



(11) Publication number : **0 542 447 A1**

(12)

EUROPEAN PATENT APPLICATION

(21) Application number : **92309808.1**

(51) Int. Cl.⁵ : **H01Q 21/06**

(22) Date of filing : **27.10.92**

(30) Priority : **15.11.91 GB 9124291**

(43) Date of publication of application :
19.05.93 Bulletin 93/20

(84) Designated Contracting States :
DE FR IT SE

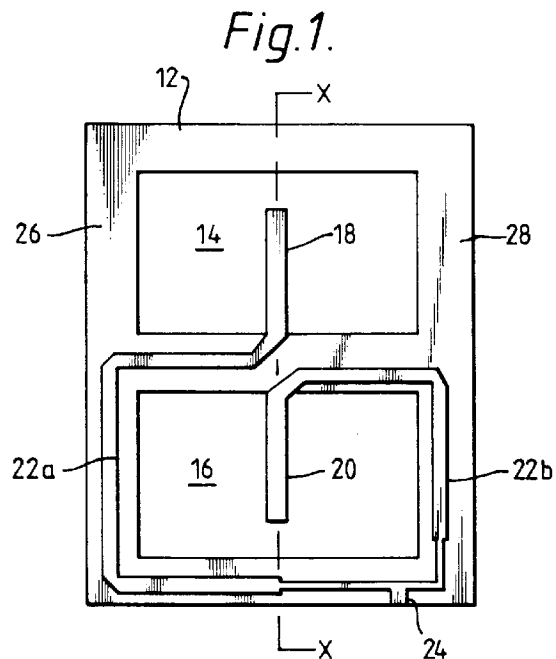
(71) Applicant : **NORTHERN TELECOM LIMITED**
World Trade Center of Montreal, 380 St.
Antoine Street West, 8th Floor
Montreal, Quebec H2Y 3Y4 (CA)

(72) Inventor : **Smith, Martin Stevens, Dr.**
8 Chuzzlewit Drive
Chelmsford, Essex CM1 4XQ (GB)
 Inventor : **Kitchener, Dean, Dr.**
15 Burwood Court, Goldlay Avenue
Chelmsford, Essex CM2 0TW (GB)

(74) Representative : **Ryan, John Peter William et al**
Northern Telecom Europe Limited Patents and
Licensing West Road
Harlow Essex CM20 2SH (GB)

(54) **Flat plate antenna.**

(57) A flat plate antenna having at least one radiating element comprising a dipole (18,20) and a distribution network (22a,22b) therefor formed as a single printed conductive pattern layer means (12,30) for preventing radiation from the distribution network, and parasitic elements (26,28) parallel with radiating element dipole(s).



This invention relates to flat plate antennas having either directional or omnidirectional field patterns in azimuth with limited elevation radiation patterns.

Conventional dipole antennas in which a pair of colinear quarter wavelength radiators are fed in anti-phase will produce a substantially omni-directional radiation pattern in a plane normal to the axis of the radiators. If the radiators are placed parallel to and quarter of a wavelength from a reflecting ground plane the radiation pattern becomes substantially directional. If several radiators are arrayed vertically the radiation pattern is substantial in azimuth and restricted in elevation. An important factor in the design of an antenna is the gain of the antenna. Provision of a reflector will increase the gain in front of the antenna while reducing the gain behind. For modern telecommunications application at high frequencies, e.g. above 100 MHz, apart from the electrical performance of the antenna other factors need to be taken into account, such as size, weight, cost and ease of construction of the antenna. Depending on the requirements an antenna can be either a single radiating element (e.g. one dipole) or an array of like radiating elements.

According to the invention there is provided a flat plate antenna having at least one radiating element comprising a dipole and a distribution network therefor formed as a single printed conductive pattern layer and means for preventing radiation from the distribution network.

According to one embodiment of the invention there is provided a flat plate antenna having at least one radiating element comprising a ground plane having a pair of identical rectangular apertures in alignment, a pair of colinear probes each projecting in opposite direction into a respective aperture to form a dipole, a feed network conductor pattern connected to and arranged to feed the probes in antiphase whereby each probe radiates through its respective aperture, wherein the dimensions of the apertures in relation to the overall dimensions of the ground plane are such that the portions of the ground plane parallel to the probes act as parasitic radiating elements, the probes are continuations of the feed network conductor pattern, the feed network conductor pattern and the probes are formed on an insulating substrate adjacent to and parallel with the ground plane and the feed network conductor pattern is positioned so as to be in alignment with unapertured portions of the ground plane in a microstrip configuration.

In a preferred embodiment of the antenna a plurality of like radiating elements are formed in alignment in a common ground plane with a common feed network conductor pattern arranged to feed all the probes having one orientation in phase and all the probes having an opposing orientation in antiphase.

In a further embodiment the antenna includes a second ground plane having the same arrangement

of apertures as the first ground plane, the feed network and probes and the two ground planes together forming a triplate structure.

The antenna may further include a reflector plane spaced from the rear of the antenna.

Embodiments of the invention will now be described with reference to the accompanying drawings, in which:-

Fig. 1 illustrates a flat plate antenna having one pair of dipoles with a feed network formed in microstrip;

Fig. 2 is a schematic side view of the antenna on the line X-X of Fig. 1;

Fig. 3 is an exploded perspective view of a triplate version of the single element antenna of Figs. 1 and 2;

Fig. 4 is an exploded perspective view of a triplate single element antenna with a back reflector;

Fig. 5 shows the measured azimuth radiation pattern for an antenna constructed in (a) microstrip and (b) triplate, both with a back reflector, and;

Fig. 6 illustrates a four element microstrip antenna array.

The flat plate antenna element shown in Figs. 1 and 2 comprises a fibre glass substrate 10 to one side of which is positioned a metallic ground plane 12 having two identical rectangular apertures 14, 16. On the opposite side of the substrate there is positioned a metallic conductor pattern which consists of two probes 18, 20 and a common feed network 22a, 22b. A feed point 24 is provided for connection to an external feed (not shown). The feed network 22a, 22b is positioned so as to form a microstrip transmission line with portions of the ground plane defining the rectangular apertures. The position of the feed point 24 is chosen so that when an r.f. signal of a given frequency is fed to the network the relative lengths of the two portions 22a and 22b of the network are such as to cause the two probes 18 and 20 to be fed in antiphase, thereby creating a dipole antenna structure. Furthermore, the dimensions of the rectangular apertures and the bounding portions of the ground plane are chosen so that the bounding portions 26, 28 parallel with the probes act as parasitic antenna radiating elements, shaping the pattern of the antenna.

Fig. 3 shows a triplate version of the antenna of Figs 1 and 2 in which a second ground plane 30 identical with ground plane 12 is placed on the other side of the substrate 10. The second ground plane is spaced from the plane of the feed network by dielectric spacing means (not shown) so that the feed network is equally spaced from both ground planes. In practice the feed network can be formed by conventional printed circuit techniques on a fibre glass board and the ground planes can be stamped out of aluminium sheets. Spacing between the network and the ground planes can be foamed dielectric sheets or by

dielectric studs interposed between the various layers. To provide a degree of directionality for the antenna a metallic back reflector 32 can be attached to the antenna as shown in Fig. 4.

An experimental single element antenna was constructed as shown in Figs. 1 and 2 using a fibre glass substrate board 10 of 1.6mm thickness on which the feed network 22a, 22b and probes 18, 20 were formed as printed circuitry. The overall antenna width was 80mm and length was 115mm. Each aperture was 40mm by 60mm. Each probe was 26.5mm long. The feed network was in general 5mm wide but parts of it were only 3mm wide to achieve suitable impedance matching. A reflector 32, 40mm wide by 115mm long, was spaced 40mm from the antenna. Fig. 5a shows the measured azimuth radiation pattern for this antenna at a frequency of 1795MHz. It will be noted that a beamwidth of approximately 120° is obtained with a peak gain of 6dBi.

A second single element triplate antenna was constructed as shown in Fig. 4 but with a modified feed network. The wide portions of the feed network were 3.5mm and the narrow portions were 2mm wide. The overall dimensions were still 80mm by 115mm and the dimensions of the apertures were again 40mm by 60mm. The back reflector of 40mm width was retained at a spacing of 40mm but the ground plane spacing was changed to 2.4mm and the effective dielectric constant for the structure was = 1. the azimuth radiation pattern at 1795 MHz is shown in Fig. 5b.

Finally a four element microstrip array was built using element apertures 40mm by 60mm as shown in Fig. 6. A modified feed network having a central feed point 40 incorporated additional lengths of printed circuit track 42 to provide the necessary phase adjustments for the individual probe feeds. All the probes having one orientation are fed in phase by the network down one side of the array and all the probes having opposite orientation are fed in antiphase by the network on the other side of the array.

The element spacing was 115mm (0.69 at 1795MHz) and a back reflector was attached as before. The array has a 3dB azimuth beamwidth of approximately 120°, a good front-to-back ratio and a low cross-polar level.

Claims

1. A flat plate antenna having at least one radiating element comprising a dipole and a distribution network therefor formed as a single printed conductive pattern layer and means for preventing radiation from the distribution network, characterised in that the antenna includes parasitic elements parallel with radiating element dipole(s).
2. A flat plate antenna according to claim 1 characterised in that said means for preventing radiation comprise a metallic layer parallel with and spaced from the conductive pattern layer, the metallic layer being shaped to screen the distribution network only.
3. A flat plate antenna according to claim 2 characterised in that the metallic layer is further shaped to form the parasitic elements.
4. A flat plate antenna having at least one radiating element characterised in that a ground plane having a pair of identical rectangular apertures in alignment, a pair of colinear probes each projecting in opposite direction into a respective aperture to form a dipole, a feed network conductor pattern connected to and arranged to feed the probes in antiphase whereby each probe radiates through its respective aperture, wherein the dimensions of the apertures in relation to the overall dimensions of the ground plane are such that the portions of the ground plane parallel to the probes act as parasitic radiating elements, the probes are continuations of the feed network conductor pattern, the feed network conductor pattern and the probes are formed on an insulating substrate adjacent to and parallel with the ground plane and the feed network conductor pattern is positioned so as to be in alignment with unapertured portions of the ground plane in a microstrip configuration.
5. A flat plate antenna according to claim 4 characterised in that a plurality of like radiating elements are formed in alignment in a common ground plane with a common feed network conductor pattern arranged to feed all the probes having one orientation in phase and all the probes having an opposing orientation in antiphase.
6. A flat plate antenna according to claim 5 characterised in that the antenna includes a second ground plane having the same arrangement of apertures as the first ground plane, the feed network and probes and the two ground planes together forming a triplate structure.
7. A flat plate antenna according to claim 4, 5 or 6 including a reflector plane spaced from the rear of the antenna.
8. A flat plate antenna according to claim 4, 5 or 6 wherein the ground plane(s) is(are) formed as a stamped aluminium sheet(s).
9. A flat plate antenna according to any one of claims 4-8 wherein the feed network and the

probes are formed as a printed circuit pattern on an insulating substrate.

- 10.** A flat plate antenna according to any one of claims 4-9 including between the feed network and the ground plane(s) foamed dielectric sheet spacer(s).

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Fig. 1.

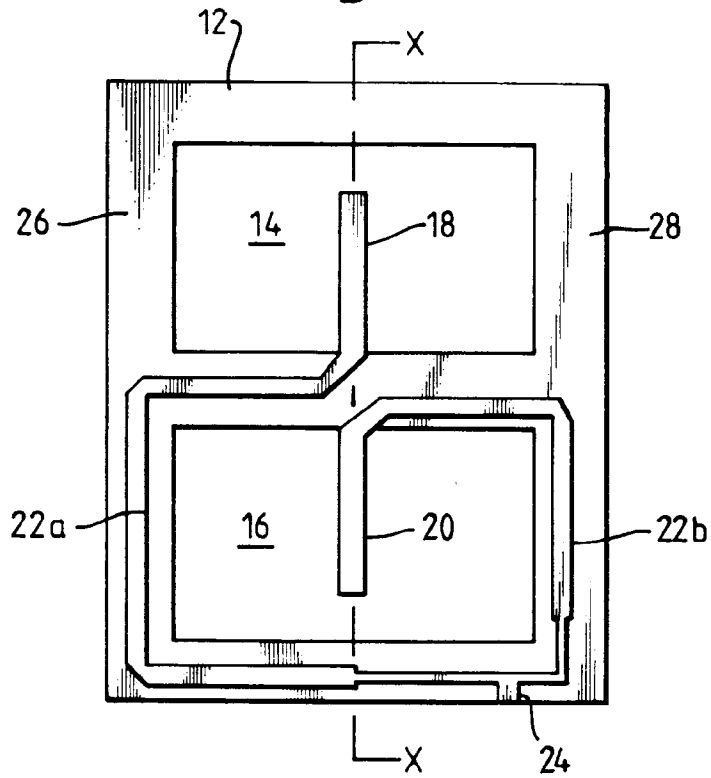


Fig. 2.

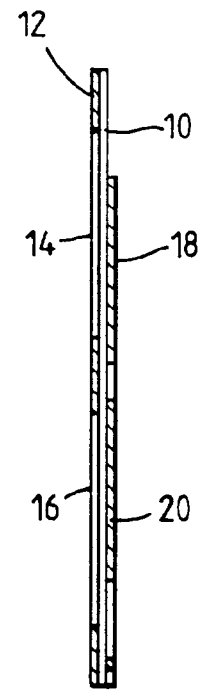


Fig. 3.

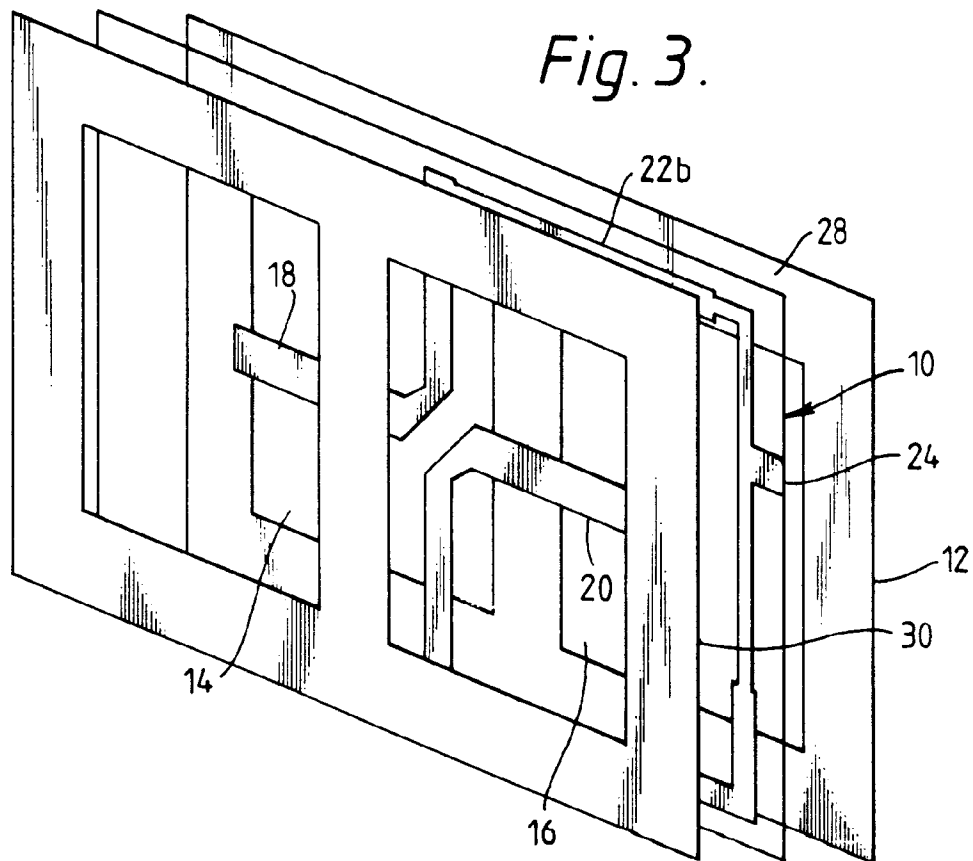


Fig. 4.

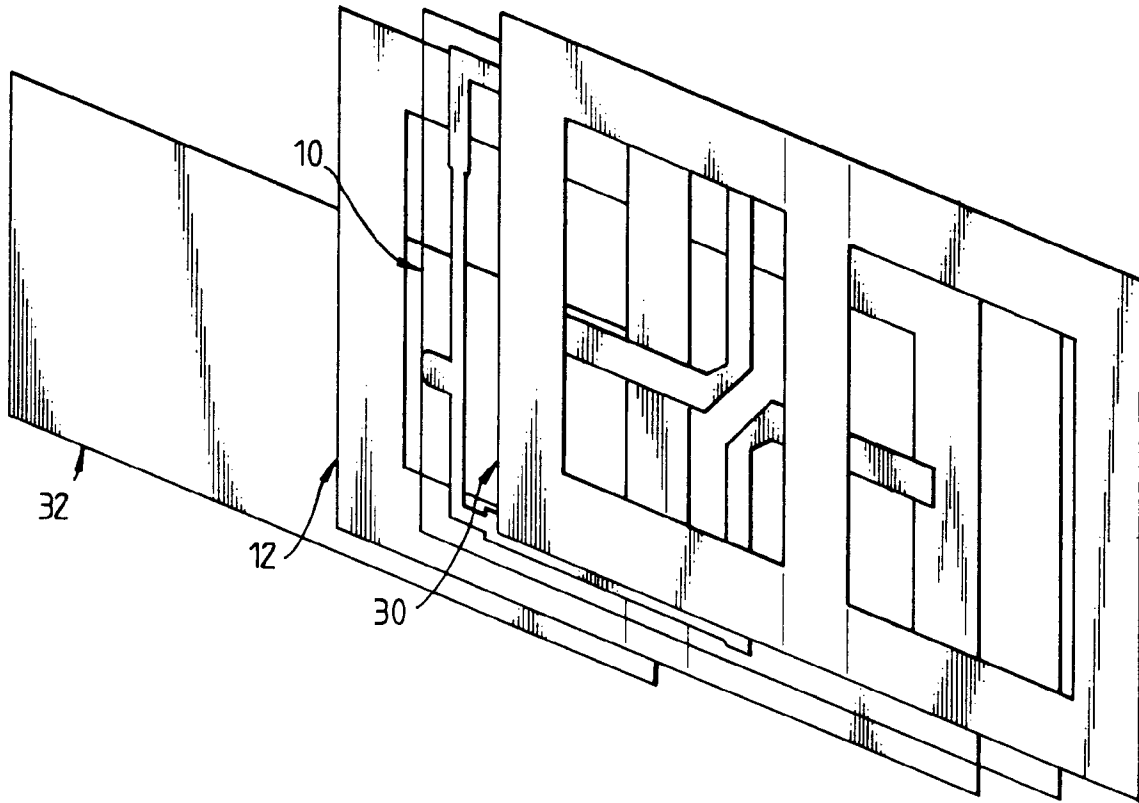


Fig. 5a.

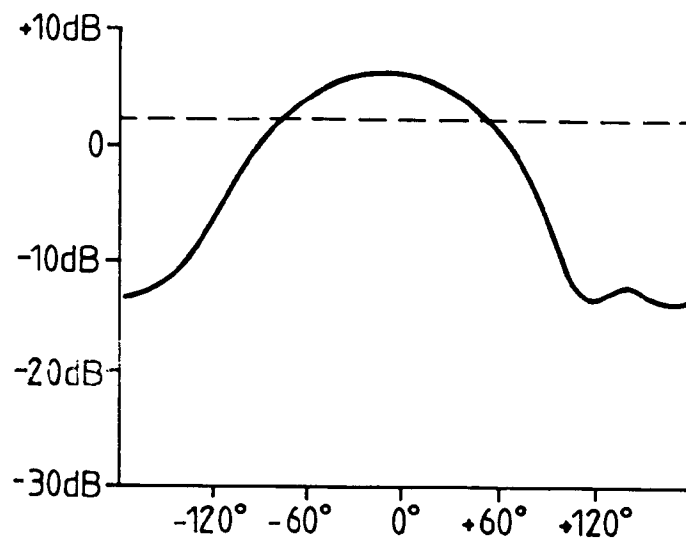


Fig. 5b.

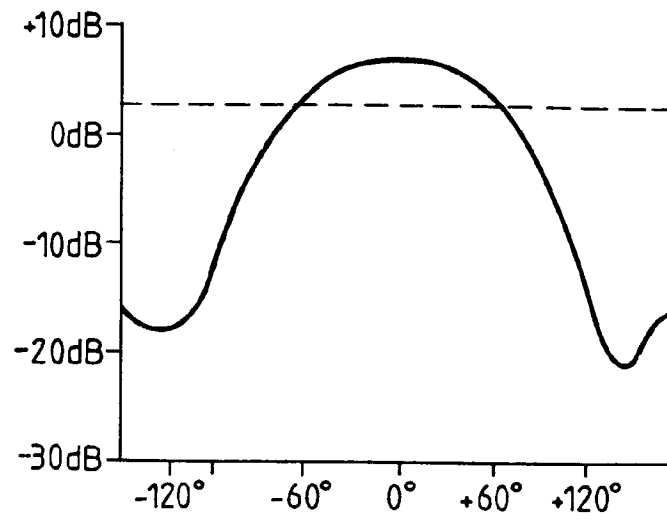
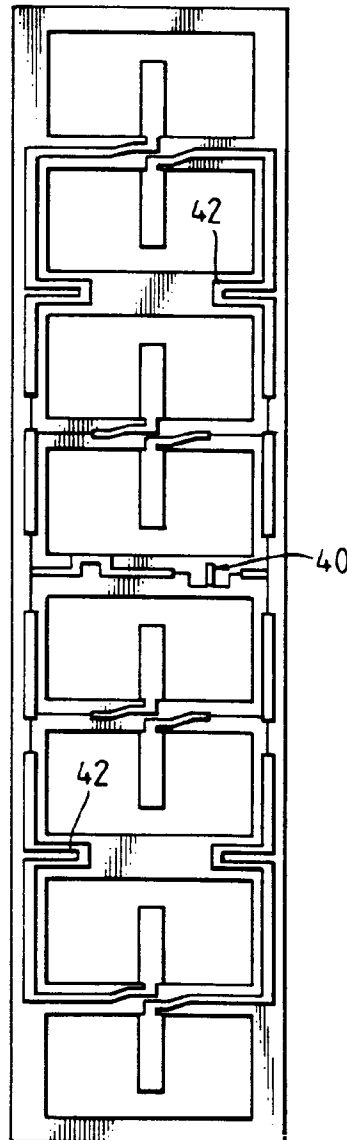


Fig. 6.





European Patent
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EUROPEAN SEARCH REPORT

Application Number

EP 92 30 9808

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.5)
A	EP-A-0 445 453 (STC PLC) * claims 1-7; figures 1,2,4,5 * ---	1-10	H01Q21/06
A	WO-A-9 112 637 (BRITISH TELECOMMUNICATIONS) * abstract; figures 1-6 * ---	1,4	
P,A	EP-A-0 463 649 (MATSUSHITA ELECTRIC) * abstract; figures 1-12 * -----	4	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H01Q
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 05 MARCH 1993	Examiner ANGRABEIT F.F.K.
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