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NOTICE OF ENTITLEMENT

TELEFONAKTIEBOLAGET L M ERICSSON of, S-126 25 Stockholm, Sweden being the applicant in respect of Application No. 25835/95 states the following:-

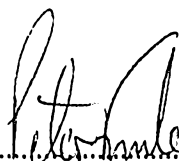
The Person nominated for the grant of the patent has entitlement from the actual inventor by assignment.

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

TELEFONAKTIEBOLAGET L M ERICSSON

By our Patent Attorneys,

WATERMARK PATENT & TRADEMARK ATTORNEYS



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Registered Patent Attorney

.....
2 October 1997



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- (56) Prior Art Documents
US 5210541
US 5132694
EP 432647
- (57) Claim

1. An antenna for a base station in a mobile radio communication system with at least one base station and at least one mobile station, comprising:

a microstrip antenna array comprising a matrix of microstrip patches with at least two columns and two rows;

a plurality of power amplifiers, wherein at least one power amplifier is connected to each column of said microstrip patches; and

beamforming means connected to each power amplifier for establishing a direction and a shape of each of a plurality of narrow antenna beams emitted by said columns of microstrip patches, wherein at least one of said narrow antenna beams has two orthogonally polarized beam components, and wherein at least one of a plurality of communication signals transmitted by said antenna is transmitted using both of said components simultaneously.

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(54) Title: MICROSTRIP ANTENNA ARRAY			
(57) Abstract			
An antenna for a base station in a mobile radio communication system with at least one base station and at least one mobile station is disclosed. The antenna comprises a microstrip antenna array with a matrix of microstrip patches with at least two columns and two rows. In addition, a plurality of amplifiers is provided wherein each power amplifier is connected to a different column of microstrip patches. Finally, beamformers are connected to each power amplifier for determining a direction and shape of narrow antenna lobes generated by the columns of microstrip patches.			

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MICROSTRIP ANTENNA ARRAY

Field of the Invention

The present invention relates to an antenna for use in a base station in a cellular communication system, and more particularly to a microstrip antenna array
5 which improves a base station's performance by increasing antenna gain and by reducing interference problems.

Background of the Invention

The cellular industry has made phenomenal strides in commercial operations in the United States as well as the rest of the world. The number of cellular users
10 in major metropolitan areas has far exceeded expectations and is outstripping system capacity. If this trend continues, the effects of the rapid growth will soon be achieved even in the smallest markets. Innovative solutions are thus required to meet these increasing capacity needs as well as to maintain high quality service and avoid raising prices. Furthermore, as the number of cellular users increases, the
15 problems associated with co-channel interference become of increased importance.

Figure 1 illustrates ten cells C1-C10 in a typical cellular mobile radio communication system. Normally, a cellular mobile radio system would be implemented with more than ten cells. However, for the purposes of simplicity, the present invention can be explained using the simplified representation illustrated in
20 Figure 1. For each cell, C1-C10, there is a base station B1-B10 with the same reference number as the corresponding cell. Figure 1 illustrates the base stations as situated in the vicinity of the cell center and having omnidirectional antennas.

Figure 1 also illustrates nine mobile stations M1-M9 which are movable within a cell and from one cell to another. In a typical cellular radio system, there
25 would normally be more than nine cellular mobile stations. In fact, there are typically many times the number of mobile stations as there are base stations. However, for the purpose of explaining the present invention, the reduced number of mobile stations is sufficient.

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Also illustrated in Figure 1 is a mobile switching center MSC. The mobile switching center MSC illustrated in Figure 1 is connected to all ten base stations B1-B10 by cables. The mobile switching center MSC is also connected by cables to a fixed switching telephone network or similar fixed network. All cables from the mobile switching center MSC to the base stations B1-B10 and cables to the fixed network are not illustrated.

In addition to the mobile switching center MSC illustrated, there may be another mobile switching center connected by cables to base stations other than those illustrated in Figure 1. Instead of cables, other means, for example, fixed radio links may also be used to connect base stations to the mobile switching center. The mobile switching center MSC, the base stations and the mobile stations are all computer controlled.

In traditional cellular mobile radio systems, as illustrated in Figure 1, each base station has an omnidirectional or directional antenna for broadcasting signals throughout the area covered by the base station. As a result, signals for particular mobile stations are broadcast throughout the entire coverage area regardless of the relative positions of the mobile stations. In the base station, the transmitter may have one power amplifier per carrier frequency. The amplified signals are combined and connected to a common antenna which has a wide azimuth beam with for example 120 or 360 degrees coverage. Due to the wide beamwidth of the common antenna, the antenna gain is low and there is no spatial selectivity which results in interference problems.

More recent techniques have focused on using linear power amplifiers which are suitable for amplifying a combined signal from several carrier frequencies which then feeds the combined signal to a common antenna which also has a wide azimuth beam. However, these systems also suffer from interference problems.

Another type of antenna that has been developed is the microstrip antenna, which is illustrated in Figure 2. Basically, the microstrip antenna consists of a conductive patch 10 formed on a dielectric substrate 12, and a ground plane 14 at a distance from the patch 10. The ground plane can be formed on the opposite side of

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the substrate 12, or the spacing between the patch and the ground plane can be completely or partially filled with air, foam, or some other dielectric material.

Using well known stripline technology, the antenna elements can be etched onto a copper-laminated board. A number of elements can then be located on the same

5 laminate. The elements are fed in series, in parallel or both by a feed network of connecting lines 16, in the same layer as the elements or in an other layer.

Frequency and impedance characteristics of the microstrip antenna are a function of the antenna size, the input feed location, and the permittivity of the substrate. In

addition, the polarization sensitivity of the antenna can be either vertical or

10 horizontal or both depending upon the layout of the conductive patches 10.

However, the use of microstrip antennas has been limited because of their inherently narrow operating bandwidth. Microstrip antenna elements have a relatively narrow bandwidth, typically 2-5 percent. Coverage of a wider frequency band can be achieved through the use of stacked elements or slot-coupled elements.

15 In an attempt to reduce the fading variations in the received signal, today's base stations use spatial diversity wherein two receiving antennas are typically separated by 20 or 30 wavelengths. However, the receiver diversity used today is less attractive with narrow beam, high gain antennas since they are more expensive and larger, giving both visual problems and mounting problems.

20 Summary of the Invention

It is an object of the present invention to improve the performance of a base station by increasing the antenna gain at the base station while reducing interference problems. It is another object of the present invention to make the technology of linear power amplifiers available for use in base stations. It is another object of the

25 present invention to provide polarization diversity in a base station that can, for example, replace space diversity arrangements.

According to one embodiment of the present invention, an antenna for a base station in a mobile radio communication system with at least one base station and at least one mobile station is disclosed. The antenna comprises a microstrip antenna

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array with a matrix of microstrip patches with at least two columns and two rows. In addition, a plurality of amplifiers is provided wherein each power amplifier is connected to a different column of microstrip patches. Finally, beamforming means are connected to each power amplifier for determining a direction and shape of narrow antenna lobes generated by the columns of microstrip patches.

According to another embodiment of the present invention, an antenna for a base station and a mobile radio communication system is disclosed. The antenna comprises a microstrip antenna array comprising a matrix of microstrip patches with at least two columns and two rows. A plurality of low noise amplifiers are used for filtering and amplifying the signals received by the microstrip antenna array, wherein each low noise amplifier is connected to a different column of microstrip patches. Beamforming means are connected to each low noise amplifier for determining a direction and shape of narrow antenna lobes generated by the columns of microstrip patches.

15 Brief Description of the Drawings

The above and further objects and novel features of the present invention will fully appear from the following description from the same as that in connection with the accompanying drawings. It is to be understood, however, that the drawings are for the purpose of illustration only, and are not intended as a definition of the limits of the present invention.

Figure 1 illustrates a portion of a cellular mobile communication system having cells, a mobile switching center, base stations, and mobile stations.

Figure 2 illustrates a microstrip antenna.

Figure 3 illustrates a microstrip antenna array according to one embodiment of the present invention.

Figure 4 illustrates another microstrip antenna array according to another embodiment of the present invention.

Figure 5 illustrates another microstrip antenna array according to another embodiment of the present invention.

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Figure 6 illustrates another microstrip antenna array according to another embodiment of the present invention.

Detailed Description of the Disclosure

The present invention is primarily intended for use in base stations in cellular communication systems. although it will be understood by those skilled in the art that the present invention can be used in other various communication applications.

According to one embodiment of the present invention, a microstrip antenna array, as illustrated in Figure 3, can be used to increase the gain of the signals from the base station while lowering interference throughout the system. The antenna array 30 consists of a matrix of microstrip patches 32 which are formed above a common ground plane 34. The elements in each column are connected either in parallel, series, or both, by connecting lines 40. While Figure 3 illustrates six columns and four rows of patches, it will be understood by one skilled in the art that the antenna array can consist of any plurality of columns and rows. Each column of patches is connected to a different power amplifier 36 in the transmit direction and a different low noise amplifier 42 in the receive direction as illustrated in Figure 4. In addition, each column of patches can also be connected to a plurality of power amplifiers in the transmit direction and a plurality of low noise amplifiers in the reverse direction. Furthermore, the columns of patches can also be connected to linear power amplifiers. The power amplifiers and the low noise amplifiers are connected to a beamforming apparatus 38 which creates antenna beams with desired shapes in desired directions. The antenna array can generate a plurality of narrow azimuth beams or lobes, where the direction and shape of the antenna beams are determined in the beamforming apparatus 38 by signal amplitude and phase relations between different columns. As a result, the base station can use the narrow beams, which have a higher gain, to broadcast and receive signals from the mobile stations in the base station's coverage area.

Another important consideration is the desire to suppress the sidelobes for each antenna beam. The beamforming can be implemented in a variety of ways

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such as digital beamforming, analog beamforming, or by a beamforming matrix, such as a Butler matrix. Analog beamformers steer the beam by introducing a frequency-independent time delay, while digital beamforming usually involves a phase delay that is equivalent to the time delay at an operating frequency.

- 5 A digital beamforming system usually has a relatively simple receiver for each element, which down-converts the frequency into I and Q (in-phase and quadrature) channels for an A/D converter. Real-time beamforming takes place by multiplying these complex pairs of samples by appropriate weights in multiply/accumulate integrated circuits. The array output is formed from

$$\text{Array output} = \sum_{n=0}^{N-1} V_n W_n e^{-j2\pi n(d/\lambda) \sin\theta} C_n$$

- 10 where

V_n = complex signal from n^{th} channel,

W_n = weighting coefficient,

$e^{-j2\pi n(d/\lambda) \sin\theta}$ = steering phaseshift, and

C_n = correction factor

- 15 Corrections may be necessary for several reasons. These reasons include errors in the position of the element, temperature effects and the difference in behavior between those elements embedded in the array and those near the edge.

- Thus, by shaping and directing the narrow antenna beams, a plurality of narrow beams can be used to simultaneously cover a large sector using the same antenna array. The present invention can use an adaptive algorithm for selecting the most feasible weight functions for the antenna. One such adaptive algorithm is disclosed in U.S. Patent Application No. 5,566,201 filed February 10, 1994 which is incorporated herein by reference.

- 25 In the antenna array, the patches in each column are polarized. The polarization can be either vertical or horizontal, or have dual polarization with two orthogonal polarization components. The two orthogonal components can for example be vertical and horizontal or diagonal polarization components. In the



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simultaneous dual polarization, the two orthogonal polarized signals are combined separately for each column, and connected to separated channels in the radio unit. The step of combining the signals can use any of the known combining schemes, for
5 example, selection diversity, maximum ratio combining, etc. The arbitrary elliptical polarization state can then be obtained in both the transmit and receive directions. As fading variations are independent for two orthogonal polarizations, polarization diversity can be used to embrace the possibility to further suppress interferers and reduce the fading variations. This will remove the necessity to use space diversity.
10 Furthermore, due to the high antenna gain in the distributed power amplification, the present invention reduces the operate power level from each power amplifier, thus easing the requirements on the linear power amplifier technology.

The system can also have the amplifiers and the beamforming apparatus permuted as illustrated in Figures 5 and 6. The amplifiers amplify the signals in
15 the channels that correspond to specific antenna beams wherein the shape and directions of the beams are determined by the beamforming apparatus weights at that instance. The permuted system has the advantage that the independent channels do not require coherent amplifiers. In addition, fault detection of an amplifier is easy since each amplifier is associated with a specific channel. However,
20 as described above, by positioning the amplifiers between the antenna elements and the beamforming apparatus, the system loss in the beamforming apparatus is reduced, the output power levels are reduced due to the distributed power amplification and there exists the possibility for graceful degradation of system performance when amplifier faults occur.

25 It will be appreciated by those of ordinary skill in the art that the present invention can be embodied in the other specific forms without departing from the spirit or central character thereof. The presently disclosed embodiments are therefore considered in all respects to be illustrative and not restrictive. The scope of the invention is indicated by the appending claims rather than the foregoing description,
30 and all changes which come within the meaning and range of equivalents thereof are intended to be embraced therein.



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Claims:

1. An antenna for a base station in a mobile radio communication system with at least one base station and at least one mobile station, comprising:
a microstrip antenna array comprising a matrix of microstrip patches
5 with at least two columns and two rows;
a plurality of power amplifiers, wherein at least one power amplifier is connected to each column of said microstrip patches; and
beamforming means connected to each power amplifier for establishing a direction and a shape of each of a plurality of narrow antenna beams emitted by said
10 columns of microstrip patches, wherein at least one of said narrow antenna beams has two orthogonally polarized beam components, and wherein at least one of a plurality of communication signals transmitted by said antenna is transmitted using both of said components simultaneously.
- 15 2. The antenna according to claim 1, wherein signals to be emitted using orthogonally polarized beam components are given an amplitude relation and a relative phaseshift such that an emitted beam comprising said components has an arbitrary elliptical polarization state.
- 20 3. An antenna according to claim 1, wherein a first column of microstrip patches comprises patches having vertical polarization and a second column of microstrip patches comprises patches having horizontal polarization.
4. An antenna according to claim 1, wherein said microstrip patches
25 within each column are tapered for elevation pattern shape.
5. An antenna according to claim 1, wherein said beamforming is implemented through analog beamforming.
- 30 6. An antenna according to claim 1, wherein said beamforming is implemented through digital beamforming.



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7. An antenna according to claim 1, wherein said beamforming is implemented through a beamforming matrix.

8. An antenna according to claim 10, wherein said beamforming matrix is
5 a Butler matrix.

9. An antenna according to claim 1, wherein each column of said microstrip patches is connected to a plurality of power amplifiers.

10 10. An antenna for a base station in a mobile radio communication system with at least one base station and at least one mobile station, comprising:
a microstrip antenna array comprising a matrix of microstrip patches with at least two columns and two rows;
a plurality of low noise amplifiers, wherein at least one low noise
15 amplifier is connected to each column of said microstrip patches; and
beamforming means connected to each low noise amplifier for establishing a direction and a shape of each of a plurality of narrow antenna beams received by said columns of microstrip patches, wherein at least one of said narrow antenna beams has two orthogonally polarized beam components, and wherein at least
20 one of a plurality of communication signals received by said antenna is received using both of said components simultaneously.

11. An antenna according to claim 10, wherein signals received using orthogonally polarized beam components are given an amplitude relation and a
25 relative phaseshift such that a received beam comprising said components has an arbitrary elliptical polarization state.

12. An antenna according to claim 10, wherein a first column of said microstrip patches comprises patches having vertical polarization and a second column
30 of microstrip patches comprises patches having horizontal polarization.



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13. An antenna according to claim 10, wherein said microstrip patches within each column are tapered for elevation pattern shape.

14. An antenna according to claim 10, wherein said beam forming is
5 implemented through analog beamforming.

15. An antenna according to claim 10, wherein said beamforming is implemented through digital beamforming.

10 16. An antenna according to claim 10, wherein said beamforming is implemented through a beamforming matrix.

15 17. An antenna according to claim 16, wherein said beamforming matrix is a Butler matrix.

18. An antenna according to claim 10, wherein each column of microstrip patches is connected to a plurality of low noise amplifiers.

20 19. An antenna according to claim 1, wherein said antenna array is used for both transmitting and receiving signals.

20. An antenna according to claim 19, wherein said antenna array has separate columns for transmitting and receiving on a same substrate.

25 21. An antenna according to claim 10, wherein said antenna array is used for both transmitting and receiving signals.

22. An antenna according to claim 21, wherein said antenna array has separate columns for transmitting and receiving on a same substrate.

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23. An antenna for a base station in a mobile radio communication system with at least one base station and at least one mobile station, comprising:

a microstrip antenna array comprising a matrix of microstrip patches with at least two columns and two rows;

5 beamforming means connected to each column of said antenna array for establishing a direction and a shape of each of a plurality of narrow antenna beams emitted by said columns of microstrip patches, wherein at least one of said narrow antenna beams has two orthogonally polarized beam components, and wherein at least one of a plurality of communication signals transmitted by said antenna is transmitted
10 using both of said components simultaneously; and

a plurality of power amplifiers, wherein at least one power amplifier is connected to each input of said beamforming means for amplifying particular emitted antenna beams.

15 24. An antenna for a base station in a mobile radio communication system with at least one base station and at least one mobile station, comprising:

a microstrip antenna array comprising a matrix of microstrip patches with at least two columns and two rows;

beamforming means connected to each column of said antenna array
20 for establishing a direction and a shape of each of a plurality of narrow antenna beams received by said columns of microstrip patches, wherein at least one of said narrow antenna beams has two orthogonally polarized beam components, and wherein at least one of a plurality of communication signals received by said antenna is received using both of said components simultaneously; and

25 a plurality of low noise amplifiers, wherein at least one low noise amplifier is connected to each output of said beamforming means for amplifying particular received antenna beams.



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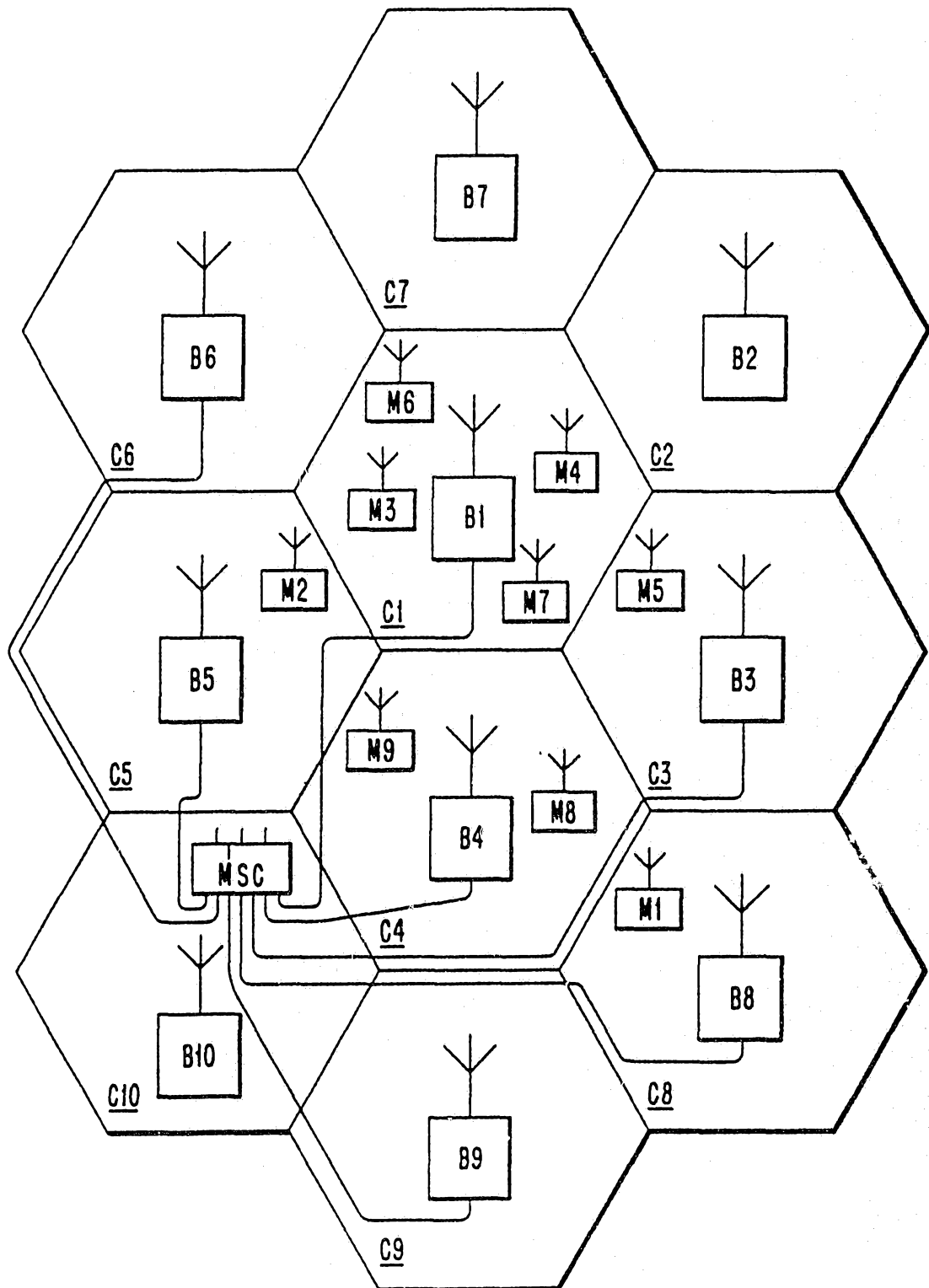
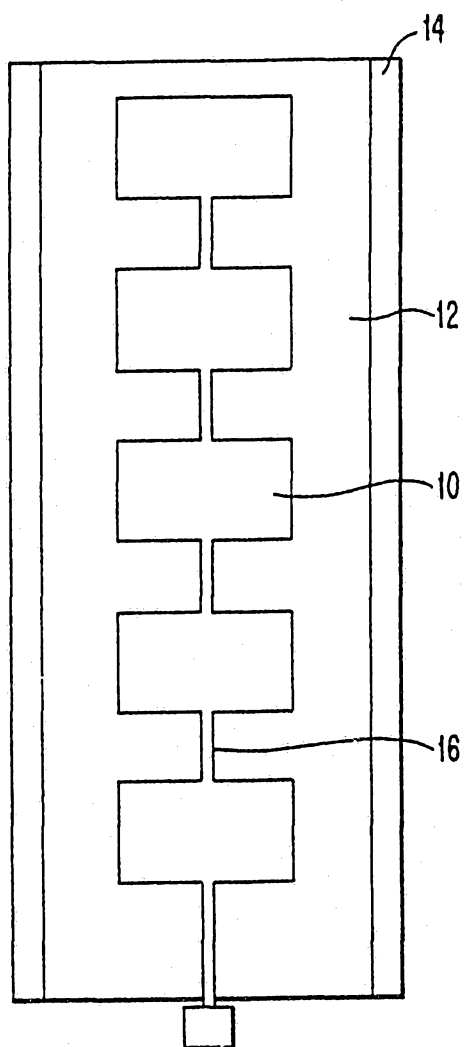
Fig. 1

Fig. 2



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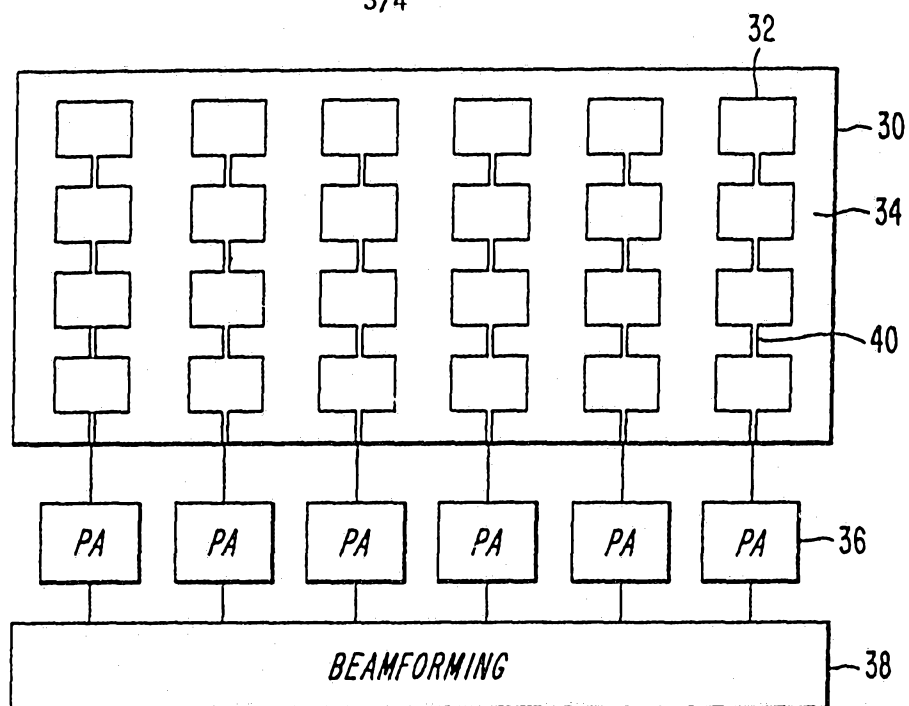


Fig. 3

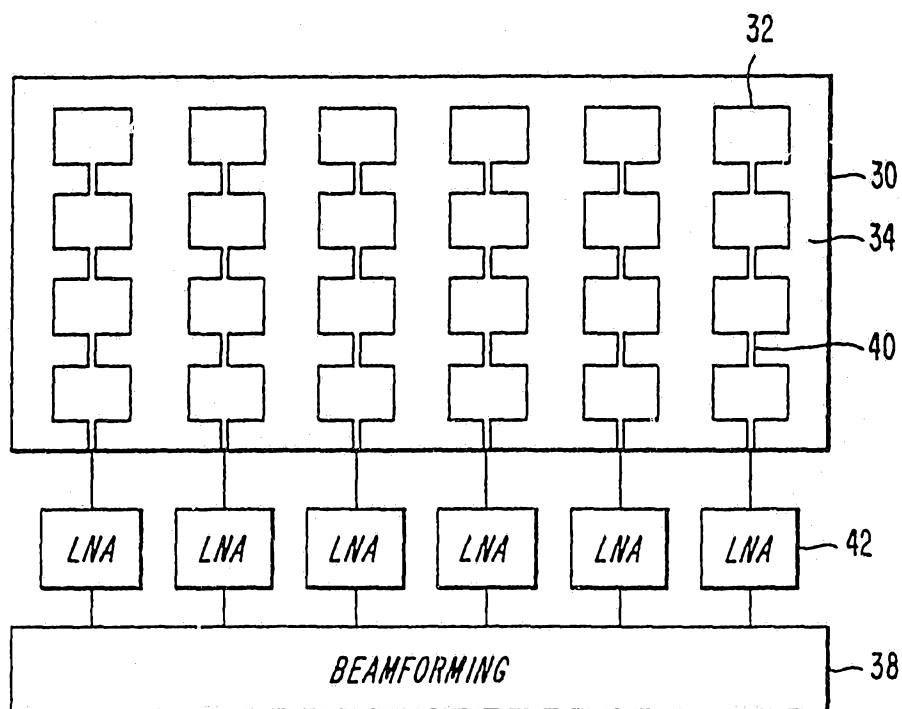


Fig. 4

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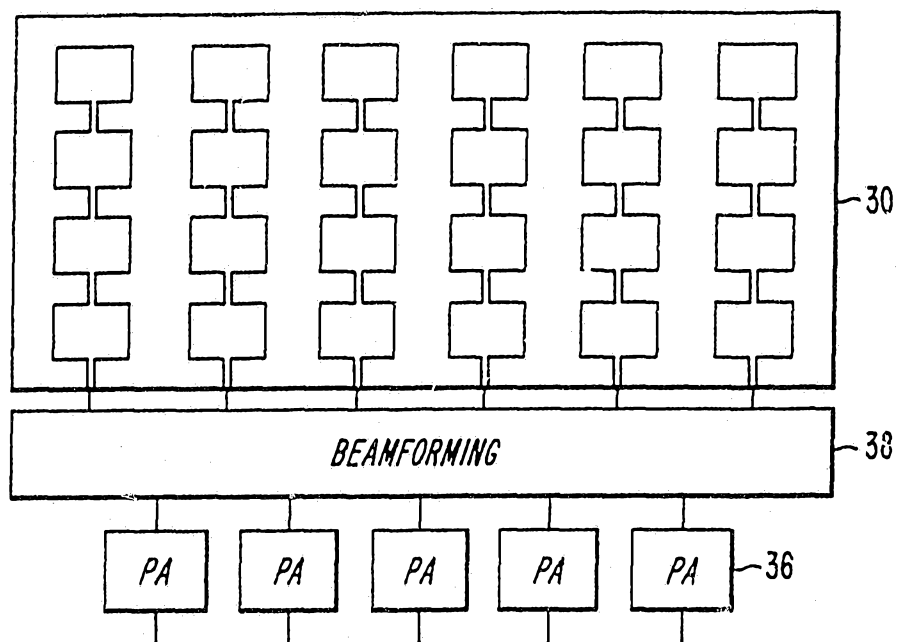


Fig. 5

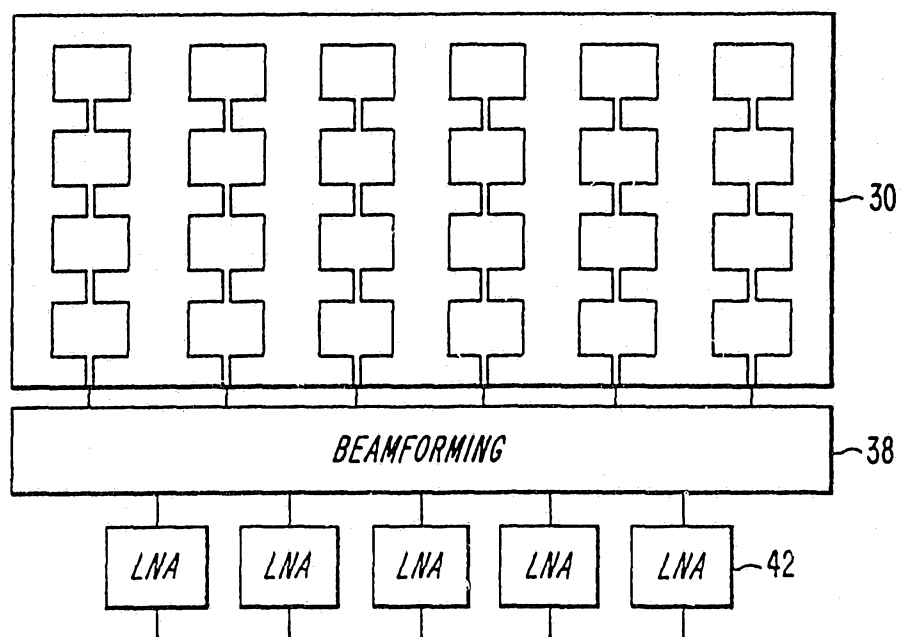


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 95/00623

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H01Q 1/38

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)

IPC6: H01Q

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

SE,DK,FI,NO classes as above

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

WPI, CLAIMS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5210541 A (PETER HALL ET AL.), 11 May 1993 (11.05.93), column 3, line 8 - column 4, line 51, figure 5, abstract	1-9;13-21;29 -30
Y	---	10-12;22-28
Y	US 5132694 A (AJAY SREENIVAS), 21 July 1992 (21.07.92), column 4, line 50 - column 5, line 49, abstract	10-12;22-28
A	EP 0432647 A3 (KABUSHIKI KAISHA TOYOTA CHUO KENKYUSHO), 19 June 1991 (19.06.91), column 15, line 40 - column 18, line 18, abstract	1-30

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Information on patent family members

02/10/95

International application No.

PCT/SE 95/00623

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 5210541	11/05/93	DE-D,T- 69014607	13/04/95
		EP-A,B- 0456680	21/11/91
		SE-T3- 0456680	
		JP-T- 4503133	04/06/92
		WO-A- 9009042	09/08/90
US-A- 5132694	21/07/92	EP-A- 0405372	02/01/91
		JP-A- 3038901	20/02/91
		US-A- 5093668	03/03/92
EP-A3- 0432647	19/06/91	AU-B- 635989	08/04/93
		AU-A- 6788490	13/06/91
		DE-D- 69020319	00/00/00
		JP-A- 3182102	08/08/91
		US-A- 5166693	24/11/92
		JP-A- 3204203	05/09/91