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(71) Applicant (for all designated States except US):  
ALCATEL TELECOMUNICAÇÕES S.A. [BR/BR]; Rua Dr. Cardoso de Mello No 1855, São Paulo, SP (BR).

(72) Inventor; and

(75) Inventor/Applicant (for US only):  
KOROWAJCZUK, Leonhard [BR/BR]; Rua Shigeo More No 1980, 13100-Campinas, SP (BR).

(74) Agent:  
GOUVÊA VIEIRA, MITAINI, MARTINEZ & JUCÁ S/C LTDA.; Rua Cadineus No 44, 04087-São Paulo, SP (BR).

(54) Title:  
CELL-TYPE TELEPHONE SYSTEM WITH EXTENDED CELL

(57) Abstract

A cell-type telephone system having an extended cell, particularly designed to be used in rural areas is provided, comprising a commutation and control unit (CCC) connected to the national telephone network (RNT) and in communication with several cells, each cell being provided with a receiving and retransmitting base radio station (ERB) comprised of a tower and an antenna array, said tower being preferably of great size and constructed on an elevated site and having high power antennas in order to cover a great area, and a plurality of fixed terminal stations (ETF), each said fixed terminal station (ETF) being provided with a high detection power directional antenna coupled to a transreceiver to make out a subscriber's terminal.
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"CELL-TYPE TELEPHONE SYSTEM WITH EXTENDED CELL"

Background of the Invention

Field of the Invention

The present invention generally relates to cell-type telephone systems and, more specifically, to a cell-type telephone system having an extended cell which is particularly suitable for use in rural areas.

Description of the Prior Art

Generally, the provision of an efficient telephone system for rural areas poses a number of problems, among which are:

(i) low population density due to natural dispersion of people;
(ii) great distances to be covered which practically bring about expensive implementation of a cable telephone network serving all prospective users; and
(iii) difficulty in stretching and maintaining telephone network cables, in view of geographic profiles.

In view of such difficulties there is, inter alia, a great tendency towards the use of radiotelephony for the supply of telecommunication to rural areas.

Tipically, a rural radiotelephone system such as the one presently in use comprises interconnecting small villages or settlements through radiotelephony and, at a given site, connecting said radiotelephone system to the national telecommunication network.

This solution, however, apart from not attending all prospective users, also presents serious predicaments, mainly related to the highly expensive installation of the whole infrastructure required for every small village or settlement and the complete lack of privacy in the communication, since anyone may intercept a given call if he is provided with a suitable equipment.

Aiming to solve all above-discussed problems and provide an efficient telecommunication system for rural areas, it was proposed to use a cell-type telephone system.

Briefly, a cell-type telephone system is a radiotelephone system in which the available frequency band
is divided into groups of frequencies designated as cells, which cells are geographically distributed in such a way that groups of frequencies from two adjacent cells always differ from each other in order to eliminate any possible interference in the communication.

Similarly, the frequencies in a given group of frequencies are only repeated when the distance between the cells is enough to assure that there will no more be any interference between such frequencies in a cell and the same frequencies used in another cell.

Since every cell is provided with a given group of frequencies, it is possible to perform or conduct a certain number of simultaneous conversations. However, as the areas covered by each cell may present different telephone traffic loads, the dimension of the cells may change in accordance with the fluctuation of said telephone traffic load. In other words, depending on the traffic load, the size of the cell may have a radius between approximately 1 and 5 km (one and five kilometers).

Though the smallest size of the cell is limited by the presently available technology to a radius of approximately 1 km (one kilometer), since below such limit there may arise interference problems which can not be solved within the group of frequencies used, the highest size of the cell now depends on the user's receiver detection capacity, the antenna of which often presents low detection power. Thus, the average size of cells in the presently known cell-type telephone systems incorporates radii within a range of 5 to 15 km (five to fifteen kilometers).

Typically, a conventional cell-type telephone system comprises:

(i) a commutation and control unit (CCC) connected through cable to the national telephone network and in communication with several cells by radio waves;

(ii) a receiving and retransmitting base radio station (ERB) in every cell, comprising a tower and an antenna array; and

(iii) a plurality of mobile terminal stations
provided with low detection power antennas and able to establish radiofrequency communication with every base radio station referred to in the preceding paragraph.

In view of the above-discussed problems related to traffic load, cell size and interference between frequencies, conventional cell-type telephone systems, in their base radio stations, use low power antennas assembled on relatively low towers preferably constructed on not too elevated sites, in order to avoid as much as possible any interference between the frequencies of each group.

Summary of the Invention

Thus, there is a need to provide an efficient telephone system for rural areas, which is one of the objects of the present invention.

Another object of the present invention is the provision of such an efficient telephone system for rural areas which may serve all prospective users.

An additional object of the present invention is the provision of such an efficient radiotelephone system for rural areas which does not present the above-discussed problems related to highly expensive installation and difficult cable stretching and maintenance.

Still another object of the present invention is the provision of such a telephone system for rural areas which does not present the above-discussed problems related to expensive implementation of infrastructure for conventional rural radiotelephony.

One additional object of the invention is the provision of such a telephone system for rural areas which does not present the above-discussed problems related to lack of privacy in the communication.

According to the present invention, said objects are fulfilled by the provision of a cell-type radiotelephone system particularly designed to be used in rural areas, characterized by comprising a commutation and control unit connected to the national telephone network and in communication with several cells; a receiving and retransmitting base radio station in every cell, said base
radio station being comprised of a tower and an antenna array, said tower being preferably a large one and constructed on an elevated site and provided with high power antennas in order to cover a great area; and a plurality of fixed terminal stations distributed within the reach of each above-mentioned base radio station, each fixed terminal station being provided with a high detection power directional antenna coupled to same which is directed towards said base radio station.

According to the present invention, the base radio station antenna power increase, their installation on an elevated site and the increase in the detection capacity of fixed terminal stations which are now coupled to a high detection power directional antenna which is directed towards the base radio station, make it possible to increase the size of each individual cell to a radius of approximately 60 km (sixty kilometers) on a flat surface, practically quadruplicating the radius of the largest cells in cell-type radiotelephone systems of the prior art.

Thus, by inverting the basic principles of cell-type radiotelephone systems of the prior art, the size of each cell may be extended to the natural geographical boundaries without posing any interference problem between groups of frequencies of two adjacent cells.

Additionally and, contrary to what is found in conventional cell-type radiotelephone systems, the base radio station antenna power increase does not imply any interference problem, since the size and distribution of cells in addition to the low telephone traffic load normally observed in rural areas eliminate this kind of problem.

Brief Description of Drawings

The present invention will be described herein after in greater detail with reference to the non limitative embodiment thereof shown in the attached drawings as an example, in which:

Figure 1 is a schematic representation of a cell-type radiotelephone system according to the present invention showing a centralized configuration; and
Figure 2 is a schematic representation of a cell-type radiotelephone system according to the present invention showing a decentralized configuration.

Description of the Preferred Embodiment

With reference now more particularly to the drawings, a cell-type radiotelephone system having an extended cell according to the present invention is shown in Figures 1 and 2. The system comprises, basically, a commutation and control unit CCC, a plurality of base radio stations ERB and a plurality of fixed terminal stations ETF.

The commutation and control unit CCC is a digital electronic commutation equipment which uses distributed processing and stored program control operational techniques to control base radio stations ERB and fixed terminal stations ETF in order to provide an efficient communication system.

Preferably, the commutation and control unit CCC is of a type known in the state of the art which is able to commutate voice and data circuitry and perform analog-digital (A/D) and digital-analog (D/A) conversions and thus it shall not be described in details below. The objective of the commutation and control unit CCC is to provide an interface between base radio stations ERB in the cell-type radiotelephone system having an extended cell according to the present invention and the national telephone network through RNT cables. Said interface may be both local and traffic dependent.

Thus, through the commutation and control unit CCC it is possible to afford an automatic interconnection between a fixed terminal station ETF and a telephone central station of both national and international extent.

The commutation and control unit CCC is basically comprised of a main control unit CCP and a commutation unit CC. The function of the main control unit CCP is to establish an interface between the operator and the system, for which purpose it is provided with a data bank for the whole system, and allow for the performance of system management and maintenance functions through protocols
designed for man-machine communication. On the other hand, the objective of the commutation unit CCP is to control call processing, monitor base radio station ERB equipment and perform management and maintenance functions commenced either at peripheral equipment in the main control unit CCP or at a local terminal interface of the commutation unit CCP itself.

Additionally, the commutation unit CCP is responsible for all call connection and disconnection phases including signaling, supervision, commutation and allocation of radiofrequency channels.

The base radio stations ERB which define individual cells are connected to the commutation and control unit CCC by means of a four wire analog or digital channel, the communication between cells being carried out through radiofrequency, PCM beam or optical fibers, in accordance with the specification of each project. In such a communication system there is a voice and data flow, however with a specific data link for sending and receiving control, supervision and informative messages.

The main function of each base radio station ERB is to interface local subscribers with one another and/or interface local subscribers with national telephone network RNT subscribers.

For this purpose, the base radio station ERB should preferably comprise at least two racks, designated as radiofrequency and ordinary ones, which are connected to two omnidirectional antennas assembled at a suitable height which may afford a complete coverage within an average radius of 60 km (sixty kilometers) around the base radio station ERB, thus configuring an extended cell.

The communication of the base radio station ERB with fixed terminal stations ETF is carried out through radiofrequency channels which use standard protocols for sending and receiving control data and voice signals, such a communication being carried out through frequency modulation in a radio system operating within the 800 MHz range. In other words, the communication between the base radio station ERB and a given fixed terminal station ETF is carried out
through control and voice channels.

The control channel supplies data between the base radio station ERB controller and the fixed terminal stations ETF of each cell, and its functions are to: send information to fixed terminal stations and monitor their registers, including message register parameters and the frequency transmitted to fixed terminal stations; control started and completed calls; and determine the availability of fixed terminal stations for receiving a call.

The voice channel provides an audio interface between fixed terminal stations ETF and the commutation unit CC. Through the voice channel are sent the audio supervision tone TSA and the signaling tone TS.

The voice channels are to: supply the audio link and signal conversion to sustain the call; monitor the radiofrequency signal intensity; monitor the fixed terminal station for access of facilities to subscriber; and disconnect the audio supervision tone TSA during the call.

The fixed terminal stations ETF comprise a low power transceiver coupled to a directional antenna which is directed towards the base radio station and is also provided with the subscribers' terminal, which is fixed and of special interest to the cell-type telephone system of the present invention.

The operation of the cell-type telephone system with extended cell according to the present invention shall be described herein as follows with reference to three kinds of calls: one call from a fixed terminal station ETF to the national telephone network RNT; one call from the national telephone network RTN to a fixed terminal station ETF; and one call from a fixed terminal station ETF to another fixed terminal station ETF.

In the call from a fixed terminal station ETF to the national telephone network RTN, when the fixed terminal station ETF subscriber starts the call, the base radio station ERB receives and identifies the request through the control channel and sends same to the commutation unit CC together with all other information required to complete the
call, viz: the subscriber's telephone number, the subscriber's serial number and the dialed number.

The commutation unit CC then selects a vacant channel to be used in the call and signals the base radio station ERB to instruct the fixed terminal station ETF to use the selected channel. Additionally, the commutation unit CC carries out the validation of the dialed numbers to assure that the subscriber can then make the call and to determine the required route as well as the type of call.

The connection established through the digital commutation the commutation unit CCU completes the voice link from the fixed terminal station ETF and the base radio station ERB with the national telephone network RTN.

Alternatively, in order to provide a low cost route, the call may be routed by the commutation unit CC from the cell-type telephone system to another commutation unit CC in another cell-type telephone system to then reach the national telephone network RTN according to the decentralized system shown in Figure 2.

When the call is completed, any of the parties who disconnect the commutation unit CC releases all resources used in the call. The register corresponding to said call is then transmitted to the main control unit CCP to be used subsequently in the production of the rating tape and traffic analysis.

When a call is made from the national telephone network RNT to a fixed terminal station ETF, the national telephone network RTN accesses a trunk in the commutation and control unit CCC and, through a digital switch, sends the corresponding informative digit to the fixed terminal station ETF subscriber.

The commutation and control unit CCC carries out the validation and digit translation and instructs the base radio station ERB corresponding to the located area to activate, through the control channel, the fixed terminal station ETF selected, in order to enable its linkage with the national telephone network RTN.

The base radio station ERB locates the fixed
terminal station ETF through the control channel and, when
the latter answers the call, the commutation unit CC is
instructed by the base radio station ERB to select the vacant
voice channel to be used in the call. The fixed terminal
station ETF is informed about the selected channel by the
base radio station ERB, and the commutation unit CC connects
the corresponding digital switch when the fixed terminal
station ETF is ready to receive the call.

Thus, the base radio station ERB is instructed to
alert the subscriber, and the telephone set in the fixed
terminal station ERB starts to ring. When the fixed terminal
station subscribe answers the call, the voice link in the
national telephone network RTN is completed.

Again, when the call is completed, any of the
parties who disconnect the commutation unit CC releases all
resources used in the call and generates a register
corresponding to said call, which register is sent to the
main control unit CCP to be used subsequently in the
production of the rating tape and traffic analysis.

When a call is made from a fixed terminal station
ETF to another fixed terminal station ETF, when a fixed
subscriber starts the call, it is processed as above until
the digit translation step. At this point, the commutation
unit CC determines through its data bank if the call was
directed towards another fixed terminal station ETF.

If this other fixed terminal station ETF is
served by the same commutation unit CC, the call is processed
in a regular way. On the contrary, if the subscriber is
served by another commutation unit CC, a vacant trunk is
designated for the call and it is then processed as a fixed
terminal station ETF to a fixed terminal station ETF type
call.

The subscriber called is located and, by
answering the call, a voice channel is designated to
establish the voice link between the stations. Said voice
link is established starting from the commutation unit CC of
the base radio station ERB corresponding to the fixed
terminal station ETF which originated the call to the
commutation unit CC in the base radio station ERB of the fixed terminal station ETF aimed at.

When a call is completed, any of the parties who disconnect the commutation unit CC releases all resources used in the call and the register corresponding to said call is generated in the origin base radio station ERB to be transmitted to the main control unit CCP to be used subsequently in the production of the rating tape and traffic analysis.

In this system, the calls may be made through a fixed terminal station ETF where there is room in the data bank available for the register of calls made by every subscriber.

An important feature of the cell-type telephone system with extended cell according to the present invention is the possibility of its expansion through sectoring and/or division of cells.

Thus, through a predetermined project, it is possible to configure the cells required for the initial coverage of a given area, precisely determining the location and the number of cells, and thus the base radio stations ERBs required in the area to be served. To support such traffic, groups of channels are allocated for each cell, always proportional to the maximum expected traffic.

However, the cell-type telephone system with extended cell of the present invention, because of the number of subscribers, telephone traffic load and other factors including topographic ones, allows for sectoring and division of every cell in a second stage.

In the former case, a given cell is divided into sectors which then begin to be dealt with by the commutation and control unit CCC as new cells and, in the latter case, the cell to be divided has its area reduced by the transmitted power decrease, the remaining area thus being covered by a new cell, which results in several microcells instead of one macrocell.

The invention being described, it shall be understood that several modifications and variations may be
made thereto, provided that such modifications and variations
do not depart from the spirit and scope of the invention as
defined in the appended claims.
CLAIMS

1. A cell-type telephone system having an extended cell, particularly designed to be used in rural areas, characterized by comprising:
   a commutation and control unit connected to the national telephone network and in communication with several cells;
   a receiving and retransmitting base radio station in each cell, said base radio station being comprised of a tower and an antenna array, said tower being preferably of great size and constructed on an elevated site and having high power antennas in order to cover a great area; and
   a plurality of fixed terminal stations distributed within the range of each said base radio station, each fixed terminal station being provided with a high detection power antenna coupled to the same which is directed towards the base radio station.

2. A cell-type telephone system according to claim 1, wherein each base radio station is connected to the commutation and control unit by means of a four wire analog or digital channel, the communication between same is by radiofrequency, PCM beam or fiber optics.

3. A cell-type telephone system according to claim 1, wherein each fixed terminal station comprises a low power transceiver coupled to the directional antenna, making out a fixed subscriber's terminal.

4. A cell-type telephone system according to claim 1, wherein the base radio stations communicate with fixed terminal stations through radiofrequency channels which comprise control and audio channels.

5. A cell-type telephone system according to claim 1, wherein the base radio station interfaces local subscribers with one another and/or interface local subscribers with national telephone network subscribers.

6. A cell-type telephone system according to claim 1, wherein the base radio station communicates with fixed terminal stations through radiofrequency channels which use standard protocols for sending and receiving control
7. A cell-type telephone system according to claim 6, wherein said communication between the base radio station and fixed terminal stations is provided by frequency modulation of a radio system operating within the 800 MHz range.

8. A cell-type telephone system according to claim 6, wherein each base radio station comprises at least two racks interconnected to omnidirectional antennas.

9. A cell-type telephone system according to claim 8, wherein said antennas are installed at a suitable height sufficient to allow for a coverage having a radius of approximately 60 km around the base radio station.

10. A cell-type telephone system according to claim 1, wherein the commutation and control unit is comprised of a main control unit and a switching unit, the former designed to interface the operator with the system and the latter designed to control the processing of calls and all connection and disconnection phases of calls.
### I. CLASSIFICATION OF SUBJECT MATTER

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

Int.Cl. 5 H04Q7/04;

### II. FIELDS SEARCHED

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

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<td>INTERNATIONAL CONFERENCE ON COMMUNICATIONS vol. 1, June 1989, BOSTON,US pages 324 - 329; BUSTILLO ET AL.: 'Planning and Configuration of Networks for Accessing too Isolated Rural Subscribers by Means of Multiaccess Radio Systems' see the whole document</td>
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### IV. CERTIFICATION

Date of the Actual Completion of the International Search: 27 AUGUST 1992

Date of Mailing of the International Search Report: 02.09.92

International Searching Authority: EUROPEAN PATENT OFFICE

Signature of Authorized Officer: JANYSZEK J.M.
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<td>NEC RESEARCH AND DEVELOPMENT. no. 76, January 1985, TOKYO JP pages 24 - 35; HIYAMA ET AL.: 'Digital Radio Concentrator System (DRCS)' see the whole document</td>
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<td>SUPERCOMM/ICC, 90 vol. 1, April 1990, ATLANTA, US pages 52 - 58; LIN ET AL.: 'Basic Exchange Radio - From Concept to Reality' see paragraph 5.2 see paragraph 6; figure 2</td>
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<td>EP, A, 0 239 093 (NEC) 30 September 1987 see page 1, line 8 – page 3, line 17; figures 1, 3</td>
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ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO. BR 9200005  
SA 59881

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