comprises the steps of:

sending to a switching node currently serving that mobile station an identification of the certain ones of the plurality of cells defined within the service area for which the subscribed to restricted area calling service permits incoming call delivery;

determining whether the serving switching node services any of those certain ones of the plurality of cells;

paging initially only in the serving switching node serviced certain ones of the plurality of cells; and

providing a mobile station not found indication if no serving switching node serviced certain ones of the plurality of cells exist.

3. The method as in claim 1 further including the step of providing a mobile station not found indication if no acknowledgment from the step of paging is received from that mobile station.

4. With respect to a mobile station subscribed to a restricted area calling service wherein incoming call delivery is permitted only within certain ones of a plurality of cells defined within a service area, a method for paging for that mobile station in response to an incoming call comprising the steps of:

analyzing a B-number for that mobile station to identify served certain ones of the plurality of cells defined within the service area for which the subscribed to restricted area calling service permits incoming call delivery; and

paging for the mobile station initially only within those identified served certain ones of the plurality of cells.

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5. The method as in claim 4 wherein the step of paging comprises the steps of:

determining whether a switching node currently serving that mobile station services any of those certain ones of the plurality of cells defined within the service area for which the subscribed to restricted area calling service permits incoming call delivery;

paging initially only in the serving switching node serviced certain ones of the plurality of cells; and

providing a mobile station not found indication if no serving switching node serviced certain ones of the plurality of cells exist.

6. The method as in claim 4 further including the step of providing a mobile station not found indication if no acknowledgment from the step of paging is received from that mobile station.

7. A method for call delivery within a cellular telephone network including an originating switching node receiving an incoming call dialed to a mobile station, and a serving switching node serving the called mobile station, the method comprising the steps of:

transmitting a routing number request message to the serving switching node;

identifying by the serving switching node of certain ones of a plurality of cells defined within a service area of the cellular telephone network for which a restricted area calling service subscribed to by the called mobile station permits incoming call delivery;

paging from the serving switching node for the called mobile station initially only within the serving switching node serviced certain ones of the plurality of cells;

selecting by the serving switching node of a routing number in response to a paging acknowledgment received from the called mobile station;

transmitting the selected routing number from the serving switching node back to the originating switching node; and

utilizing the selected routing number to route the incoming call from the originating switching node to the serving switching node for delivery to the called mobile station.

8. The method as in claim 7 wherein a subscriber service profile downloaded to the serving switching node includes an identification of the certain ones of the plurality of cells defined within the service area for which the subscribed

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to restricted area calling service permits incoming call delivery, and the step of identifying further includes the step of identifying which of the identified certain ones of the plurality of cells are serviced by the serving switching node.

9. The method as in claim 7 wherein the step of identifying further comprises the steps of:

analyzing a B-number for the mobile station to identify the certain ones of the plurality of cells defined within the service area for which the subscribed to restricted area calling service permits incoming call delivery; and

identifying which of the identified certain ones of the plurality of cells are serviced by the serving switching node.

10. A method for call delivery within a cellular telephone network including an originating switching node receiving an incoming call dialed to a mobile station, and a serving switching node serving the called mobile station, the method comprising the steps of:

transmitting a routing number request message to the serving switching node;

processing a B-number for the called mobile station to determine whether it is subject to a restricted area calling service wherein incoming call delivery is permitted only within certain ones of a plurality of cells defined within a service area of the cellular telephone network;

performing conventional paging for the called mobile station if the step of processing reveals that the mobile station is not subject to the restricted area calling service; or

identifying which of the certain ones of the plurality of cells that are serviced by the serving switching node if the step of processing reveals that the mobile station is subject to the restricted area calling service; and

performing selected paging for the called mobile station only within the identified certain ones of the plurality of cells that are serviced by the serving switching node;

selecting by the serving switching node of a routing number in response to a paging acknowledgment received from the called mobile station;

transmitting the selected routing number from the serving switching node back to the originating switching node; and

utilizing the selected routing number to route the incoming call from the originating switching node to the serving switching node for delivery to the called mobile station.

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11. The method as in claim 10 wherein the routing number comprises a temporary location directory number.

12. A method for call delivery within a cellular telephone network including an originating switching node receiving an incoming call dialed to a mobile station, and a serving switching node serving the called mobile station, the method comprising the steps of:

transmitting a routing number request message to the serving switching node;  
processing a registered location of the called mobile station to determine whether it is located within an area wherein incoming call delivery to the called mobile station is permitted;

performing selected paging for the called mobile station only within certain ones of a plurality of cells that are serviced by the serving switching node and are defined within a service area of the cellular telephone network as being permitted locations for incoming call delivery to the called mobile station;

selecting by the serving switching node of a routing number in response to a paging acknowledgment received from the called mobile station;

transmitting the selected routing number from the serving switching node back to the originating switching node; and

utilizing the selected routing number to route the incoming call from the originating switching node to the serving switching node for delivery to the called mobile station.

13. The method as in claim 12 wherein the routing number comprises a temporary location directory number.

14. A cellular telephone network, comprising:

an originating switching node receiving an incoming called dialed to a mobile station, wherein the mobile station is subscribed to a restricted area calling service where incoming call delivery is permitted only within certain ones of a plurality of cells defined within a service area of the cellular telephone network;

a serving switching node currently serving the called mobile station;

a trunk connection between the originating switching node and the base station controller;

means in the serving switching node for specially paging for the called mobile station only within serving switching node serviced ones of the certain ones of the

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plurality of cells defined within a service area of the cellular telephone network for which incoming call delivery is permitted; and

means responsive to an acknowledgment of the special paging for routing the incoming call from the originating switching node to the serving switching node over the trunk connection for delivery to the called mobile station.

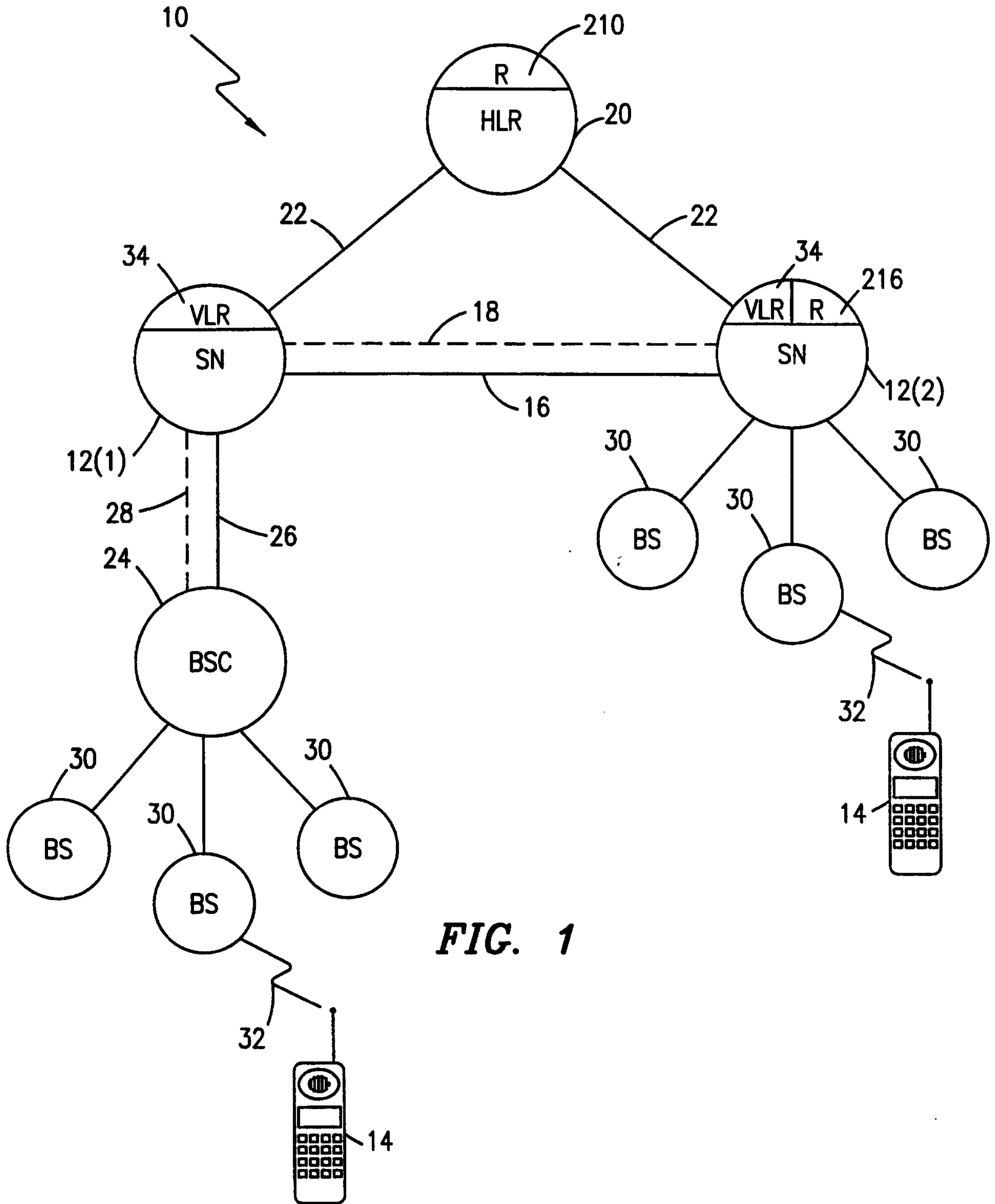
15. The network of claim 14 wherein the means for specially paging further comprises:

means for processing a B-number for the called mobile station to determine whether it is subject to the restricted area calling service and identify those of the certain ones of the plurality of cells serviced by the serving switching node.

16. The network of claim 14 wherein the means for specially paging further comprises:

means for processing a received identification of the certain ones of the plurality of cells defined within the service area for which the subscribed to restricted area calling service permits incoming call delivery to identify those of the certain ones of the plurality of cells serviced by the serving switching node.

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**FIG. 1**

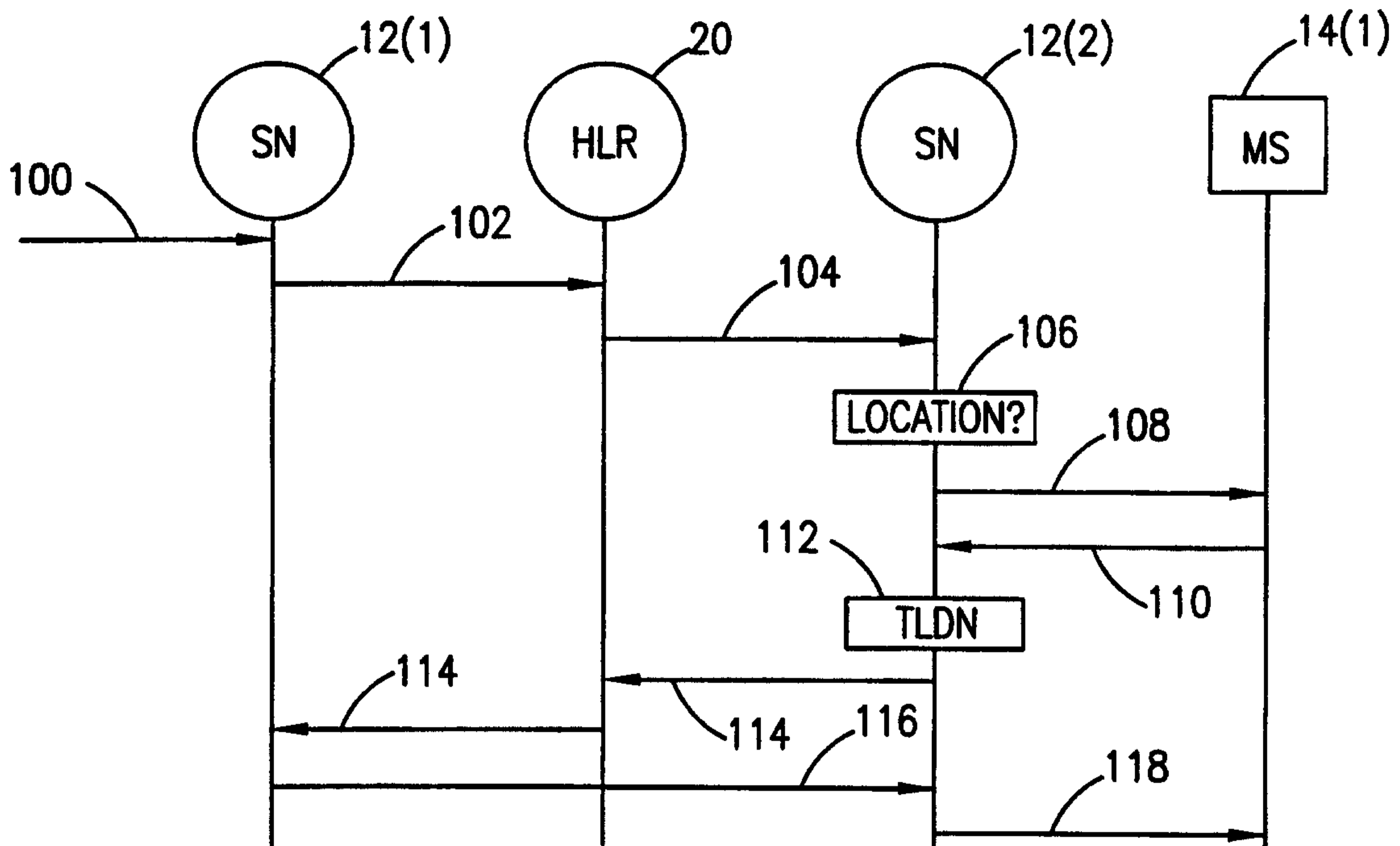


FIG. 2  
(PRIOR ART)

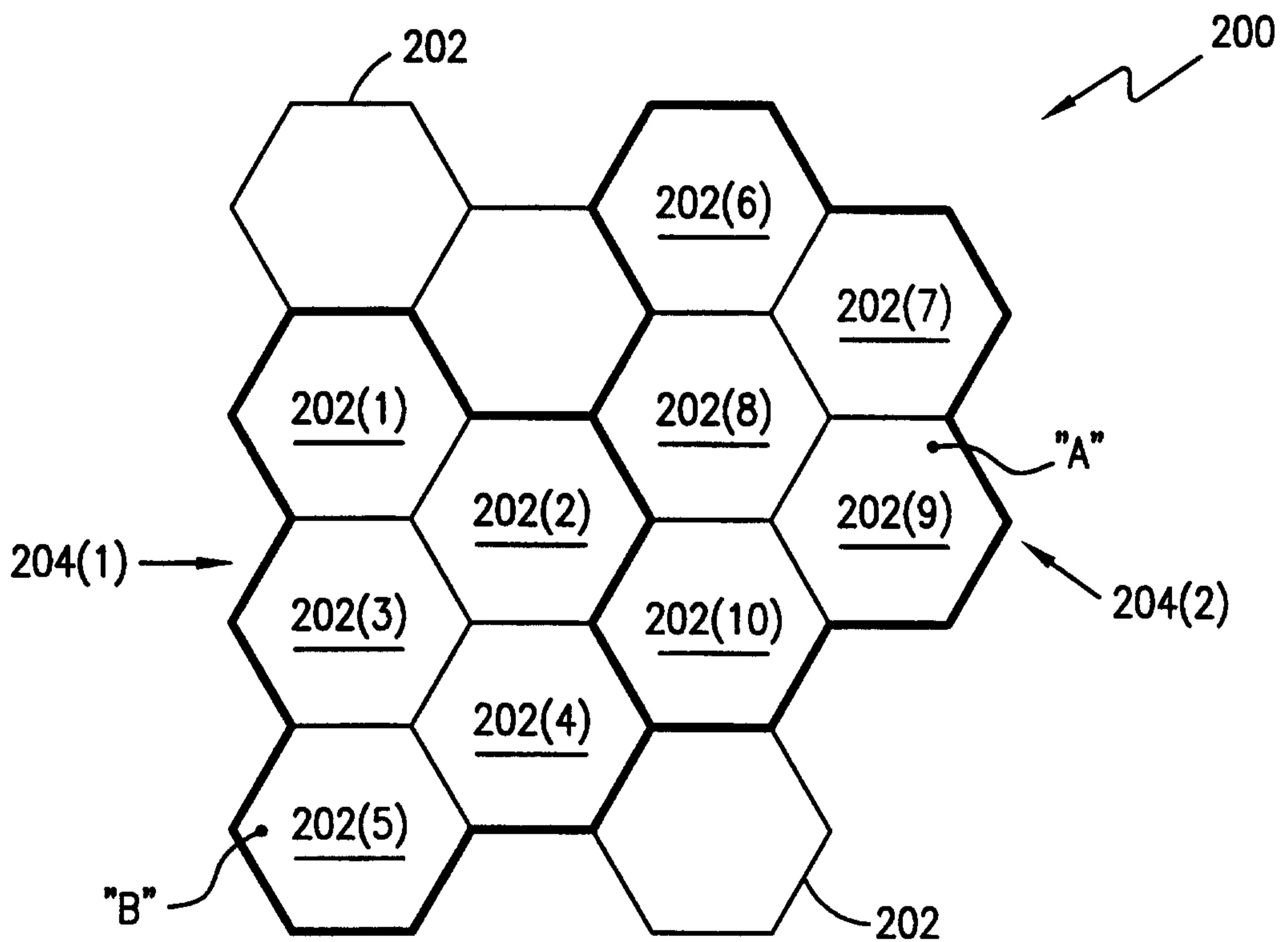


FIG. 3



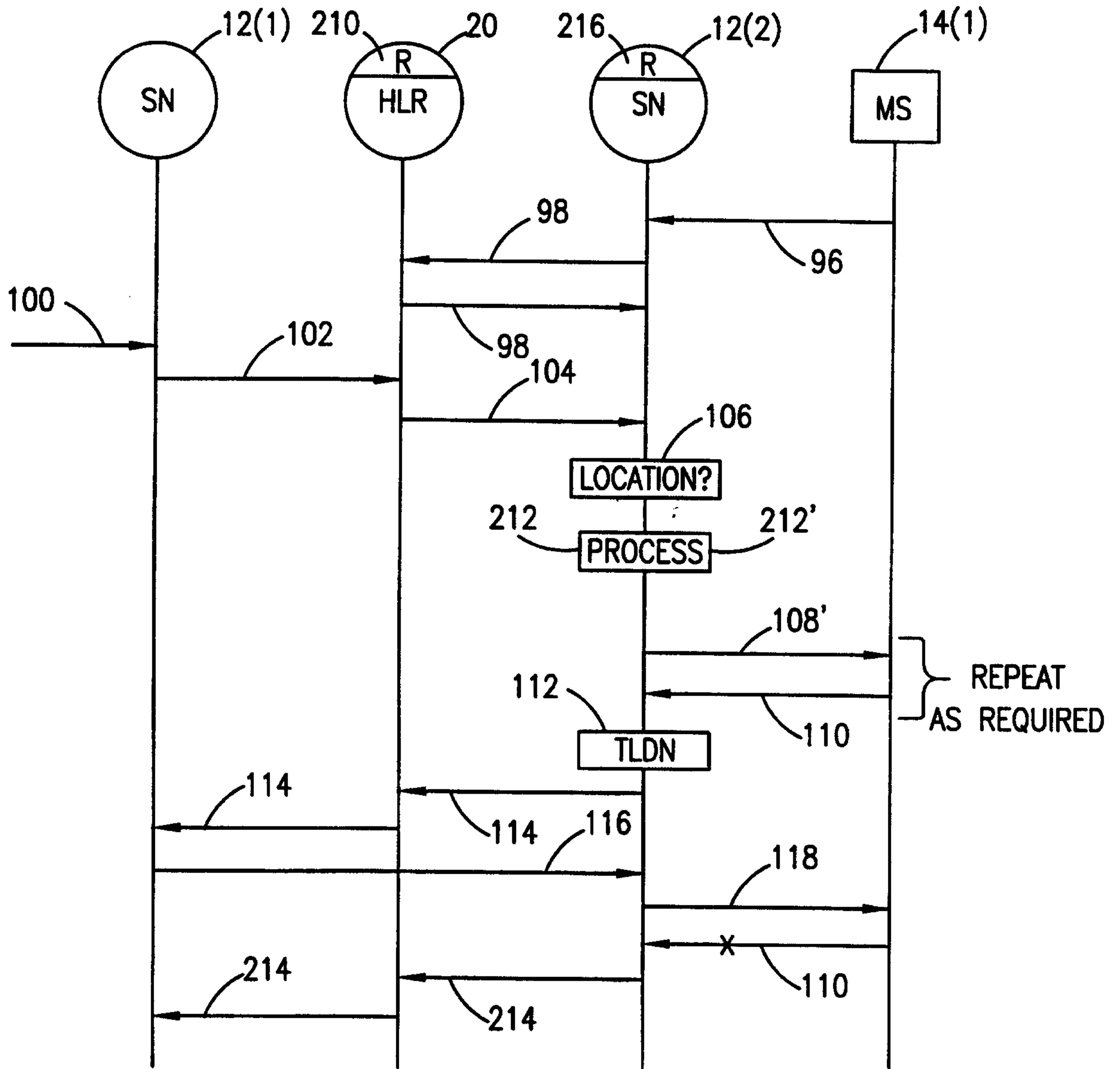
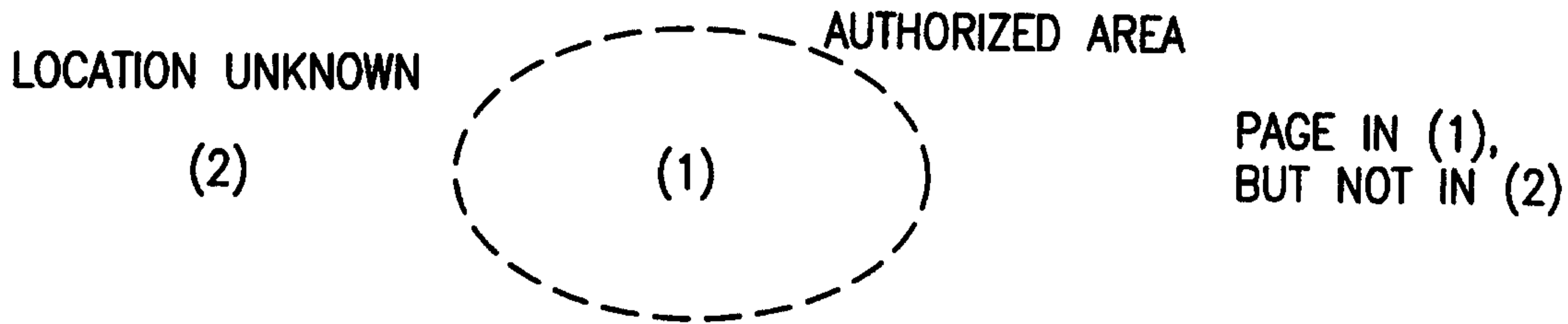
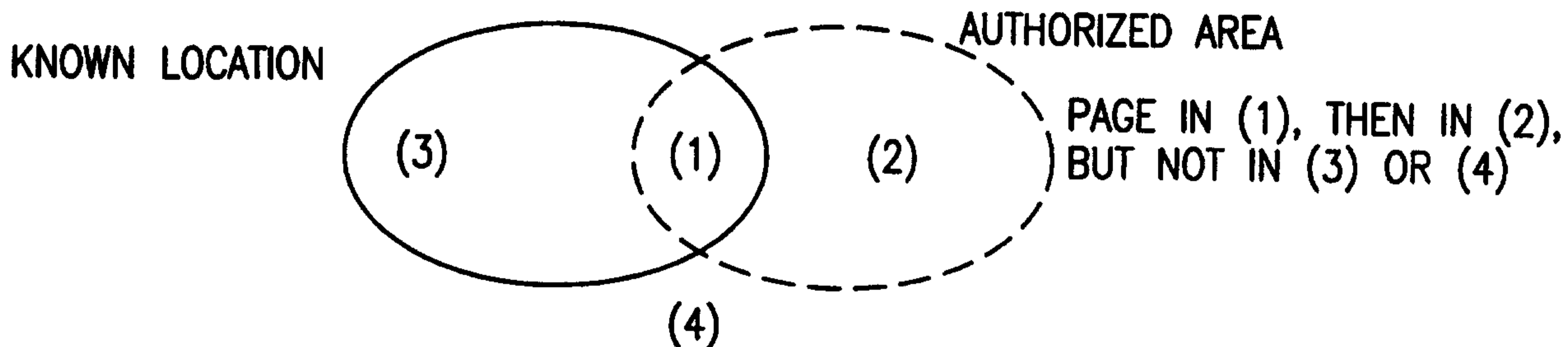


FIG. 4

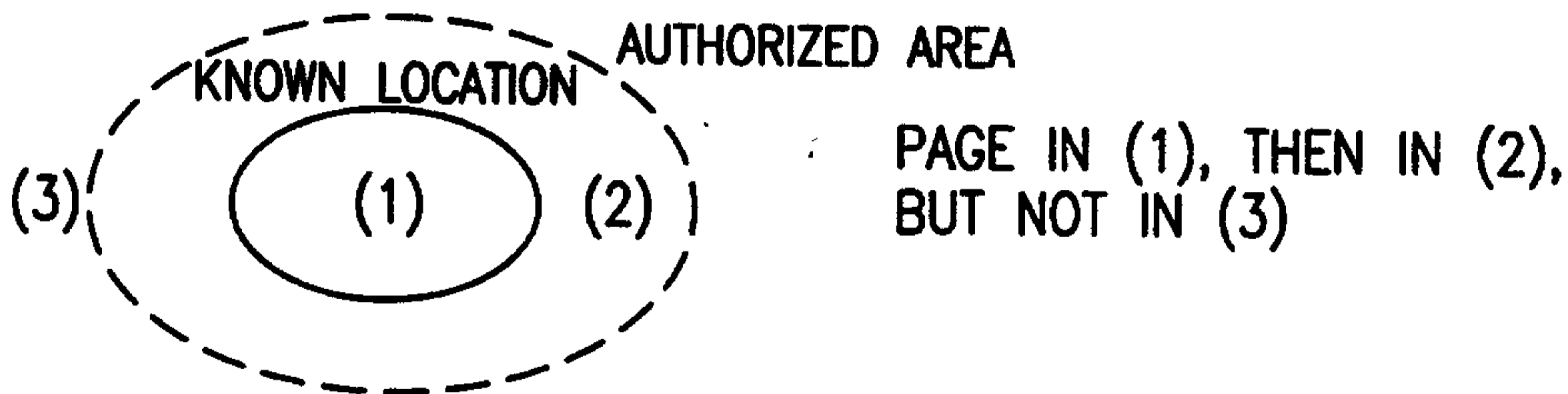
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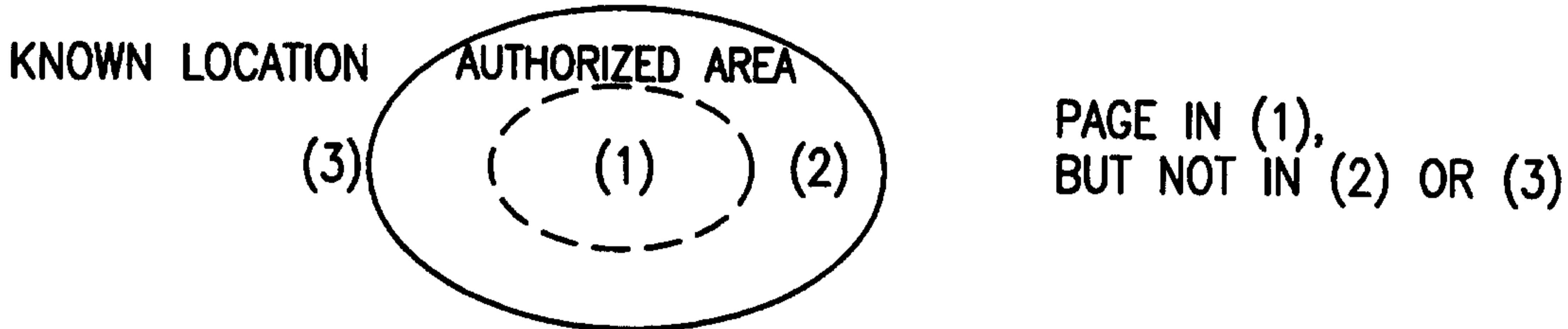
**FIG. 5A**



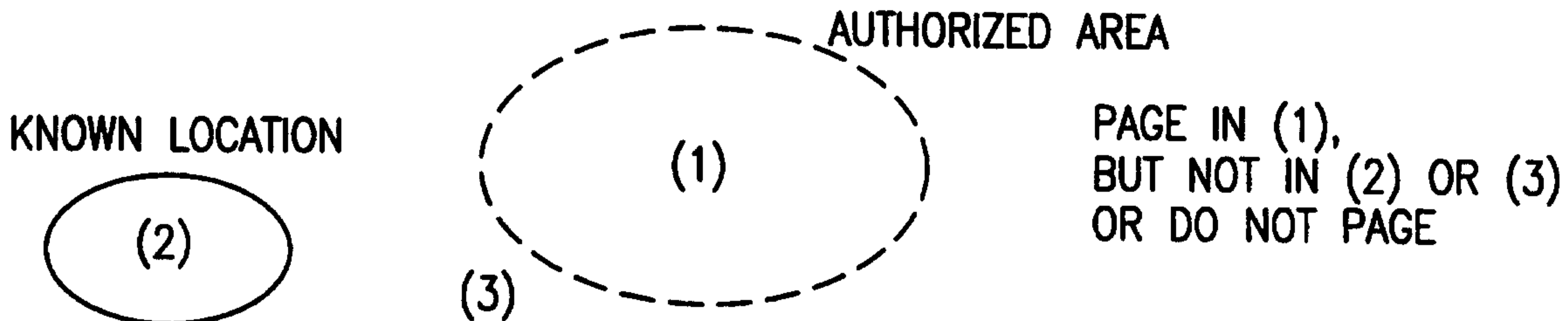
**FIG. 5B**



**FIG. 5C**



**FIG. 5D**



**FIG. 5E**

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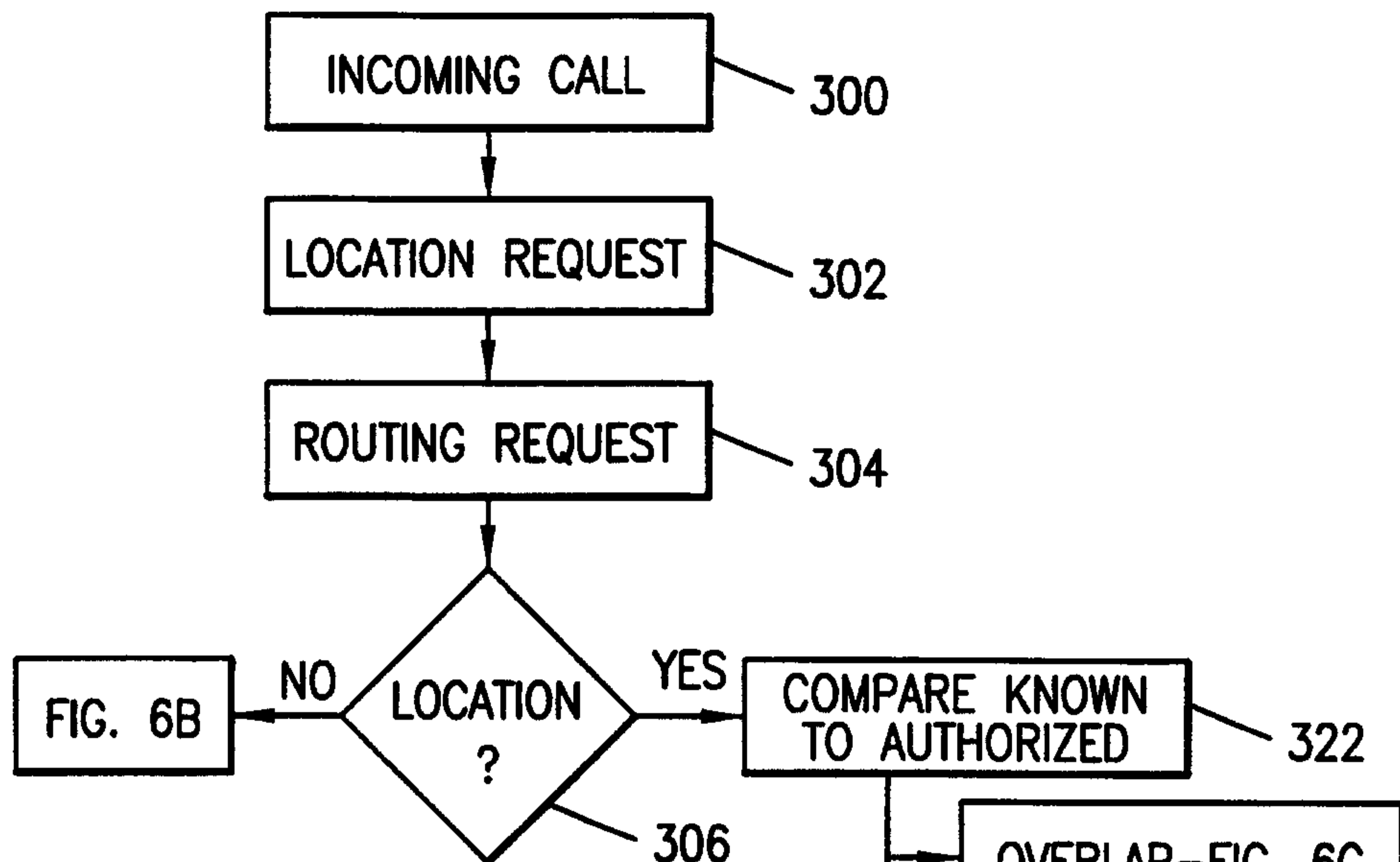


FIG. 6A

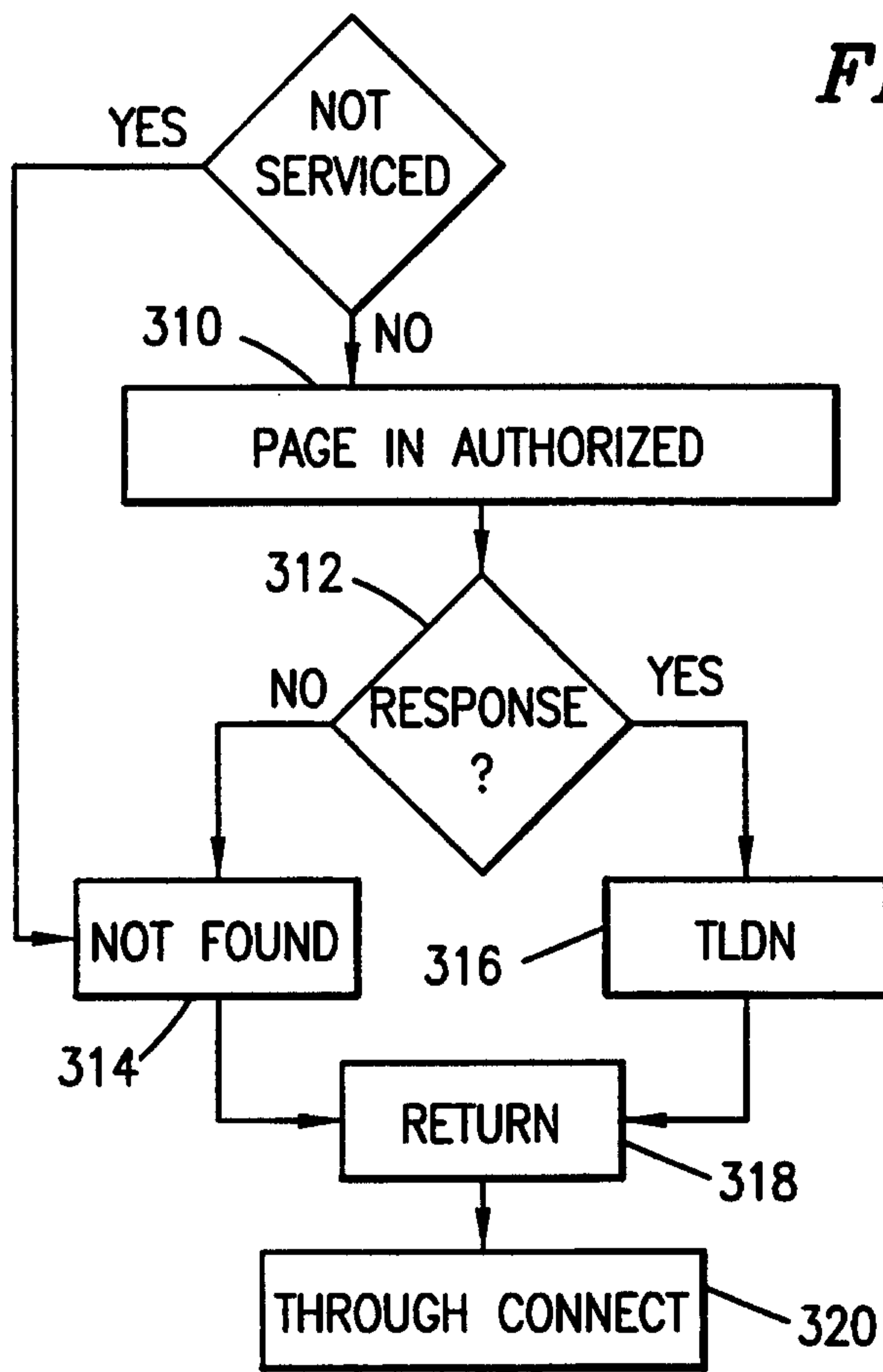


FIG. 6B

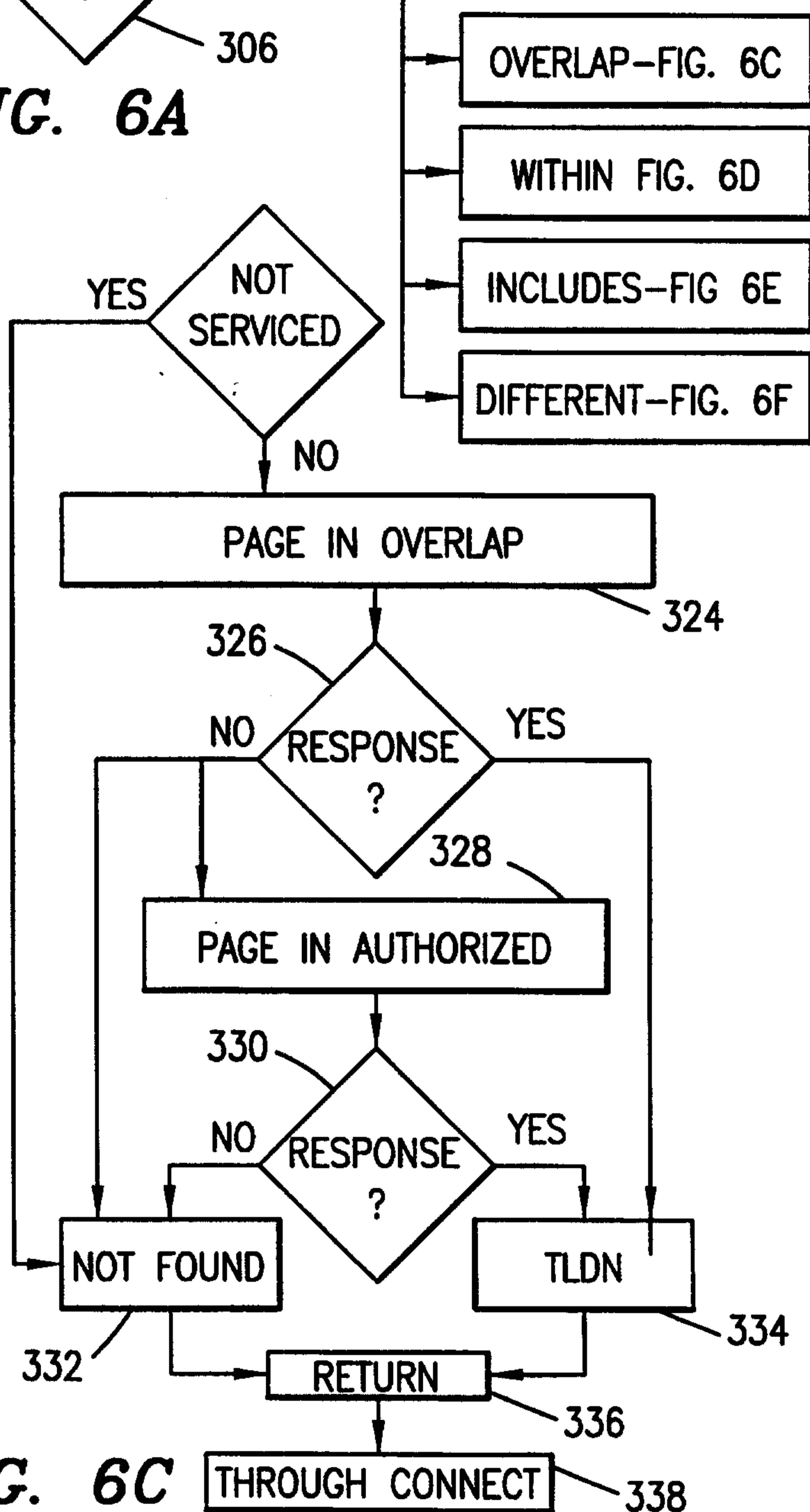


FIG. 6C

FIG. 6D

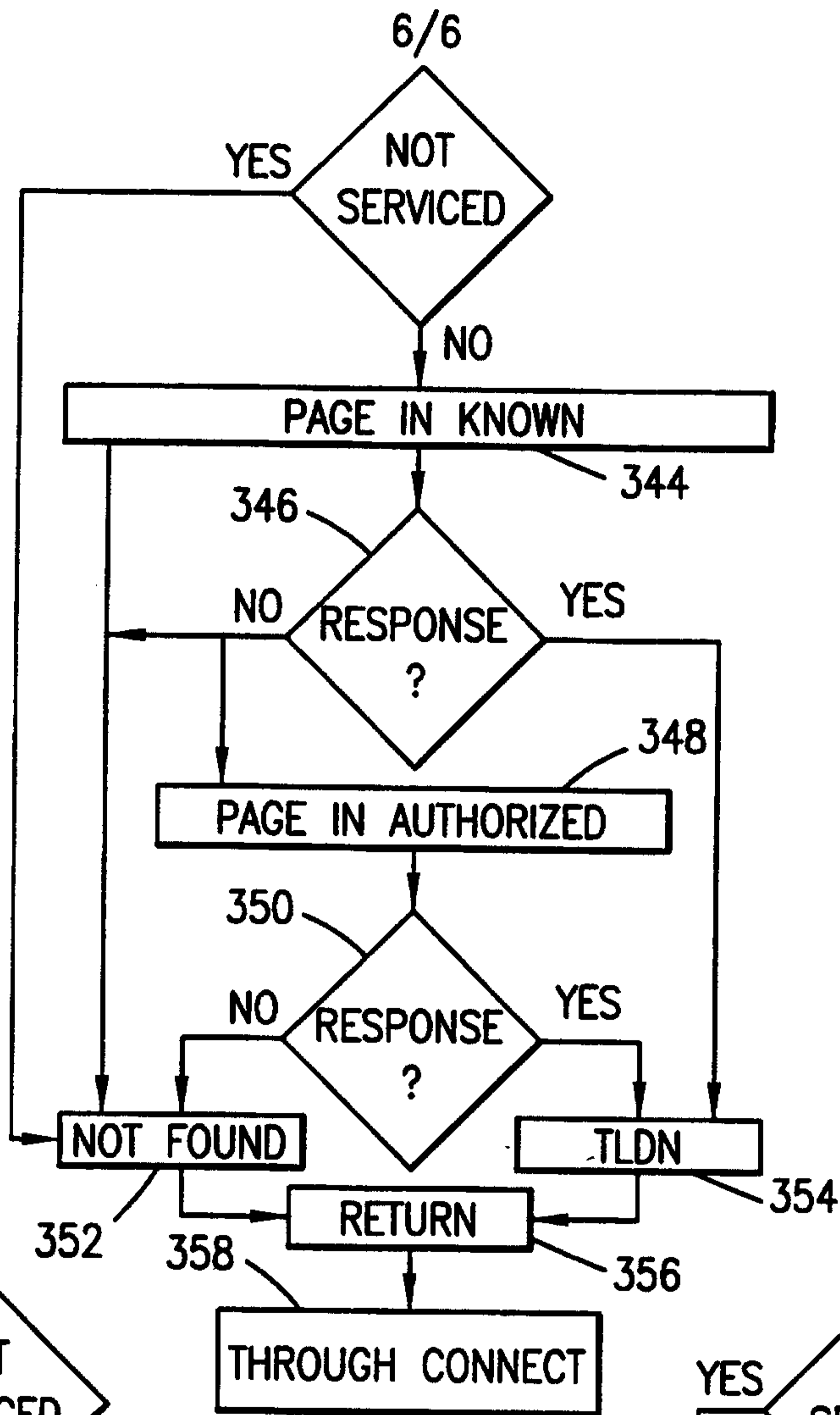


FIG. 6E

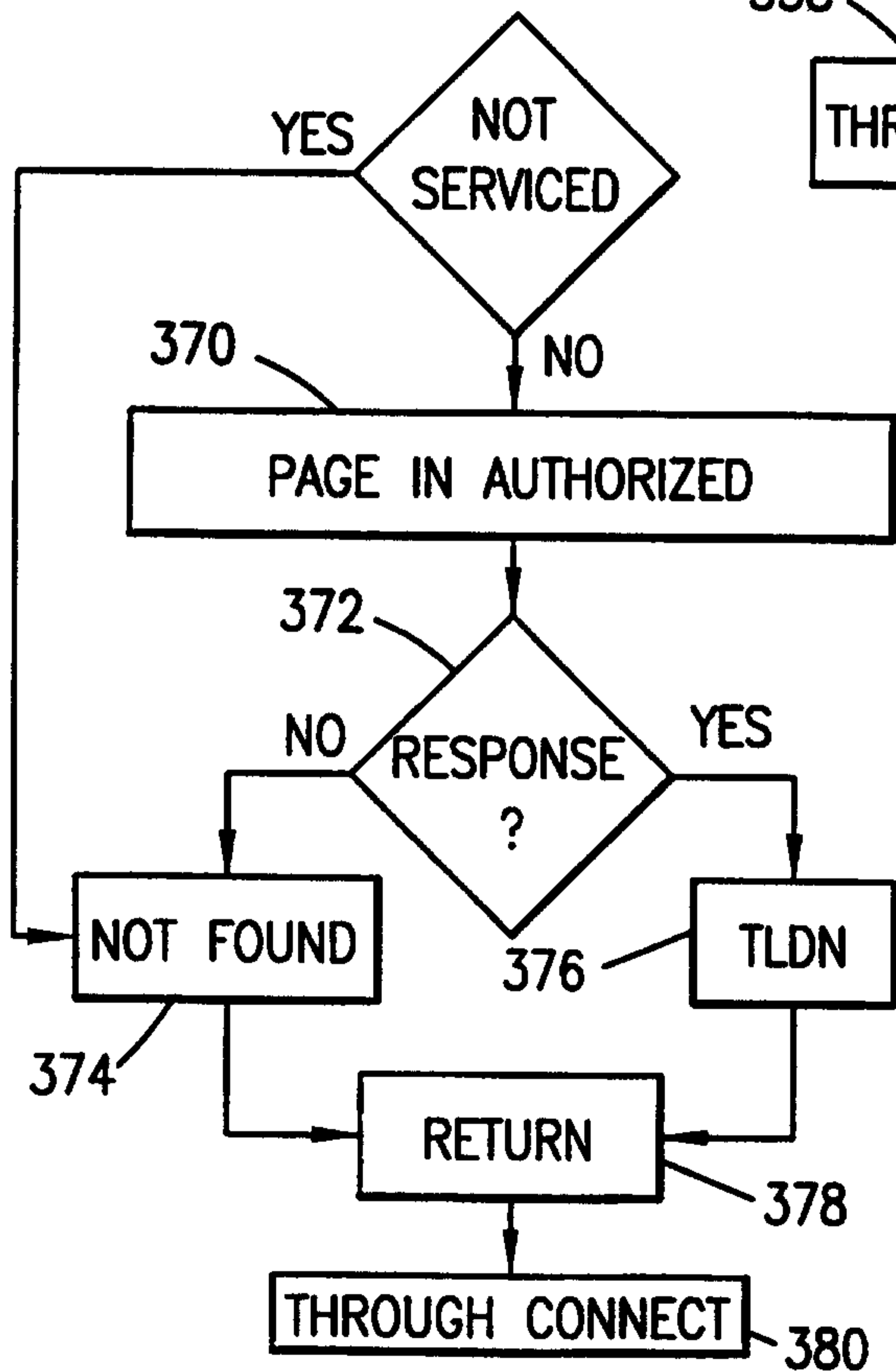


FIG. 6F

