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NOTICE OF ENTITLEMENT

We, ANT NACHRICHTENTECHNIK GMBH, of Gerberstrasse 33, D-71522 Backnang, Germany, being the applicant in respect of Application No. 68414/94, state the following:-

The person nominated for the grant of the patent has entitlement from the actual inventors by their employment with the applicant.

The person nominated for the grant of the patent is the first applicant of the application listed in the declaration under Article 8 of the PCT.

The basic application listed in the declaration made under Article 8 of the PCT is the first application made in a Convention country in respect of the invention.

DATED this 4th day of January, 1996.

Colin D. Macauley
Patent Attorney for the Applicant

AU9468414

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MOBILE RADIO AERIAL INSTALLATION

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(56) Prior Art Documents
US 3717814
EP 0214806
EP 0364190

(57) Claim

1. An antenna system for base transmitter-receiver stations of a communications system for mobile radio operators, said system having at least two transmission channels and two reception channels assigned to them, wherein the transmitters and receivers of the base transmitter-receiver stations operate on separate frequencies, with at least two antennas which allow for redundant reception, each antenna is used as a transmission antenna for at least one channel, the transmitting operation is carried out without redundancy so that each antenna is fed by a different transmission channel, and at least one antenna is set for the redundant reception of that channel which is fed to another antenna as the transmission channel.

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(81) Bestimmungsstaaten: AU, FI, HU, US, europäisches Patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

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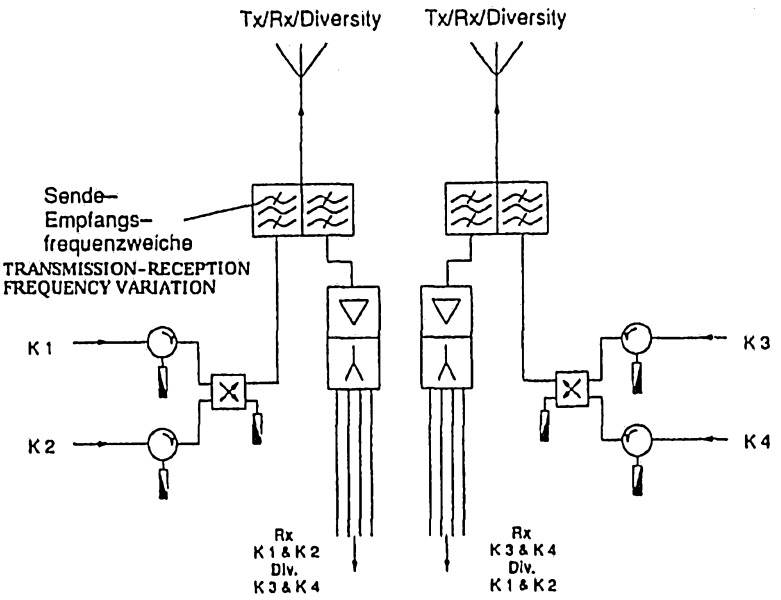
Mit internationalem Recherchenbericht.

(54) Title: MOBILE RADIO AERIAL INSTALLATION

(54) Bezeichnung: *MOBILFUNKANTENNENANLAGE*

(57) Abstract

The invention relates to an aerial installation for small base transmitter-receiver stations in a radio communication system for mobile participants with at least one transmission and reception channel operating on separate frequencies and at least two aerials designed for redundant reception (reception diversity). Each aerial is used as a transmission aerial for at least one channel. In non-redundant transmission, each aerial is fed by another transmission channel and the reception diversity is such that at least one aerial is set up for the reception of a channel which is allocated to the transmission channel of another aerial. For use in mobile radio systems, especially D and E networks. Advantages: low cost, low transmission loss and high channel flexibility and, above all, avoidance of system interference by intermodulation products.



Description

Mobile Radio Antenna Installation

The invention relates to an antenna installation or system for base transmitter-receiver stations of a communication system for mobile radio operators.

Such antenna installations have been known to be used for mobile radio communication systems. One of these antenna installations is based on a three-antenna solution, see Fig. 1, wherein one of the antennas is used exclusively as a transmitter antenna, while the channels to be transmitted are combined by diplexers or coupling circuits and fed to the transmitter antenna. Both other antennas are used for reception only, while each antenna receives all channels and the antennas are mounted so that the reception of the antennas is independent consequently the desired redundancy is assured (reception diversity).

Another known antenna installation uses only two antennas, see Fig. 2, wherein one antenna is used as a combined transmitting and receiving antenna and the other exclusively as a reception antenna for the redundant reception of the operating channels. The transmission and reception signals of the combined antenna are separated by a corresponding multiplexer. Also in the case of this solution the transmission channels are to be combined via combiner networks containing frequency filters the interference power increases very strongly with the number of the transmission channels. This has a particularly disadvantageous effect in the two-antenna solution (Fig. 2), as in this case the signals reach the receiving amplifier without isolation, whereas in the three-antenna solution according to Fig. 1 an antenna coupling of approx. 30 dB can be considered. For this reason the more complicated three-antenna solution is preferred in many applications.

From the German patent 35 08 285 a radio transfer station for a mobile radio network is known, wherein as antenna arrangement an even number of omni-directional antennas are provided with a transmitter-receiver set each, which are evenly distributed on the circumference of a circle, and wherein the receivers of the transmitter-receiver sets are constructed as diversity receivers, each of which has two omni-directional antennas of the antenna arrangement as reception antennas to receive an incoming signal in two ways and to each omni-directional

antenna of the antenna arrangement the same number of transmitters are available.

In the German published patent application 31 45 992 a digital mobile radio installation of high capacity is described, wherein the digital fixed station has a plurality of antenna elements which work both in the receiving direction and in the transmitting direction with space diversity.

It is common to both mobile radio installations that they operate in time division multiplex and by means of a switch they switch over to the alternating transmission or reception operation.

The object of this present invention is to specify an antenna installation of the type mentioned in the introduction, which prevents an impairment of the system by intermodulation products even when operating several channels and which has a high channel flexibility and low transmission attenuations. In addition, the expense for the antenna installation should be as small as possible.

According to the invention there is provided an antenna system for base transmitter-receiver stations of a communications system for mobile radio operators, said system having at least two transmission channels and two reception channels assigned to them, wherein the transmitters and receivers of the base transmitter-receiver stations operate on separate frequencies, with at least two antennas which allow for redundant reception, each antenna is used as a transmission antenna for at least one channel, the transmitting operation is carried out without redundancy so that each antenna is fed by a different transmission channel, and at least one antenna is set for the redundant reception of that channel which is fed to another antenna as the transmission channel.

The antenna installation according to the invention makes the operation of several channels feasible and it has a high channel-flexibility as well as small transmission attenuation, which are in any case under those of known installations. Another great advantage is that in the case of the antenna installation according to the invention impairment due to intermodulation products is not only reduced but is practically prevented.

This is the case not only when being used in the mobile radio network D (DMCS 900) but also in the planned E-network. In the D-network the reception

range is between 890 to 915 MHZ and the transmission range between 935 to 960 MHZ, thus in case of a band width of 25 MHZ and a separation of 20 MHZ 5 MHZ is at risk.

In the E-network the reception range is between 1710 to 1785 MHZ and the transmission range between 1805 to 1880 MHZ, and in contrast with a band width of 75 MHZ and a separation of 20 MHZ in this case 55 MHZ is at risk. Particularly critical in conventional antenna installations are the intermodulation products which consist of three carriers since these have higher energy constituents.

The advantage of this antenna installation is that these intermodulation products can be totally prevented and that an impairment of the system by other 2-carrier products can be almost completely excluded also for the E-network.

The invention is described in detail based on the embodiments of Figs. 5a and 5b.

In Fig. 5 the antenna installation comprises two antennas, each of which is connected with a diplexer, which separates the transmission and reception signals. A transmission channel K1 and K2 each is connected to both antennas, while the signals o both channels are received by each antenna. In case of this solution a loss-encumbered combiner network becomes redundant for both transmission channels; this results in a gain of approx. 3 dB. In addition, no intermodulation products can occur at all.

If more than two channels are operating, the transmission channels can be divided to both antennas, Fig. 5b shows an arrangement for four channels, wherein two transmission channels are switched to one antenna. In this case both transmission channels, which are assigned to one antenna, are combined by a 3 dB coupler to be introduced then to the transmission-receiver diplexer. Due to the combination of the channels the transmission attenuation is increased, in fact by 3 dB; it is, however, still 3 dB lower than in case of conventional solutions with coupler-combiner networks, which also enable a complete channel flexibility.

In case of the solution according to Fig. 5b intermodulation products may also occur, since two power transmitters are operated on one antenna; however, an impairment of the station by a suitable allocation of the transmission channels

to both antennas can be prevented in a very simple manner. In addition, the number of the possible intermodulation products in the case of two transmitters is considerably lower than is in the case of four transmitters in conventional antenna installations. In contrast, a suitable allocation of two transmission channels is considerably simpler to plan than that of four transmission channels to one antenna.

As in the case of the two-channel example of Fig. 5a both antennas receive all four channels and thus ensure the redundant reception of the station.

An interesting version of an antenna installation according to the invention is that using three antennas, each of which is fed by a transmission channel and each of which receive the other two channels. In this case all transmission channels operate with the highest output, expensive combiner-networks with increased transmission attenuation become redundant, and when each antenna receives all three channels, a double redundance is obtained.

Even when more than four channels are to be operated, a three-antenna or multi-antenna installation according to the invention presents itself, wherein each antenna is covered with up to two transmission channels. Thus a six-channel installation with three antennas has the advantage of a transmission channel with a smaller transmission attenuation of up to 6 dB and the advantage that intermodulation products can be avoided, while in the case of a combination of six transmission channels on a transmission antenna according to Fig. 1 a strong impairment occurs caused by the unavoidable intermodulation products.

The claims defining the invention are as follows:-

1. An antenna system for base transmitter-receiver stations of a communications system for mobile radio operators, said system having at least two transmission channels and two reception channels assigned to them, wherein the transmitters and receivers of the base transmitter-receiver stations operate on separate frequencies, with at least two antennas which allow for redundant reception, each antenna is used as a transmission antenna for at least one channel, the transmitting operation is carried out without redundancy so that each antenna is fed by a different transmission channel, and at least one antenna is set for the redundant reception of that channel which is fed to another antenna as the transmission channel.

2. The antenna system according to claim 1, wherein at least one antenna is set to receive a channel which is transmitted by it.

3. The antenna system according to claim 1 with three antennas, wherein each antenna is set to receive the channels transmitted by the other antennas.

4. The antenna system for two-channel base transmitter-receiver stations according to claim 1 or 2 with two antennas, wherein each antenna is fed one transmission channel and is set to receive both channels.

5. The antenna system for four-channel base transmitter-receiver stations according to claim I or 2 with two antennas, wherein each antenna is fed two transmission channels and is set to receive all four channels.

6. An antenna system for base transmitter-receiver stations of a communications system for mobile radio operators with at least one transmission channel and one reception channel associated with this transmission channel, wherein the transmitter and receiver of the base transmitter-receiver stations operate on separate frequencies, with at least two antennas which allow for redundant reception, each antenna is used as a transmission antenna for at least one channel, and for at least one channel the transmission operation is also carried out with redundancy and at least one antenna is set for the redundant reception of that channel, which is transmitted as a transmission channel by a different antenna.

7. The antenna system according to any one of claims 1 to 3 with two antennas and three transmission channels, wherein the one antenna is fed two transmission channels and the other antenna is fed one transmission channel, which latter antenna can be used for broadcasting functions.

8. The antenna system according to any one of claims 1 to 3 or 6 with more than one transmission channel per antenna, wherein the transmission channels are combined via coupler combiner networks.

9. The antenna system according to any one of the preceding claims, wherein the separation of transmission and reception signals is carried out by diplexers.

DATED this 30th day of December, 1996.

BOSCH TELECOM GMBH

By their Patent Attorneys:

CALLINAN LAWRIE

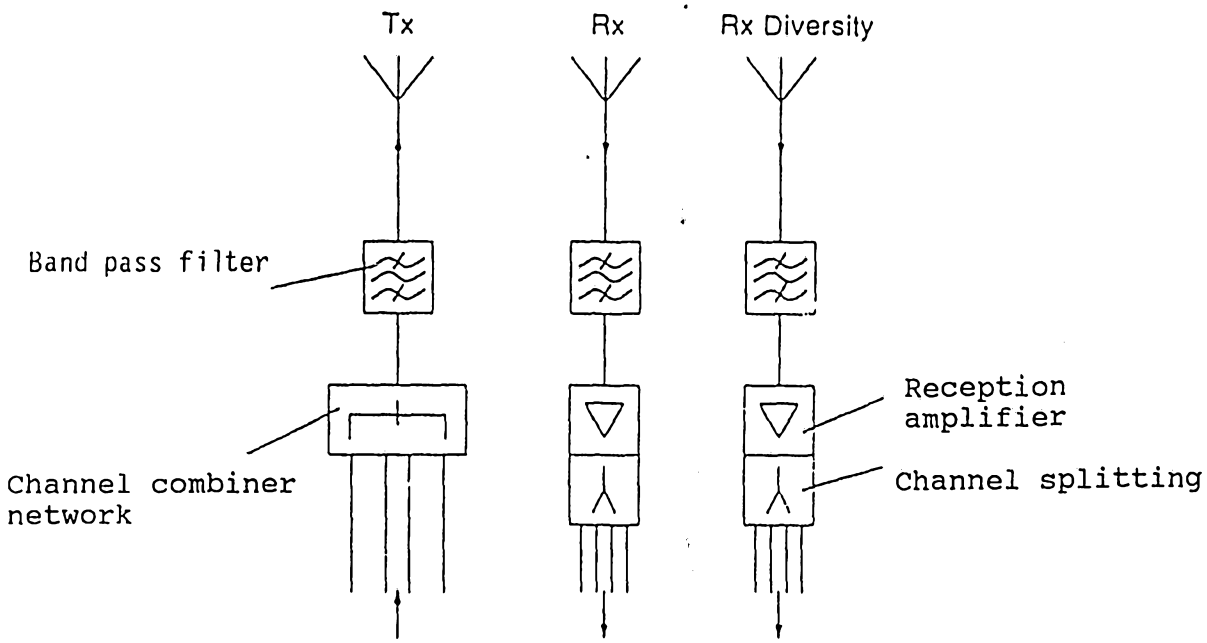


Fig.1 Conventional antenna installation "three-antenna solution"

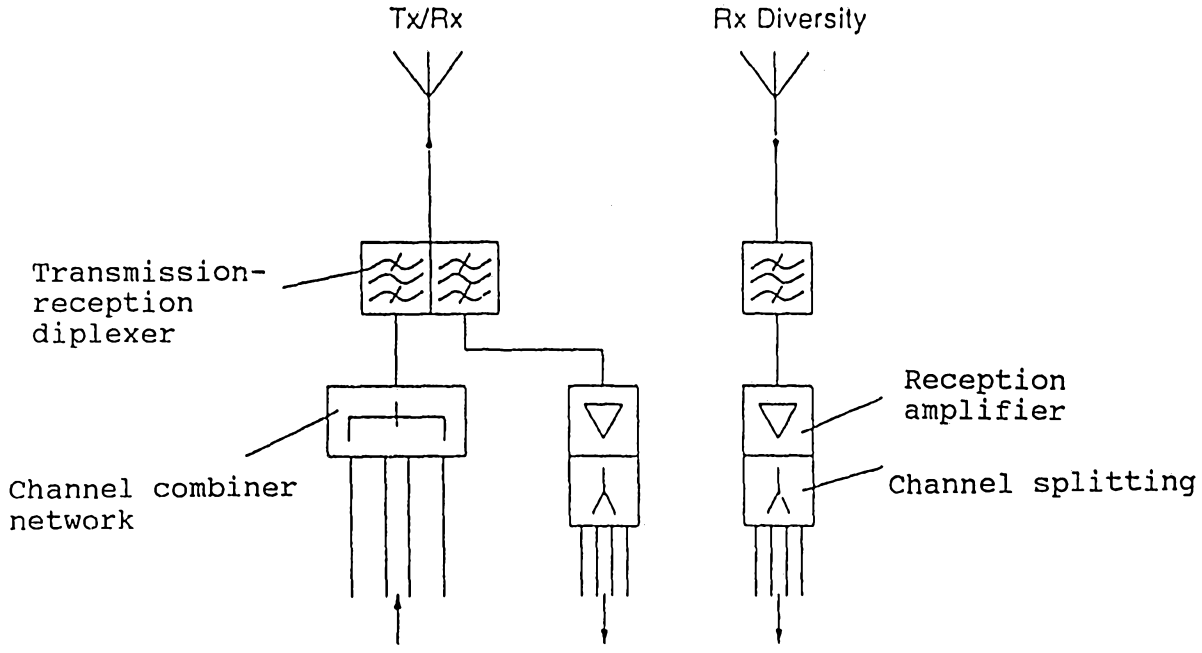


Fig.2 Conventional antenna installation "two-antenna solution"

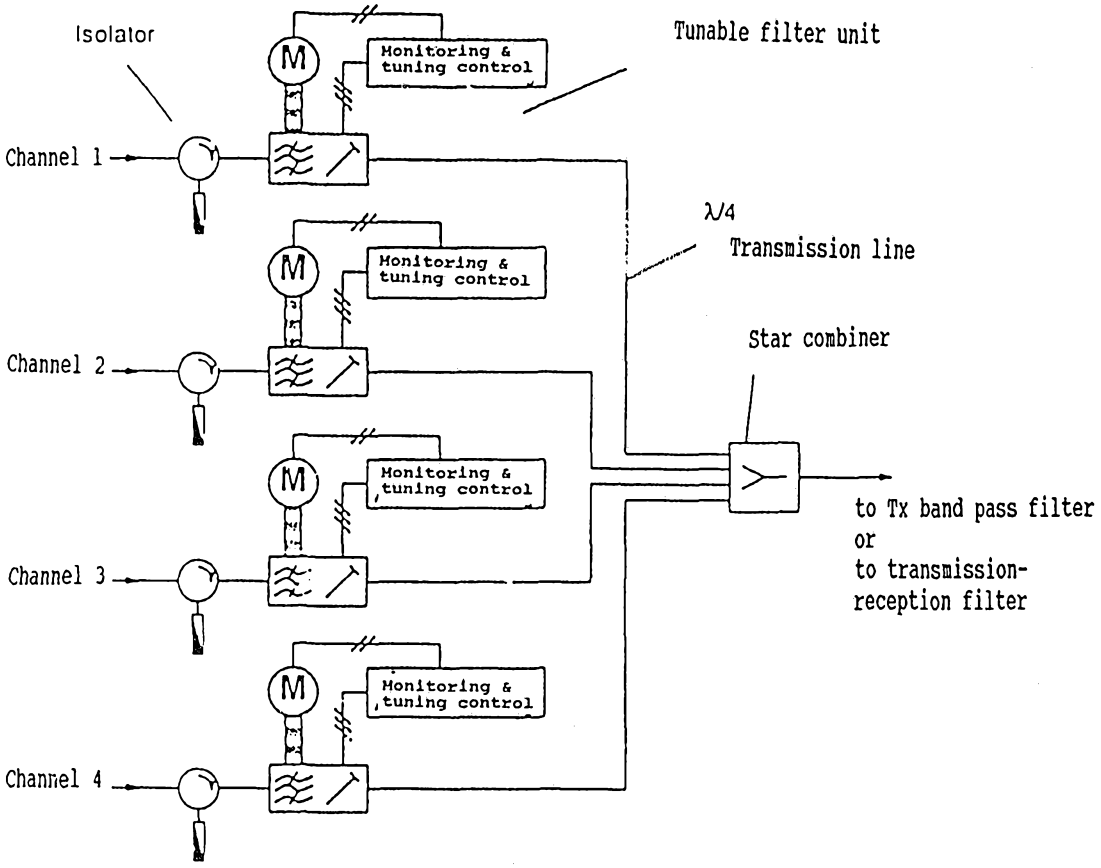


Fig.3 Channel combiner network with filters

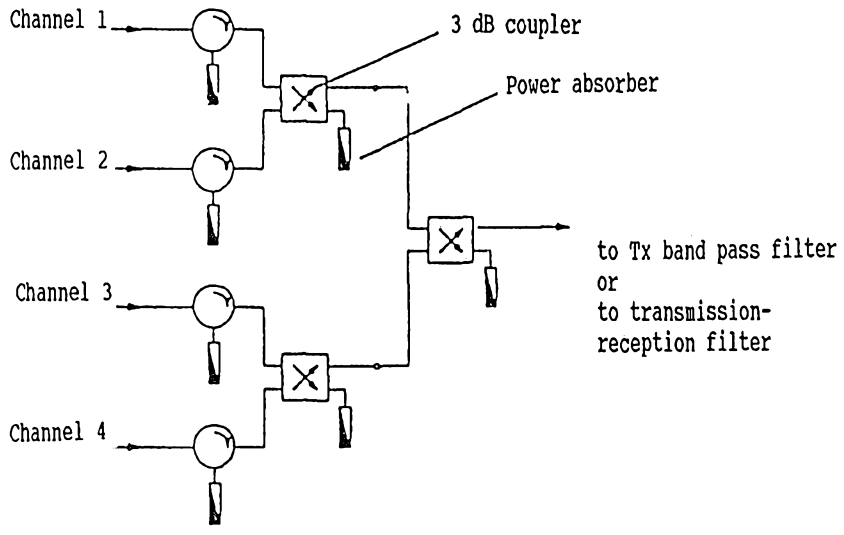


Fig.4 Channel combiner network with couplers

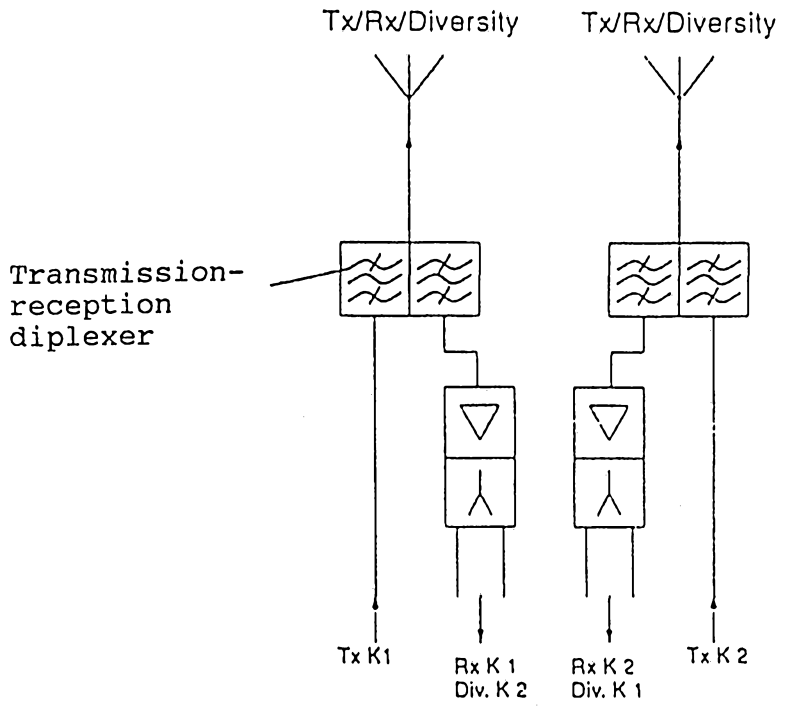


Fig.5a Antenna installation according to the invention; Embodiment 1

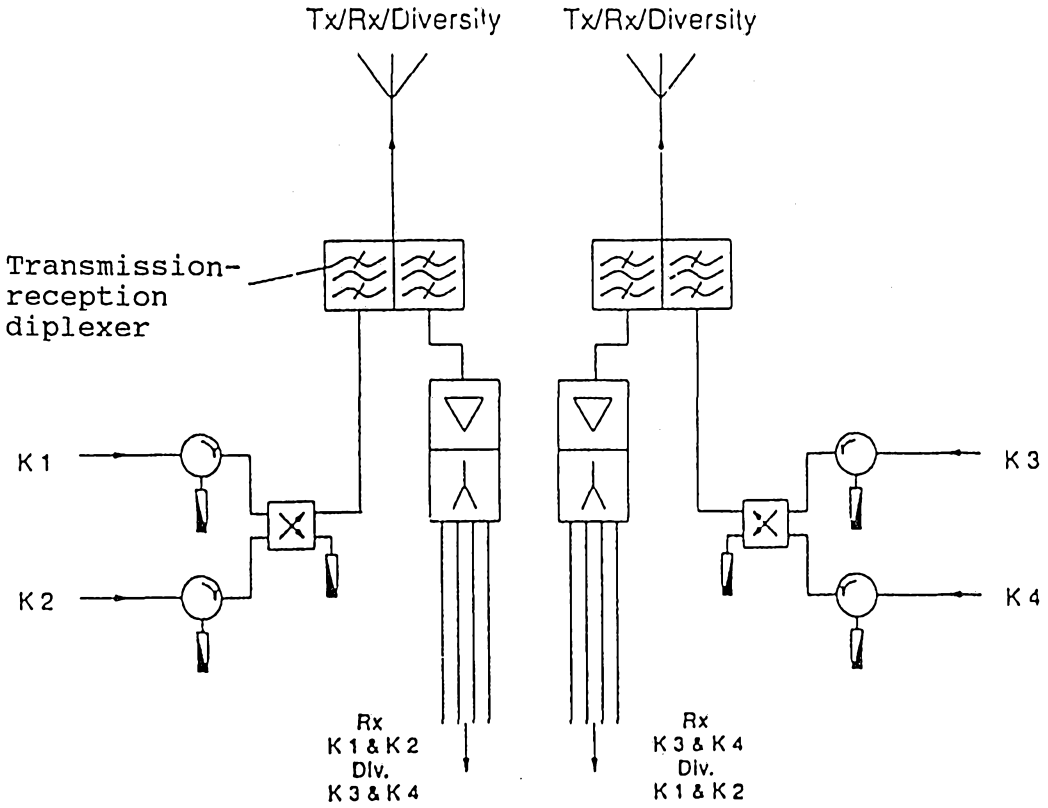


Fig.5b Antenna installation according to the invention; Embodiment 2

INTERNATIONAL SEARCH REPORT

International Application No
PCT/DE 94/00666

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04B7/04 H04L1/06 H01Q21/28 H01Q1/32

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 6 H04B H04L H01Q

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	EP,A,0 364 190 (SUMITOMO ELECTRIC) 18 April 1990 see claims 1-4; figures 1,3-8 ---	1,6
A	ELECTRONICS LETTERS., vol.28, no.24, 19 November 1992, STEVENAGE GB pages 2201 - 2202 SAWAHASHI ET AL. 'TRANSMITTER DIVERSITY EFFECT IN TDMA/TDD MOBILE RADIO TRANSMISSION' see the whole document --- -/--	1,6

[X] Further documents are listed in the continuation of box C. [X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 August 1994	12. 09. 94
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax. (+ 31-70) 340-3016	Authorized officer Angrabeit, F

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INTERNATIONAL SEARCH REPORT

Intern. ...nal Application No
PCT/DE 94/00666

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	TRANSACTIONS OF THE INSTITUTE OF ELECTRONICS, INFORMATION AND COMMUNICATION ENGINEERS OF JAPAN, vol.E74, no.6, June 1991, TOKYO JP pages 1547 - 1555 YAMADA ET AL. 'Base and Mobile Station Antennas for Land Mobile Radio Systems' see page 1547, paragraph 2.1 - page 1548 ---	1,6
A	EP,A,0 214 806 (NEC) 18 March 1987 see page 7; figure 1B ---	1,6
A	39TH IEEE VEHICULAR TECHNOLOGY CONFERENCE, vol.I, May 1989 pages 353 - 358 CLARK 'CELLULAR RURAL STATISTICAL AREA (RSA) TRANSMIT AND RECEIVE COMBINING' see page 354 - page 356; figures 2-8 -----	1,6

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
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		AU-A-	6183786	05-03-87
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