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(54) Radio communication system

(57) A system combining a mobile telephone 3 and an integrated RF radio pager 4 which is used to activate the telephone 3 when an incoming paging signal is sent from a main control centre 2 to the pager 4 upon receipt of an incoming call at the main control centre 2. The pager 4 automatically instructs the mobile telephone 3 to call a callback number to establish the link. The radio link is monitored and re-established with priority if the connection is lost. A cordless telephone system is thereby afforded a handoff facility as well as the capability of accepting incoming calls on a cordless handset.

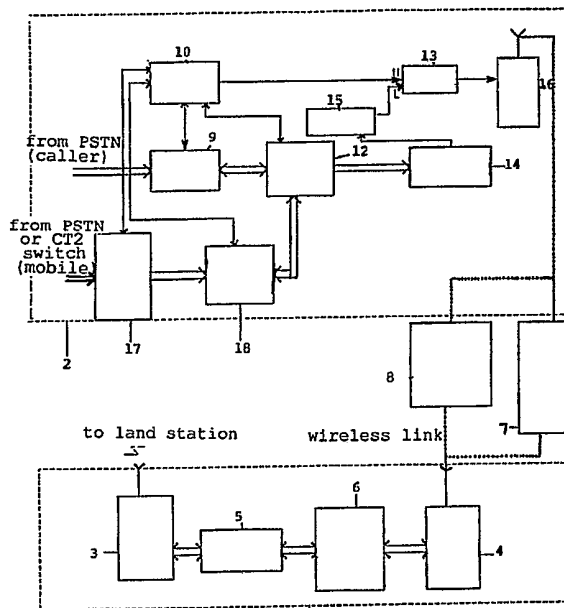


FIG 1

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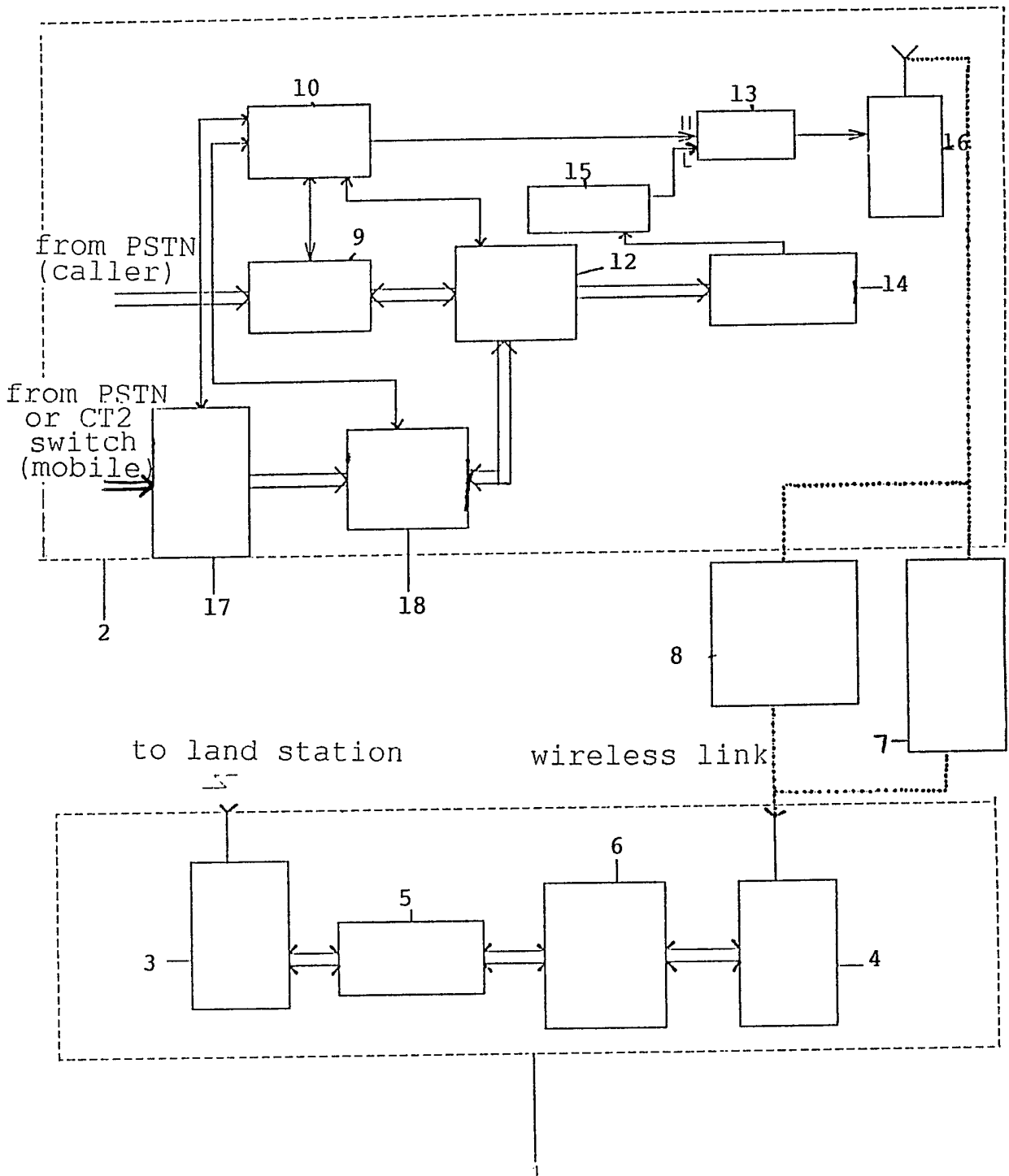
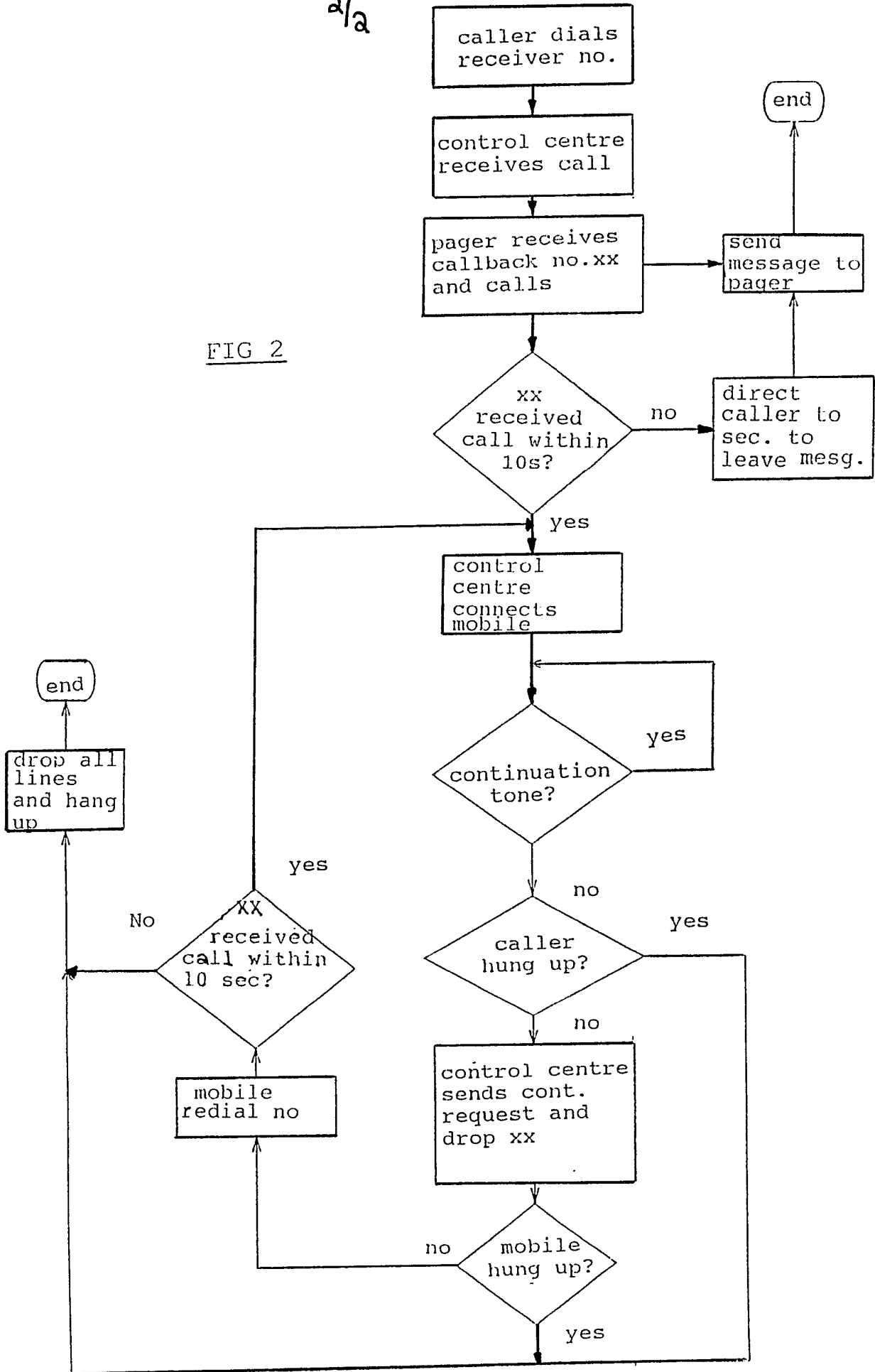


FIG 1



Radio Communication System

5           The present invention relates to a radio communication system whereby a paging signal receiver controls a cordless telephone, according to received information, to connect an incoming call to the telephone.

10           Many radio and mobile telephone communication systems are known, for example cellular mobile telephone systems or simple cordless telephones such as the CT2 system.

          The CT2 system utilizes a plurality of RF channels for radio communication. The channels provide RF links between the cordless telephones or CT2 handsets and the base station which is connected to the existing telephone network. When the user is at his home base, telephone calls are transmitted via the home base station to the cordless telephone. When away from the home base, the cordless telephone unit can be used to originate calls when the user is within range of a telepoint or call point. To originate a call, the telephone scans the channels for an available channel. The telepoint similarly scans the channels for incoming radio calls. When it receives a call request a link is made.

          A cellular radio telephone allows a mobile user to place a call anywhere within an area covered by the cellular communications system antennas. The cellular radio telephone allows the user to access the landline telephone system to conduct two-way telephone conversations.

          However, the known cellular systems are complex and expensive as regards equipment, frequency band utilization and maintenance. Further, such systems have non-compatible cell size requirements in built-up areas,

underground locations, covered shopping centres, etc. They require complex and expensive equipment and have high power requirements.

5 On the other hand, simple cordless telephones such as the CT2 are too primitive and are poor in performance. The CT2 is unable to receive incoming calls. Also, a user who starts a call in one zone has to re-initiate the call when moving into a new zone. Also, such systems have to minimize power consumption to  
10 extend the standby time.

The present invention aims to overcome the problems of existing systems by modifying a cordless telephone to enable it to receive incoming calls and also to provide cellular type zone exchange without substantially  
15 increasing the cost, complexity and power consumption.

The present invention has a wide range of applications, e.g. in private telephone systems, commercial PABX and public networks.

20 According to a first aspect of the present invention, there is provided a method of establishing a communication link between a receiver and a caller in a radio communication system including a receiving subscriber station and a main control centre which communicates with said receiving subscriber station via  
25 a control channel; wherein said subscriber station includes a mobile station and an RF receiver connected thereto, wherein an incoming call from a caller to said mobile station is received by said main control centre; said main control centre identifies said called mobile  
30 station, allocates a callback number and sends a control signal via a control channel to the RF receiver connected to said mobile station, said control signal including said callback number and a control  
35 instruction; and wherein, on receipt of said control signal, said RF receiver commands said mobile station to call said callback number, whereby, on receipt of said callback number from said subscriber station, said main

control centre connects said mobile station with said caller via a communication line.

The mobile station is preferably a mobile cordless telephone such as the CT2 and the RF receiver is preferably a radio pager.

In a preferred embodiment, upon receipt of an incoming call, the main control centre validates the status of the called mobile station and allocates and reserves an available telephone line before sending the control signal along the wireless link to the pager.

Also, in a preferred embodiment, the pager may instruct the mobile station to drop the line when its user fails to answer the call within, e.g., 10 seconds.

The preferred embodiment also includes means for monitoring the existence and condition of the radio link and for re-establishing the link if it is lost due to the mobile moving into a different zone or due to the signal being lost or attenuated. This may be done by providing a continuity tone as long as the link exists. This continuity tone or other continuity indication ceases when the link ceases to exist and steps are taken to re-establish the link with priority.

If the mobile user does not answer the incoming call within, e.g. 10 seconds, the caller may be routed to a secretary or answering machine to leave a message. Some indication that a message has been left may be provided at the mobile station.

The mobile station may also include a memory for recording the called numbers.

According to a second aspect of the present invention there is provided a method of maintaining a radio communication link between a receiving mobile station and caller when said mobile station crosses into a different reception zone, wherein the call is connected to the receiving mobile station over a line via a main control centre and said mobile station is connected to an RF receiver adapted to receive control

signals from said main control centre via a wireless link; wherein, when the mobile station crosses into a different zone the main control centre maintains the connection to the caller and drops the link to the mobile station, the main control centre then sends a control signal to the RF receiver containing a callback number and a control instruction; in response to said control instruction, said RF receiver commands said mobile station to automatically call said callback number; on receipt of said callback number, said main control centre re-connects said mobile station and said caller.

According to a third aspect of the invention, there is provided a radio communication system comprising a mobile station, an RF receiver connected to said mobile station and a main control centre connected via a control channel to said RF receiver; wherein, upon receipt of an incoming call to said mobile station at said main control centre, said main control centre sends a control signal including a callback number and a control instruction to said RF receiver; the RF receiver acts according to said control instruction to command said mobile station to automatically call said callback number.

A preferred embodiment of the invention will now be described by way of example only, with reference to the accompanying drawings, wherein:

Fig. 1 shows a block diagram of a system according to the present invention; and

Fig. 2 shows a flowchart of a method according to the invention.

As shown in Fig. 1, the system includes a mobile station 1 and a control centre 2. The mobile station 1 includes a cordless telephone handset 3, such as a CT2 handset. An RF receiver, or pager 4 is connected to the handset 3 via an interface 5 and a processor and display 6. The RF receiver 4 receives signals from the control

centre 2 via a wireless link and, if necessary, via repeaters 7 and/or through a base station 8.

The control centre 2 includes a call decoder/router 9 for receiving incoming calls from a caller (not  
5 shown). The decoder/router 9 is connected to channel control 10 and a switch matrix 12. The channel control 10 is also connected to the switch matrix 12 and to a priority scheduler 13.

The output of the priority scheduler 13 is sent to  
10 a paging transmitter 16 which sends paging signals via the wireless link to the pager 4.

The control centre 2 also includes a decoder/auto-dialler 17 to receive calls from the public network or the mobile telephone. The decoder 17 is connected to  
15 the channel control 10 and to a signal conditioner 18 which is connected to the channel control 10 and to the switch matrix 12.

The present invention may be realized by either modifying an existing system or by building a completely  
20 new system.

In the first case, a cordless mobile telephone 3, e.g. a CT2, is equipped with a microprocessor control 6 and an RF receiver or pager 4 which receives commands from the channel control 10.

25 The way in which the mobile receives an incoming call will now be described with reference to Fig. 2.

The mobile is allocated a direct-dial number, either statically or dynamically, which is stored in the control centre 2. The caller dials this number which is  
30 received at the control centre 2. The called number is decoded and the called mobile is identified.

The control centre 2 then validates the status of the mobile and allocates and reserves an available telephone line for the connection. The channel control  
35 10 then sends a signal to the mobile pager 4, via the paging transmitter 16. This instructs the pager 4 to wake up the mobile 3 and instruct it to call the



reserved number. When the control centre 2 receives  
this reply from the mobile 3, it connects the mobile 3  
to the caller over the reserved line. If the mobile 3  
does not answer the call from the control centre 2  
5 within a given time, e.g. 10 seconds, the caller may be  
directed to a secretary to leave a message. A further  
message to the pager can provide a display on the mobile  
to indicate that a message has been left.

10 The line is dropped if the call is not answered  
within a preset period.

A radio link continuity tone within the audio band  
is transmitted while the link is connected. The system  
then monitors the existence and condition of the radio  
link by sensing the continuity tone or other continuity  
15 indication. The continuity tone may be isolated by a  
notch filter.

If the radio link ceases to exist, and the caller  
has not hung up, the system keeps the caller line  
connected. In the meantime, the telephone line from the  
20 mobile is dropped and the mobile is instructed, via the  
pager 4, to re-establish the link. Since the status of  
the mobile 1 has already previously been validated, the  
link is re-established with priority. Re-establishment  
of the link is transparent to the mobile user.

25 The call will be disconnected only when the caller  
hangs up or when there has been no response from the  
mobile 1 after a preset time, e.g. 10s, or after  
repeated redial requests from the paging channel.

To make outgoing calls from the mobile 1, the pager  
30 4 adds a prefix to the number dialled. This causes the  
call to be routed via the main control centre, and the  
control centre maintains the communication link between  
the mobile and the receiving end in the same way as for  
incoming calls.

35 Alternatively, rather than modifying an existing  
system to incorporate a pager to control the mobile, a  
completely new system can be built incorporating a

mobile and an enhanced base station. The base station is equipped with a microprocessor control and a built-in RF receiver such as a pager which receives commands from the control channel. Using such a system, cross-cell link re-establishment can be handled more efficiently.

Each base station has its own identification number and stores a table containing the identification numbers of adjacent base stations. The identification numbers can be updated via the pager.

When a connection between a caller and a receiver has been established, the status of the mobile 1, together with the base station's identification number are sent to the main control centre 2. The mobile and base station identification numbers are broadcast on the control channel. Other base stations receiving the broadcast will check the identification number against their stored table. If the broadcast identification corresponds to an adjacent base station, the receiving station will prepare for a priority cross-cell link re-establishment.

The paging signal or wireless link may be transmitted or relayed by repeating stations, cables or leaky cables running across the site, a signal injected into a mains cable or a combination of these.

Thus, the present invention relates to a system whereby a cordless telephone, such as a CT2, is converted, by combining it with a pager, to enable it to receive incoming calls as well as to handle cross-cell switching. The pager is connected to the telephone and actually controls it according to information received by the pager from the main control centre, to automatically call a callback number allocated by the control centre. The mobile is then connected to the caller at the control centre.

Claims

1. A method of establishing a communication link  
between a receiver and a caller in a radio communication  
5 system including a receiving subscriber station and a  
main control centre which communicates with said  
receiving subscriber station via a control channel;  
wherein said subscriber station includes a mobile  
station and an RF receiver connected thereto, wherein an  
10 incoming call from a caller to said mobile station is  
received by said main control centre; said main control  
centre identifies said called mobile station, allocates  
a callback number and sends a control signal via a  
control channel to the RF receiver connected to said  
15 mobile station, said control signal including said  
callback number and a control instruction; and wherein,  
on receipt of said control signal, said RF receiver  
commands said mobile station to call said callback  
number, whereby, on receipt of said callback number from  
20 said subscriber station, said main control centre  
connects said mobile station with said caller.

2. A method as claimed in claim 1 wherein, upon  
receipt of an incoming call, the main control centre  
25 validates the status of the called mobile station and  
allocates and reserves an available telephone line  
before sending the control signal along the control  
channel to the RF receiver.

30 3. A method as claimed in claim 1 or 2 wherein the RF  
receiver instructs the mobile station to drop the line  
when its user fails to answer the call within a  
predetermined period.

35 4. The method of any preceding claim wherein the  
caller is routed to an alternative call answering means  
if said user fails to answer the call within a

predetermined period.

5. A method as claimed in any of claims 1 to 4,  
further comprising monitoring the existence and  
5 condition of the radio link and re-establishing the link  
if it is lost.

6. The method of claim 5 wherein a continuity  
indication is provided so long as the link exists, said  
10 continuity indication ceasing when said link ceases to  
exist.

7. A method of maintaining a radio communication link  
between a receiving mobile station and caller when said  
15 mobile station crosses into a different reception zone,  
wherein the call is connected to the receiving mobile  
station over a line via a main control centre and said  
mobile station is connected to an RF receiver adapted to  
receive control signals from said main control centre  
20 via a wireless link; wherein, when the mobile station  
crosses into a different zone the main control centre  
maintains the connection to the caller and drops the  
link to the mobile station, the main control centre then  
sends a control signal to the RF receiver containing a  
25 callback number and a control instruction; in response  
to said control instruction, said RF receiver commands  
said mobile station to automatically call said callback  
number; on receipt of said callback number, said main  
control centre re-connects said mobile station and said  
30 caller.

8. The method of claim 7 wherein, when said mobile  
station is making an outgoing call, said RF receiver or  
an interface to said mobile station adds a prefix to the  
35 number dialled which cause the call to be routed via  
said main control centre.

9. A radio communication system comprising a mobile station, an RF receiver connected to said mobile station and a main control centre connected via a control channel to said RF receiver; wherein, upon receipt of an incoming call to said mobile station at said main control centre, said main control centre sends a control signal including a callback number and a control instruction to said RF receiver; the RF receiver acts according to said control instruction to command said mobile station to automatically call said callback number.

10. A method of enhancing the speed of switching between adjacent base stations when a mobile station passes from the area covered by one base station to that covered by an adjacent base station, wherein each of said base stations is equipped with a microprocessor control and an RF receiver adapted to receive commands from a control channel; wherein each base station is allocated a personal identification code and also stores identification codes of adjacent base stations; wherein, when a link is established between the control centre and the mobile station via one of said base stations, the identification codes of said mobile station and said base station are broadcast on said control channel, others of said base stations receive said broadcast codes and compare them with stored codes of adjacent base stations, if said broadcast code corresponds to a stored code in any of said base stations, said base station(s) will prepare for a priority cross-cell link re-establishment.

11. The method or system of any preceding claim wherein said mobile station is a cordless telephone.

12. The method or system of any preceding claim wherein said RF receiver is a radio pager.

13. A method of establishing a communication link between a receiver and a caller in a radio communication system, substantially as hereinbefore described with reference to the accompanying drawings.

5

14. A radio communication system substantially as hereinbefore described with reference to the accompanying drawings.

**Relevant Technical Fields**

(i) UK Cl (Ed.L) H4K (KY4P, KY4D14H)

(ii) Int Cl (Ed.5) H04Q 7/04

**Databases (see below)**

(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) Online: WPI

Search Examiner  
N W HALL

Date of completion of Search  
14 DECEMBER 93

Documents considered relevant following a search in respect of Claims :-  
1-9

**Categories of documents**

- X: Document indicating lack of novelty or of inventive step.
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- A: Document indicating technological background and/or state of the art.
- P: Document published on or after the declared priority date but before the filing date of the present application.
- E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.
- &: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages	Relevant to claim(s)
X,Y	GB 2227143 A (IBA) see particularly page 6 line 30 - page 7 line 27; page 8 lines 20-27	1,7,9 at least
Y	US 5090015 (MUPPIDI) whole document	1,7,9 at least

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).