(54) Title: SYSTEM FOR OFFERING RADIO COVERAGE IN AN ENVIRONMENT ENCLOSED FOR RADIO-TRANSMISSION PURPOSES

(57) Abstract: System for offering radio coverage in an environment enclosed for radio-transmission purposes, for the benefit of VHF-radiotelephone traffic, comprising a number of base transceiver stations which are mounted within said enclosed environment at a number of locations, and which are capable of simultaneous transmission. All base transceiver stations are connected to one another by way of a fixed internal four-wire house-telephone line, by way of a concentrator unit, and the transmitters of the base transceiver stations retransmit the signal of an identified transmitting radiotelephone, which signal is simultaneously received on one or more receivers of the base transceiver stations, at the same frequency on all locations, by way of the concentrator unit.
System for offering radio coverage in an environment enclosed for
radio-transmission purposes.

The invention relates to a system for offering radio coverage in
an environment enclosed for radio-transmission purposes for the
benefit of VHF radiotelephone traffic [VHF = very high frequency or
30-300 MHz], comprising several base transceiver stations, which are
arranged within said enclosed environment at several locations and
which are capable of transmitting simultaneously.

Such a system is disclosed in the American patent specification
No. 5,432,838.

This involves the use of several base stations to achieve a more
complete radio coverage in a subterranean mine or a similar
environment, e.g., underwater.

In this case, simultaneous broadcasting is applied for emergency
messages.

Said system, however, does not provide a solution for providing
a full radio coverage in, e.g., large building complexes such as,
e.g., office complexes, hospitals, prisons, tunnels and the like for
the benefit of VHF radiotelephone traffic.

There is a need, however, of a system for mobile radio
communication in said complex large buildings, tunnels and the like,
the users conducting direct communication with one another by way of
radiotelephones at whatever location they might be within the
boundaries of the system, without it being required to carry out
additional actions, such as, e.g., the introduction of mobile or
group numbers.

The invention now provides such a system, which is characterised
for said purpose in that all base transceiver systems, by way of a
fixed, internal four-wire house telephone, are connected to one
another in a star shape, by way of a concentrator unit, and in that
the transmitters of the base transceiver stations retransmit the
signal received on one or more receivers of the base transceiver
stations from an identified transmitting radiotelephone
simultaneously at the same frequency in all locations by way of the
concentrator unit.

In this manner, a relatively simple and advantageous system for
mobile radio communication is provided for in complex large
buildings, tunnels and the like having minimal high-frequency power,
and each user having direct connection, without any additional
actions, to all users and the central control within the boundaries of the service area of the system.

In particular, radio coverage may be obtained in a relatively large or specific working area without applying several channels, the government requirements relating to maximum antenna altitude and transmission capacity still being complied with.

It is noted that the application of radiotelephones as the means of communication is known per se, no time being lost due to conversation buildup, all users of the radiotelephone network being capable of listening in on a conversation and, if so required, it being possible to intervene (no congestion in the event of emergencies).

The communication between radiotelephones, however, is limited by the maximum range thereof, and becomes worse when used in buildings.

In such cases, a choice is then sometimes made for duplex traffic, a base position in a central point receiving the signal from the transmitting radiotelephone and retransmitting it to the other radiotelephones in the network.

If, however, the building in which the radiotelephones are being used is very large and, in addition, coverage is desired in cellars and/or subterranean parking places and the like, duplex traffic proves no longer to suffice.

In such case, an increase of the transmitting power of the radiotelephones might be considered, but such proves not to be the correct solution and, in addition, is not permitted due to all sorts of government regulations and rules in this area.

Below, the invention will now be explained in greater detail by reference to the drawing and the specification.

By way of example, FIG. 1 schematically shows an advantageous embodiment of the invention.

FIG. 2 schematically shows the operation of the system according to FIG. 1.

By reference now to FIG. 1, a large building complex 1, 2, 3, 4, having an underground tunnel or cellar 5, is schematically shown. E.g., sporting complexes, football stadiums, office buildings and the like might be considered.

In each building, at intentionally chosen mounting points, transceivers Z0 have been placed to obtain sufficient distribution of the high-frequency field intensity.
The transceivers ZO are suitable for full-duplex traffic. Moreover, measures known per se to experts have been taken to prevent possible problems caused by simultaneous transmission.

Each transceiver ZO is connected, by way of a fixed, internal four-wire house line H1, to a (usually) centrally placed Concentrator Unit 6. In this manner, a separate transmitter and receiver line is provided for.

The concentrator unit is the organ in which all four-wire line connections of the base stations enter, the connections to a fixed operating position are present, and the connection to a monitor receiver is located, which blocks the transmit command in the event of receipt from a co-user.

The concentrator unit includes the following:
- DC control of both transmitter control and receipt signalling;
- level compensation of receiver and transmitter audio;
- line monitoring of transmitting and receiving lines;
- phase monitoring of transmitting and receiving lines;
- high-frequency power monitoring of each transmitter;
- standard configuration having six base stations, capable of being extended to 11+17+23 etc.;
- emergency-current monitoring of the base stations.

The length of the house-line connection between the base station and the concentrator unit advantageously amounts to under 3 km.

The transmitters operate advantageously in the 170 MHz frequency band and/or in the 80 MHz frequency band. The transmitting power of the base stations is low, e.g., 500 mW ERP (Effective Radiated Power).

To the Concentrator Unit 6, a central control 7 is connected by way of an internal house line H1b. The radiotelephones Pn are standard PMR and are suitable for semi-duplex traffic.

On each transceiver ZO, an antenna Cd is advantageously mounted which is suitable for said purpose, such as, e.g., a so-called Crossed Dipole antenna, which is placed within the environment enclosed for radio-transmission purposes, i.e., in the building, cellar or tunnel and the like.

Such an antenna having a specific directional pattern, and which is known to experts and therefore will not be described in further detail, has as its property that the vertically polarised field used for this application is substantially radiated out downwards and upwards. As a result, the field intensity at a distance of 800 m
amounts to less than 1 dBuV, while there still is sufficient field intensity present in the building complex.

In this manner, it is possible to concentrate the high-frequency energy of the transmitters there where it is required.

The operation of the system of FIG. 1 will now be explained in further detail by reference to FIG. 2.

Referring to FIG. 2, a radiotelephone Pn, which is located, e.g., in the underground tunnel 5, gives off a verbal call to two radiotelephones Pn which are located, e.g., in building 1 and building 4.

Apart from the speech, the call also includes a lower-band tone frequency which is decoded in the respective transceivers ZO and filtered out to prevent the system coming in in response to undesirable signals.

In the example of FIG. 2, the call is received in the transceivers 2, 3 and 5 only [uninterrupted lines in bold].

By way of the receiver lines of the four-wire house-line connection H1, the speech, combined with a "decoder ok" signal, goes to the Concentrator Unit 6.

In the Concentrator Unit 6, the speech signals of the respective transceivers 2, 3 and 5 are joined to provide a constant level. One or more "decoder ok" signals in the Concentrator Unit 6 will result in a start for all transmitters ZO simultaneously.

Together with the combined speech level of the receivers, a transmitter-start signal is placed on the transmitter lines of the four-wire house-line connection H1. As a result thereof, all transmitters are switched on, and speech received on the receivers 2, 3 and 5 is retransmitted.

The radiotelephone Pn in building 1 now receives the call by way of transceivers ZO, which are placed in the buildings 1 and 2, while the radiotelephone Pn in the building 4 receives the call by way of the transceivers ZO which are placed in the buildings 2, 3 and 4 (interrupted lines in bold).

Talking back of the, e.g., the radiotelephone Pt in building 4, takes place in an identical manner, which will not be described in further detail here.

In order to prevent possible problems with the phase rotation of lines, as a result of which the speech becomes unintelligible, a phase-monitoring circuit may advantageously be included in the Concentrator Unit 6, as was already mentioned earlier. Such circuit
is known to experts, and therefore will not be described here in further detail.

The phase control of the four-wire internal house lines Hl, the "transmitter start" and the "decoder ok" signals are advantageously carried out using a DC circuit.

The system according to the invention is future-resistant, i.e., in the event of extensions or renovations of the buildings, tunnels, cellars and the like, in which the system is applied, base stations can quite simply be shifted or additionally mounted.

The system according to the invention advantageously has at its disposal nine channels in the 170 MHz frequency band.

Moreover, practice shows that the system according to the invention is still able to operate at a distance of approx. 300-600 m outside the building complexes.

Various modifications of the system according to the invention will be understood by experts after the above specification and drawings, and will therefore not need to be explained in further detail.

Such modifications shall be deemed to fall within the framework and the scope of protection of the invention.
CLAIMS

1. System for offering radio coverage in an environment enclosed, for radio-transmission purposes, for the benefit of VHF-radiotelephone traffic, comprising several base transceiver stations which are mounted within said enclosed environment at a number of locations, and which are capable of transmitting simultaneously, characterised in that all base transceiver stations, by way of fixed, internal four-wire house-telephone lines, are connected to one another, in the form of a star, by way of a concentrator unit, and in that the transmitters of the transceiver stations retransmit the signal received on one or more receivers of the base transceiver stations from an identified transmitting radiotelephone simultaneously, at the same frequency, at all locations by way of the concentrator unit.

2. System according to claim 1, characterised in that the base transceiver stations have a low transmitting power.

3. System according to claim 2, characterised in that the transmitting power amounts to approx. 500 mW ERP (Effective Radiated Power).

4. System according to any of the claims 1-3, characterised in that the base transceiver stations are connected to antennas which are mounted within said enclosed environment.

5. System according to claim 4, characterised in that the antennas are "Crossed Dipole" antennas which radiate out substantially upwards and downwards.

6. System according to any of the claims 1-5, characterised in that the house-line connection between base transceiver station and concentrator unit has a length inferior to 3 km.

7. System according to any of the claims 1-6, characterised in that the transmitters operate in the 170 MHz frequency band.

8. System according to any of the claims 1-6, characterised in that the transmitters operate in the 80 MHz frequency band.
9. System according to any of the claims 1-8, characterised in that the concentrator unit is connected to a fixed control station.

10. System according to any of the claims 1-9, characterised in that the concentrator unit is connected to a monitor receiver which inhibits a transmission command in the event of receiving a co-user.

11. System according to any of the claims 1-10, characterised in that the speech-level compensation of the receiving path is determined by the decoded receiving signal in the concentrator unit.

12. System according to any of the claims 1-11, characterised in that the phase monitoring of the four-wire internal house-telephone lines, the "transmitter start" and "decoder ok" signals, are carried out by a DC circuit.

13. System according to any of the claims 1-12, characterised in that said enclosed environment consists of a large building complex.

14. System according to any of the claims 1-13[?], characterised in that said enclosed environment consists of a tunnel.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H04Q7/26 H04Q7/28 H04Q7/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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</tr>
<tr>
<td>A</td>
<td>D.J. NESS-COHN: &quot;Automatic Inclusion of a Radio in an Emergency Group Call&quot; MOTOROLA TECHNICAL DEVELOPMENTS, vol. 20, 1 October 1993 (1993-10-01), pages 126-128. XP000403849 Schaumburg, Illinois ,USA * see complete article *</td>
<td>1,2,13, 14</td>
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Authorized officer

Geoghegan, C

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<th>Category</th>
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<tr>
<td>A</td>
<td>DE 44 41 421 A (KOMMUNIKATIONSTECHNIK GROTTKE) 8 June 1995 (1995-06-08) * see complete document *</td>
<td>1,8</td>
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<tr>
<td>A</td>
<td>US 3 634 627 A (VELENTINI) 11 January 1972 (1972-01-11) column 1, line 35 - line 41 column 2, line 69 -column 9, line 76; figures</td>
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<td>WO 9505721 A</td>
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<td>ZA 9109843 A</td>
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<td>DE 4441421 A</td>
<td>08-06-1995</td>
<td>DE 9318679 U</td>
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<td>US 3634627 A</td>
<td>11-01-1972</td>
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