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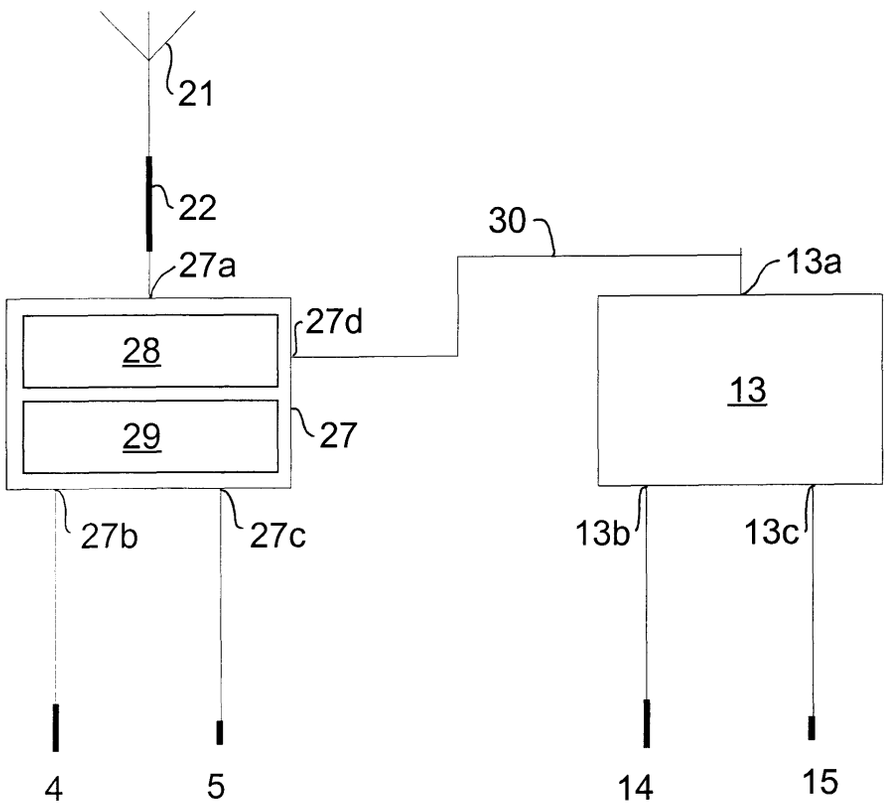
## (54) Device for transmission/reception of electromagnetic signals

(57) A device for base stations, wherein a band filter separating transmission/reception signals of a main band from those of another main band is included in a diplexer. Another diplexer is provided and both diplexers are adapted to separate two subbands of each main band.

Fig.3

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## Description

Field of the Invention

**[0001]** The invention relates to a device for transmission/reception of electromagnetic signals in general and especially to a diplexer for GSM communication systems.

Background of the Invention

**[0002]** Cellular phones, especially according to the Global System for Mobile Communications Standard (GSM) are of increasing interest. For establishing a link between a hand held cellular phone and further wire bound communication systems or other cellular phones, base stations are provided. Cellular phones and base stations have been transmitting and receiving signals on certain carrier frequencies within a single main communication band. Due to an increased communication load, the GSM-net communication has been partitioned in two main bands, the former GSM 900 and the younger GSM 1800 band. The GSM 900 band is using frequencies in the 900 MHz range, whereas the GSM 1800 is working in the 1800 MHz domain. Each main band is furthermore divided at least in two subbands for each communication link between a cellular phone and the associated base station, which subbands are used for transmitting and receiving electromagnetic signals, respectively. Dual band base station were introduced operating in both the GSM 900 and the GSM 1800 main bands to offer an increased amount of communication links. Consequently, a dual band base station includes two transmission/reception assemblies, one for the GSM 900 and one for the GSM 1800 main band causing increased costs and additional spatial requirements for the base station.

**[0003]** A common transmission/reception assembly as incorporated in such dual band base stations includes an antenna, a feeder cable, a diplexer for separating signals of the transmission subband from those of the reception subband, and vice versa, for each main band. The feeder cable establishes a link between the antenna and one of the three diplexer ports, whereas the transmission and reception members, i.e. output amplifiers and input receivers, are connected to the two other diplexer ports. Since an antenna is usually located at an elevated position, and a diplexer as well as the transmission/reception members are located at a lower position, the feeder cable is of a significant length (approximately 5 to 50 m).

**[0004]** Two transmission/reception assemblies for a dual band base station not only cause increased manufacturing costs, require additional space but also have a deleterious influence on the aesthetic appeal of the whole antenna system.

**[0005]** According to a prior approach a dual band filter is used to combine the transmission/reception assemblies of the GSM 900 and GSM 1800 bands. In such a case, only one multiband antenna and one feeder cable are necessary. However, an additional slot in a rack of the dual band base station must be supplied for the dual band filter provided by a separate module, again causing additional costs and consuming space. Furthermore, the dual band filter is connected to the diplexers by coaxial cables, which are subject to intermodulation distortions. Furthermore, a base station in general and especially the antenna system thereof is three-sectorised, wherein each sector spatially covers a 120°, and each sector contains two transmission/reception assemblies (main and diversity) for each GSM main band. Therefore, six dual band filters and six slots for insertion into the rack are provided for each three-sectorised dual band base station, causing multiplied costs and additional intermodulation distortions.

**[0006]** Accordingly, it is an object of the invention to provide an inexpensive and space-saving band filter for GSM communication systems.

**[0007]** The invention is defined by the features of claims 1.

**[0008]** According to the invention dual band base stations are realised with a minimised number of modules, of coaxial cables, and reduced intermodulation distortions.

**[0009]** Due to the inventive dual band diplexer, only one antenna and one feeder cable are necessary. The dual band diplexer separates the transmission/reception signals of different main bands assigned to the respective feeder cables and the antenna ports by an integrated dual band filter into two main band branches. The first branch is assigned to the first diplexer integrated in the dual band diplexer for diplexing the electromagnetic signals of one main band into its two subbands. The second branch is assigned to another port of the dual band diplexer for a connection to the second diplexer dividing the electromagnetic signals of the second main band into its two subbands.

**[0010]** Since the first diplexer and the dual band filter are joined in a single module, no external connection by coaxial cables between the dual band filter and the first diplexer is needed, causing a reduction of intermodulation distortion.

**[0011]** According to the invention no additional slots have to be provided for separate dual band filter modules in the rack, which means significant saving of production costs and space consumption. Furthermore, less electronic modules have to be transported and serviced, which means saving of logistics and service costs. Only one antenna has to be provided in contrast to two single band transmission/reception assemblies each comprising an antenna.

**[0012]** The transmission power of such base stations is in the order or several Watt, whereas the power of the received signals is orders of magnitude lower. Some filters cause a harmonic contents, which includes in general integral multiples of the cutoff band frequencies of the filters. Therefore, in dual band base stations working

in the GSM 900 and GSM 1800 main band it is advantageous to realise the dual band filter including only filters having cutoff frequencies far off the 900 MHz domain. Such filters e.g. are low pass filters and high pass filters with a cutoff frequency between 900 MHz and 1800 MHz and band pass filters passing through frequencies of the subbands of the GSM 1800 main band, avoiding a negative influence of harmonic frequencies in the 1800 MHz domain.

**[0013]** In dual band base stations working in the GSM 900 and GSM 1800 main band, the GSM 1800 diplexer is typically smaller than the GSM 900 diplexer. Therefore it is advantageous to integrate the dual band filter in the GSM 1800 diplexer. The dual band diplexer module can be built of the same size as the prior art GSM 1800 diplexer. In such case existing single and dual band base stations can be upgraded with the dual band diplexer according to the invention by replacing the prior art GSM 1800 diplexer by the inventive dual band diplexer, significantly saving costs and time.

**[0014]** Moreover, it is advantageous to realise the dual band filter in the GSM 1800 dual band diplexer by a band pass filter, passing through both transmission and reception subbands of the GSM 900 main band. The band pass filter suppresses both signals of higher and lower frequencies. Therefore the band pass filter meets high quality requirements.

**[0015]** It is also advantageous to realise the dual band filter in the GSM 1800 dual band diplexer by a low pass filter with a cutoff frequency between 900 MHz and 1800 MHz. The low pass filter is sufficient to suppress frequencies in the GSM 1800 main band and is simpler and therefore less expensive than a band pass filter.

**[0016]** In an alternative embodiment the dual band filter is provided in the GSM 900 diplexer by a high pass filter with a cutoff frequency between 900 MHz and 1800 MHz. The high pass filter is sufficient to suppress frequencies in the GSM 900 main band and is also simpler and therefore less expensive than a band pass filter.

## Brief Description of the Figures

**[0017]**

Fig. 1 shows two separate transmission/reception assemblies for the GSM 900 and the GSM 1800 band, respectively;

Fig. 2 shows a dual band transmission/reception assembly with an antenna, a feeder cable, a dual band filter, and two diplexers.

Fig. 3 shows a dual band diplexer with an antenna a feeder cable and a diplexer;

Fig. 4 shows a diagram of a dual band diplexer integrating a band pass filter;

Fig. 5 shows a diagram of a dual band diplexer integrating a low pass filter;

Fig. 6 shows a diagram of a dual band diplexer integrating a high pass filter; and

Fig. 7 shows a topview of a dualband diplexer using cavity resonators.

## Description of the Preferred Embodiments

**[0018]** The invention is described in more detail hereinafter by means of preferred embodiments given by way of example with reference to the accompanying drawings. However, for a better understanding of the invention prior art approaches are described below in brief.

**[0019]** Fig. 1 shows a diagram of a prior art dual band base station incorporating two separate transmission/reception assemblies for the GSM 900 and the GSM 1800 main bands, respectively. The dual band base station comprises a first and a second antenna 1, 11, a first and a second feeder cable 2, 12, and a first and a second diplexer 3, 13. The diplexers 3, 13 are assigned to the GSM 900 and GSM 1800 main bands, respectively, each having a first port 3a, 13a, a second port 3b, 13b, and a third port 3c, 13c. A first and a second transmission member 4, 14 and a first and a second reception member 5, 15 are shown. The first and second antennas 1, 11 are linked to the first ports 3a, 13a of the first and second diplexers 3, 13 by the first and second feeder cables 2, 12, respectively. The first transmission and reception members 4, 5 are connected to the second and third ports 3b, 3c of the first diplexer 3, respectively. The second transmission and reception members 14, 15 are connected to the second and third ports 13b, 13c of the second diplexer 13, respectively.

**[0020]** Fig. 2 shows a diagram of a prior art dual band base station incorporating a dual band filter module 26. The dual band base station includes an antenna 21, a feeder cable 22, a dual band filter module 26, a first and a second coaxial line 23, 24, and a first and a second diplexer 3, 13. The first and second diplexers are assigned to the GSM 900 and GSM 1800 main bands, respectively. The dual band filter module 26 comprises a first, a second, and a third port 26a, 26b, 26c. The diplexers 3, 13 comprise a first port 3a, 13a, a second port 3b, 13b, and a third port 3c, 13c, respectively. Fig. 2 furthermore shows first and second transmission 4, 14 and reception members 5, 15, respectively. The antenna 21 is linked to the first port 26a of the dual band filter module 26 by the feeder cable 22. The second and third port 26b, 26c of the dual band filter module 26 are linked to the first port of the first and the second diplexers 3a, 13a by the first and second coaxial lines 23, 24, respectively. The first transmission and reception members 4, 5 are connected to the second and third ports 3b, 3c of the first diplexer 3, respectively. The second transmission and reception members 14, 15 are connected to the second and third ports 13b, 13c of the second diplexer 13, respectively.

**[0021]** Fig. 3 shows a diagram of a dual band base station according to the invention including an antenna 21, a feeder cable 22, a dual band diplexer 27, a coaxial

line 30, a diplexer 13, a first transmission and reception members 4, 5, and a second transmission and reception members 14, 15. The dual band diplexer 27 comprises a dualband filter 28, a diplexer member 29 assigned to the GSM 1800 main band, a first, a second, a third, and a fourth port 27a, 27b, 27c, 27d. The diplexer 13 is assigned to the GSM 900 main band and comprises a first, a second, and a third port 13a, 13b, 13c. The antenna 21 is linked to the first port 27a of the dual band diplexer 27 by the feeder cable 22. The first transmission and reception members 4, 5 are connected to the second and third ports 27b, 27c of the dual band diplexer 27, respectively. The fourth pert 27d of the dual band diplexer 27 is linked to the first port 13a of the diplexer 13 by the coaxial line 30. The second transmission and reception members 14, 15 are connected to the second and third port 13b, 13c of the diplexer 13, respectively.

**[0022]** Fig. 4 shows a diagram of the dual band diplexer 37 incorporating a GSM 900 band pass filter 38. The dual band diplexer 37 comprises a first, a second, a third, and a fourth port 37a, 37b, 37c, 37d, the GSM 900 band pass filter 38, and a first and a second subband band pass filter 39, 40. The GSM 900 band pass filter 38 and the first and second subband band pass filters 39, 40 each comprise a first port 38a, 39a, 40a and a second port 38b, 39b, 40b. The first and second subband band pass filters 39, 40 are adapted to the transmission and reception subbands of the GSM 1800 main band, respectively. The first and second subband band pass filters 39, 40 together form a GSM 1800 diplexer. The band width of the GSM 900 band pass filter 38 is adapted to pass through both transmission and reception subbands of the GSM 900 main band. The first ports 38a, 39a, 40a of the GSM 900 band pass filter 38 and the first and second subband band pass filters 39, 40 are connected to each other and to the first port 37a of the dual band diplexer 37.

**[0023]** Fig. 5 shows a diagram of the dual band diplexer equivalent to the one shown in fig. 4, but incorporating a low pass filter 48 with a cutoff frequency between 900 MHz and 1800 MHz, instead of the GSM 900 band pass filter 38 as shown in fig. 4. The low pass filter is sufficient to suppress signals of the GSM 1800 main band and to pass signals of the GSM 900 main band. The dual band diplexer 47 comprises a first and a second port 48a, 48b connected to the first ports 39a, 40a of first and second subband band pass filters 39, 40 and to the first port 47a of the dual band diplexer 47.

**[0024]** Fig. 6 shows a diagram of an alternative dual band diplexer incorporating a high pass filter 58 with a cutoff frequency between 900 MHz and 1800 MHz being sufficient to suppress signals of the GSM 900 main band and to pass signals of the GSM 1800 main band. The dual band diplexer 57 comprises a first, a second, a third, and a fourth port 57a, 57b, 57c, 57d, a high pass filter 58, a first and a second subband band pass filter 59, 60. The high pass filter 58 and the first and second subband band pass filters 59, 60 comprise each a first port 58a, 59a, 60a and a second port 58b, 59b, 60b. The first and second subband band pass filters 59, 60 are adapted to the transmission and reception subbands of the GSM 900 main band, respectively. The first and second subband band pass filters 59, 60 together form a GSM 900 diplexer. The first ports 58a, 59a, 60a of the high pass filter 58 and of the first and of the second subband band pass filter 59, 60 are connected to each other and to the first port 57a of the dual band diplexer 57.

**[0025]** Fig. 7 shows a detailed view of a preferred embodiment of the dual band diplexer. The dual band diplexer 67 is sectioned by walls 71, 72 into a first, a second and a third portion 68, 69, 70, each having a first 68a, 69a, 70a and a second termination 68b, 69b, 70b. The first portion 68 is forming a main band filter adapted to pass signals of the GSM 900 band. The second and third portions 69, 70 are forming the transmission and reception portions of the GSM 1800 diplexer, respectively. The first terminations 68a, 69a, 70a, of the three portions are connected to each other and the first port 67a of the dual band diplexer 67. The second termination 68b of the first portion 68 is connected to the fourth port 67d, which is assigned to the GSM 900 diplexer. The second terminations 69b, 70b of the second and third portions 67b, 67c are connected to the second and third ports 67b, 67c of the dual band diplexer 67, which are assigned to the GSM 1800 reception and transmission members, respectively. Each portion contains a number of cavity resonators 73. In the preferred embodiment the first portion 68 contains two cavity resonators 73, the second portion 69 contains sixteen cavity resonators 73 and the third portion 70 contains twelve cavity resonators 73.

**[0026]** The invention is not restricted to the preferred embodiments described above. It will be understood, that the band filter is also not restricted to the dual band filter, but the band filter can also be realised as a multi band filter for three or more main bands.

## Claims

**1.** Device for transmitting and/or receiving electromagnetic signals comprising:

- at least one transmitting/receiving antenna (21);
- at least a first and a second diplexer (27, 13) assigned to said at least one antenna (21) and assigned to a first and a second main band, respectively;
- each of said first and second diplexers (27, 13) including ports (27b, 27c, 13b, 13c) assigned to subbands of said first and second main bands, respectively,

characterised in that

said at least said first diplexer (27) comprises

a band filter (28) separating said first and second main bands.

2. Device as claimed in claim 1, wherein said band filter is a dual band filter.

3. Device as claimed in claims 1 or 2, wherein one of said first and second main bands is a GSM 900 band and the other one of said first and second main bands is a GSM 1800 band.

4. Device as claimed in one of claims 1 through 3, wherein said band filter comprises a band pass filter.

5. Device as claimed in one of claims 1 through 3, wherein said band filter comprises a low pass filter.

6. Device as claimed in one of claims 1 through 3, wherein said band filter comprises a high pass filter.

7. Device as claimed in claim 1, wherein said first diplexer is assigned to the transmission/reception subbands of the GSM 1800 main band and said band filter is a dual band filter comprising a band pass filter (38) passing through frequencies of the transmission and reception subbands of the GSM 900 main band.

8. Device as claimed in claim 1, wherein said first diplexer is assigned to the transmission/reception subbands of the GSM 1800 main band and said band filter is a dual band filter comprising a low pass filter (48) passing through frequencies of the transmission and reception subbands of the GSM 900 main band.

9. Device as claimed in claim 1, wherein said first diplexer is assigned to the transmission/reception subbands of the GSM 900 main band and said band filter is a dual band filter comprising a high pass filter (58) passing through frequencies of the transmission and reception subbands of the GSM 1800 main band.

Fig.1

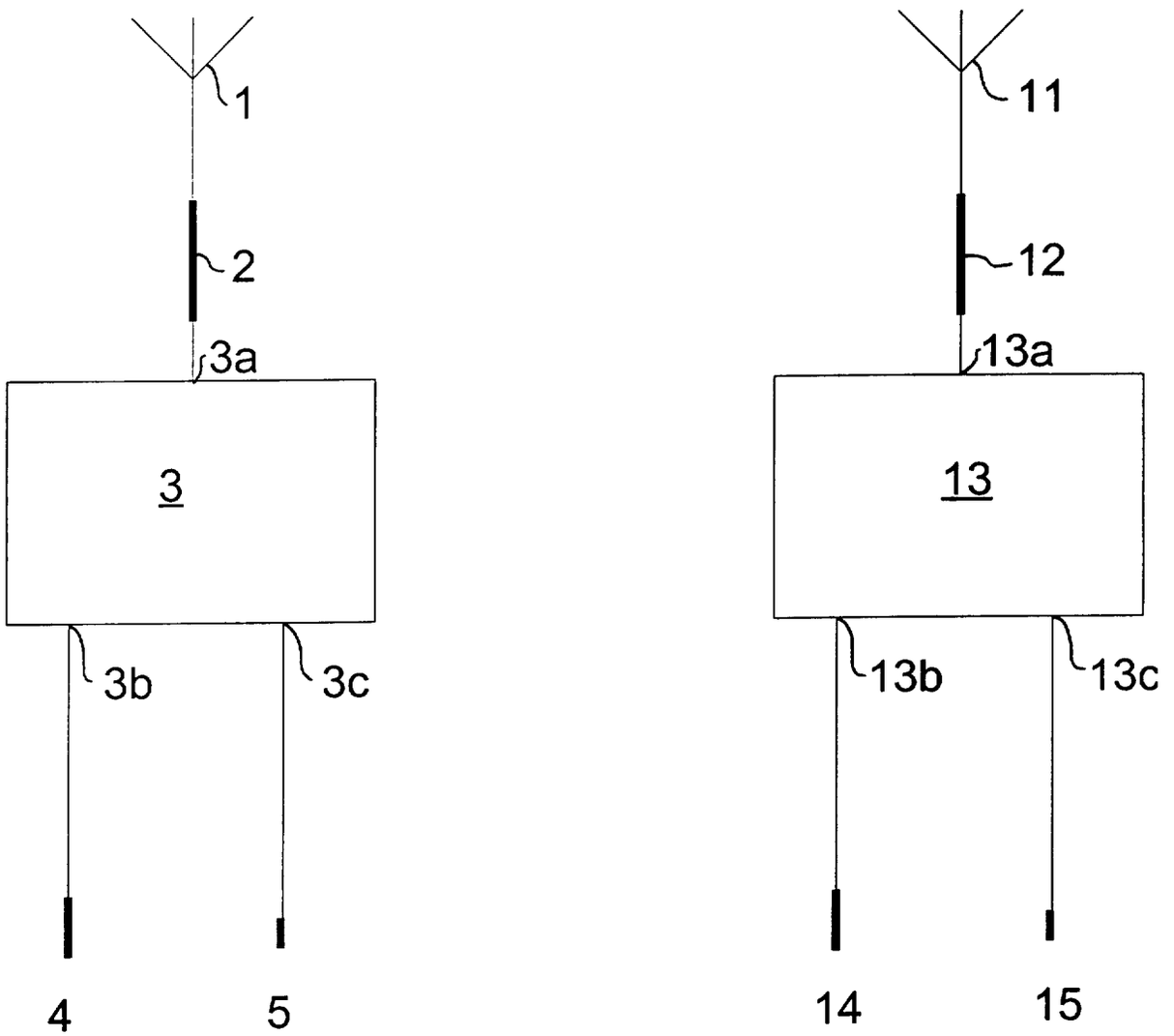


Fig.2

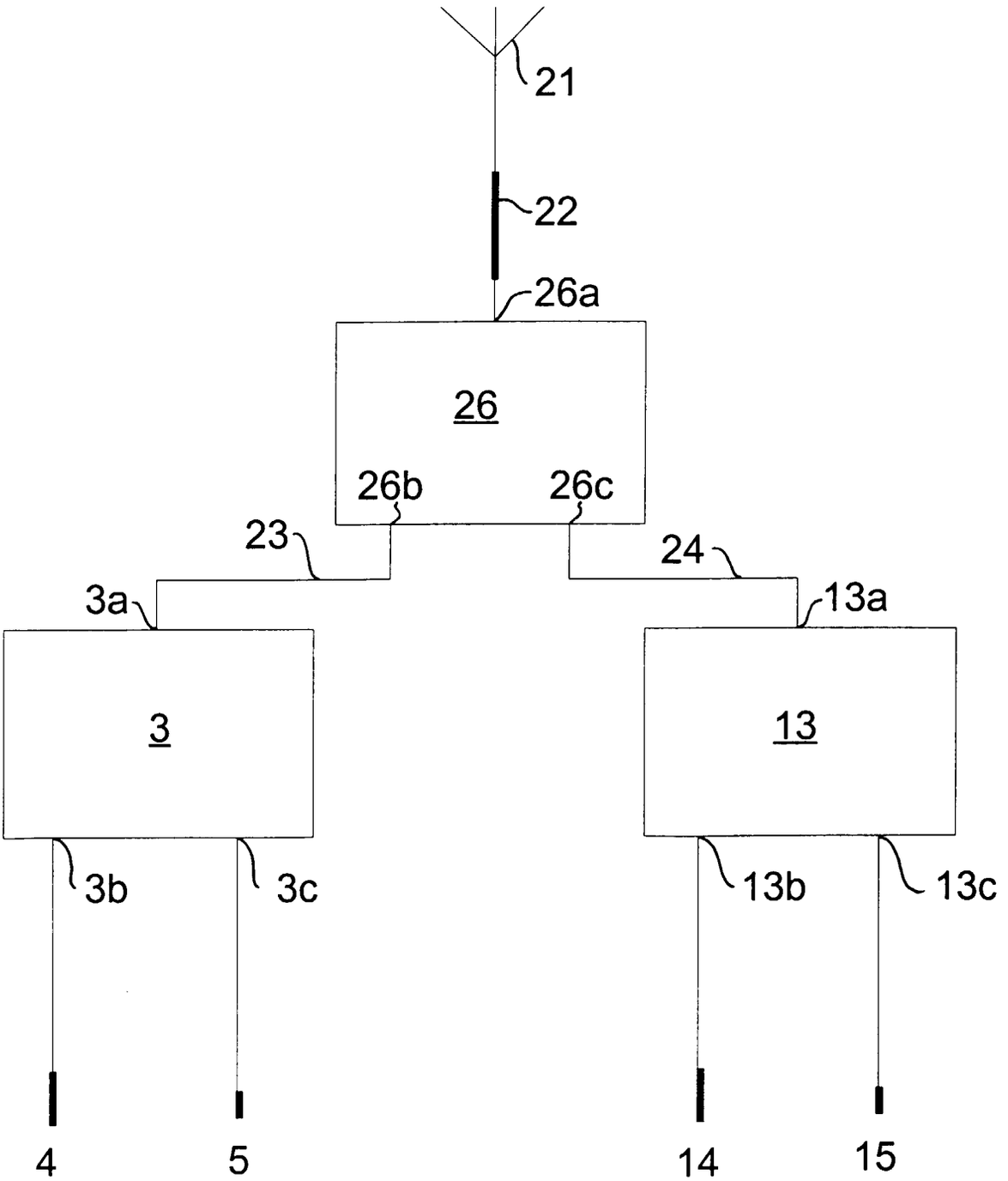


Fig.3

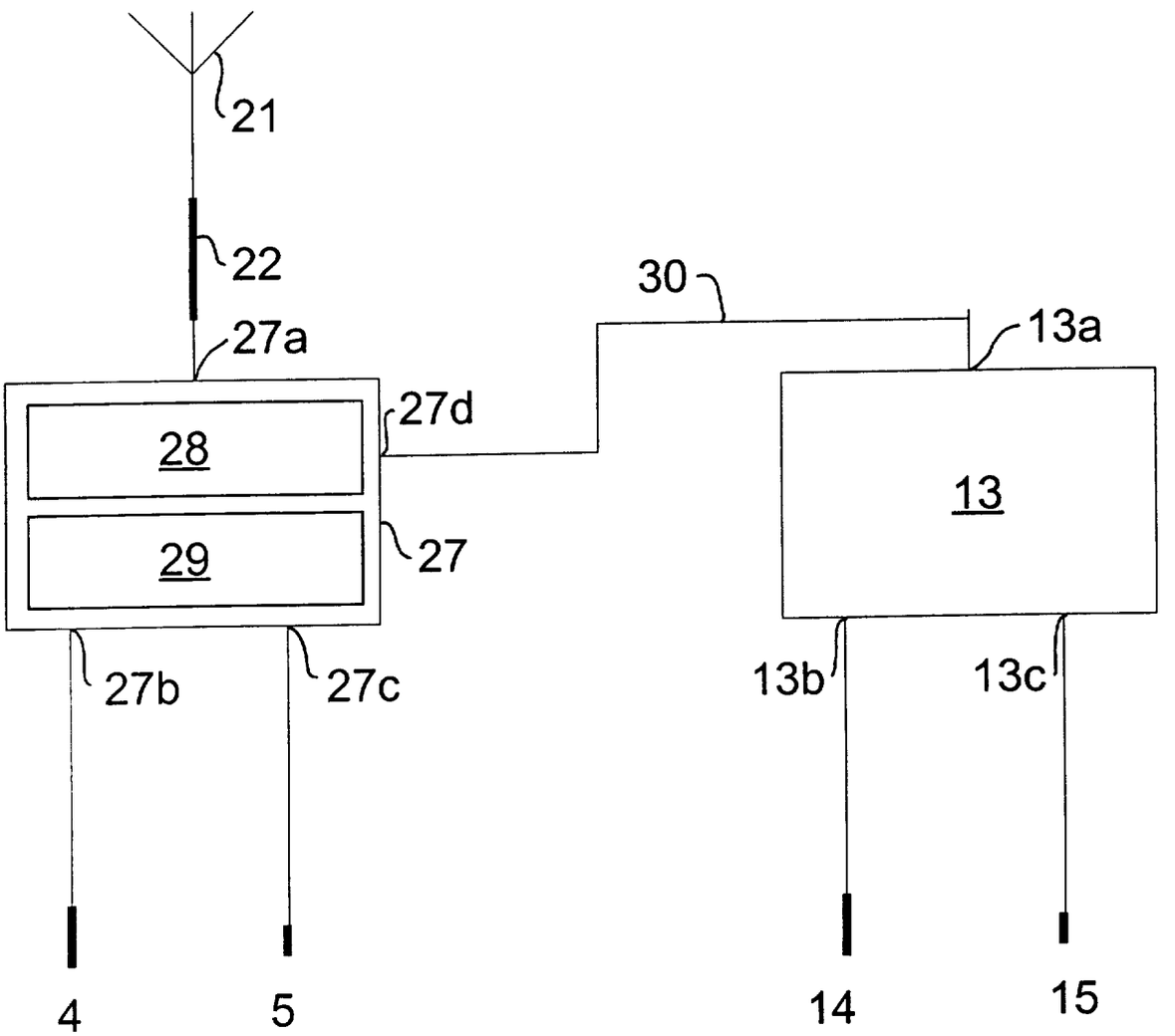
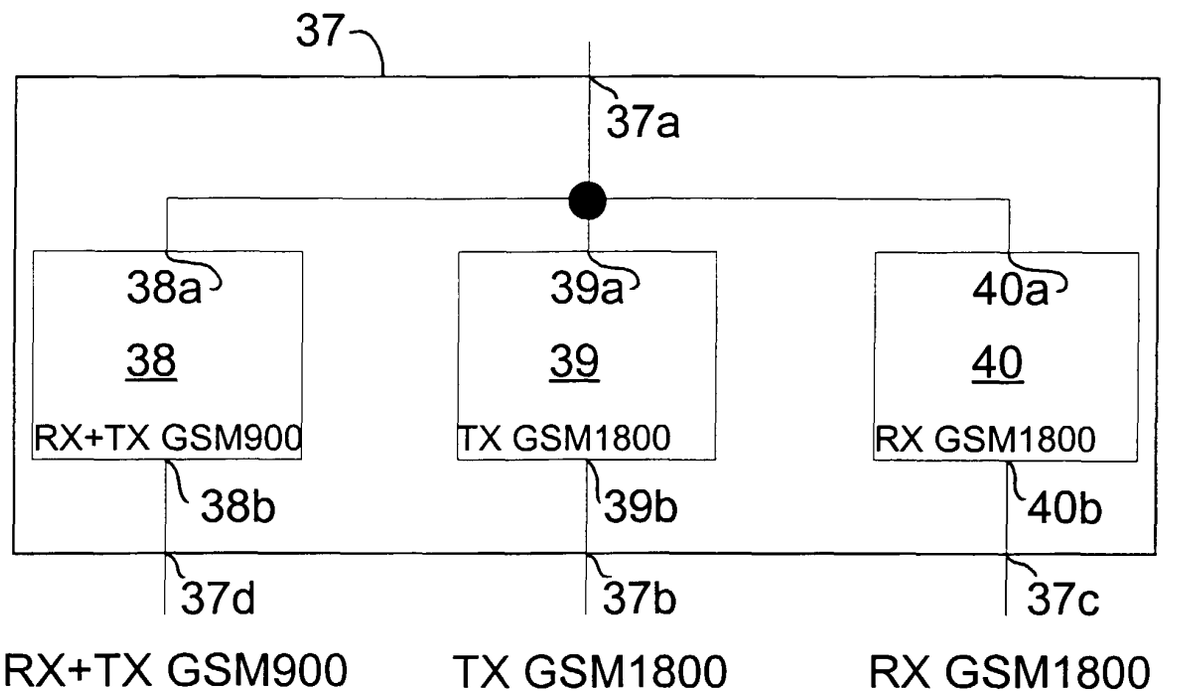


Fig.4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RX GSM1800

Fig.5

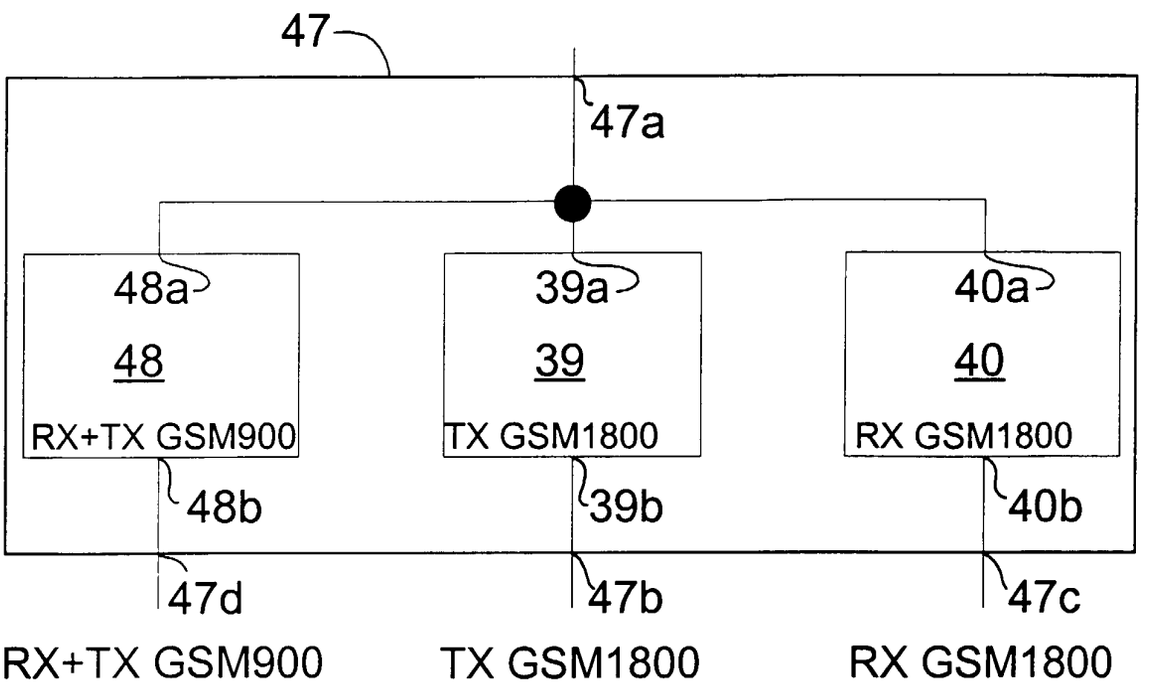
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Fig.6

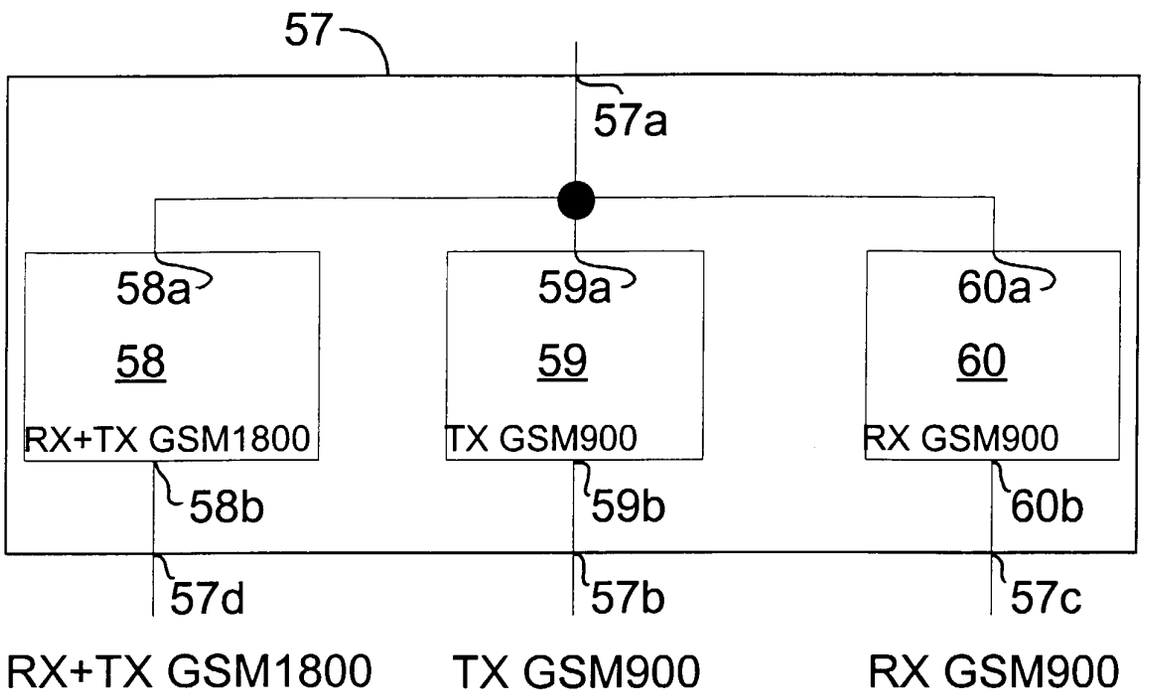
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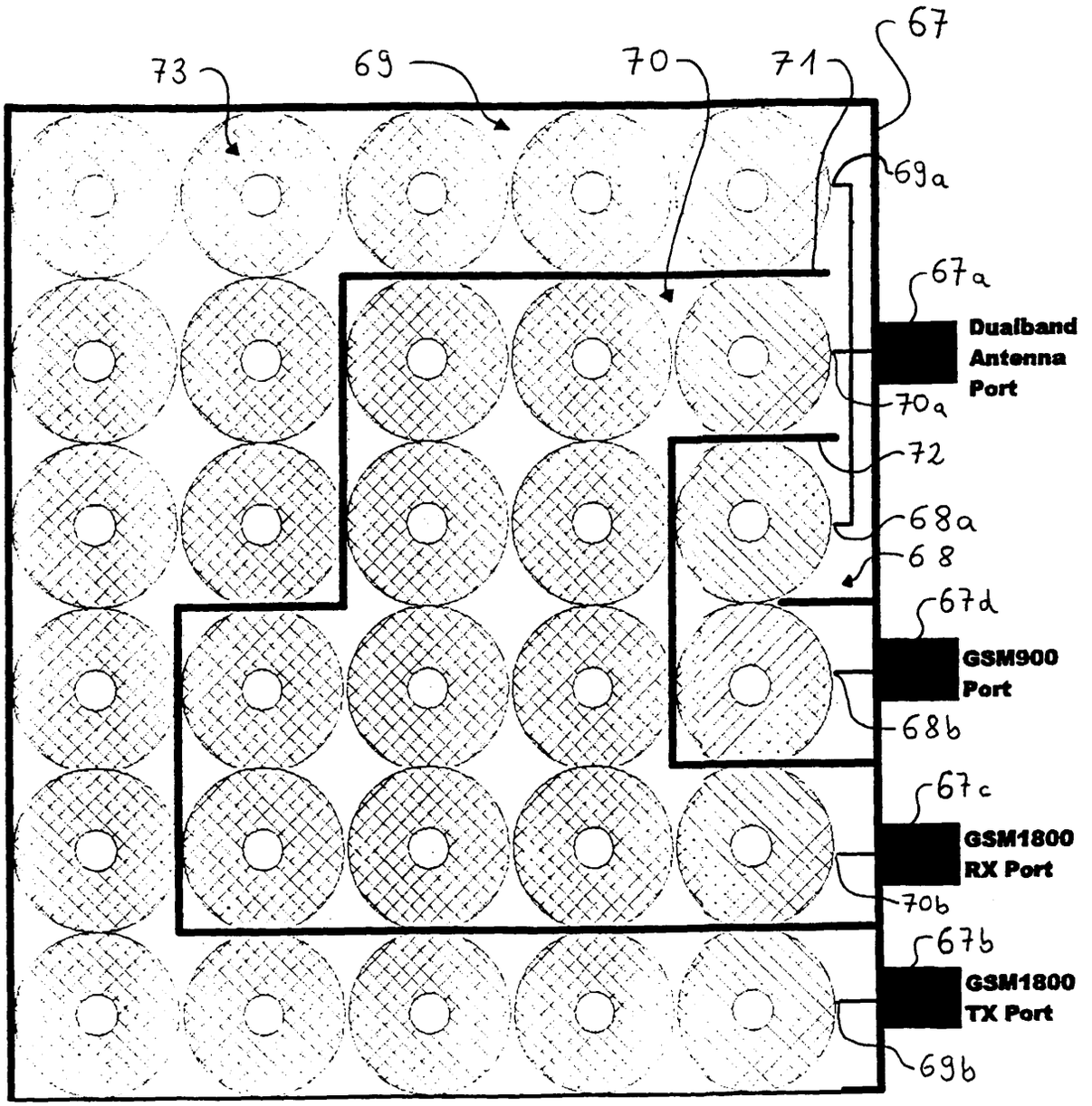
Fig. 7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GSM1800
TX Port
69b

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# EUROPEAN SEARCH REPORT

Application Number
EP 99 30 6448

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.7) |
|---|---|---|---|
| X | EP 0 829 915 A (LK-PRODUCTS OY) 18 March 1998 (1998-03-18) * page 6, line 15 - page 7, line 48 * * page 8, line 35 - line 40; figures 5,6 * | 1-4,9 | H01P1/213 |
| A | EP 0 878 917 A (NOKIA MOBILE PHONES LTD.) 18 November 1998 (1998-11-18) * column 4, line 53 - column 5, line 57; figure 3 * | 1 | |
| A | EP 0 823 751 A (NOKIA MOBILE PHONES LTD.) 11 February 1998 (1998-02-11) * column 6, line 4 - line 38; figure 5 * | 1 | |

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

H01P
H04Q
H04B

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 12 January 2000 | Den Otter, A |

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## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 99 30 6448

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12-01-2000

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