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(54) A UHF antenna for digital video broadcasting

(57) The present invention relates to a UHF antenna for use in a digital video broadcasting terrestrial system (DVB-T system) comprising a loop antenna element (2), and a U-shaped monopole antenna element (3) coupled to the loop antenna element and arranged inside the loop antenna element (2). The loop antenna element (2) is designed for a resonance frequency of about 500 MHz, and the U-shaped monopole antenna element (3) is designed for a frequency band of about 850 MHz.

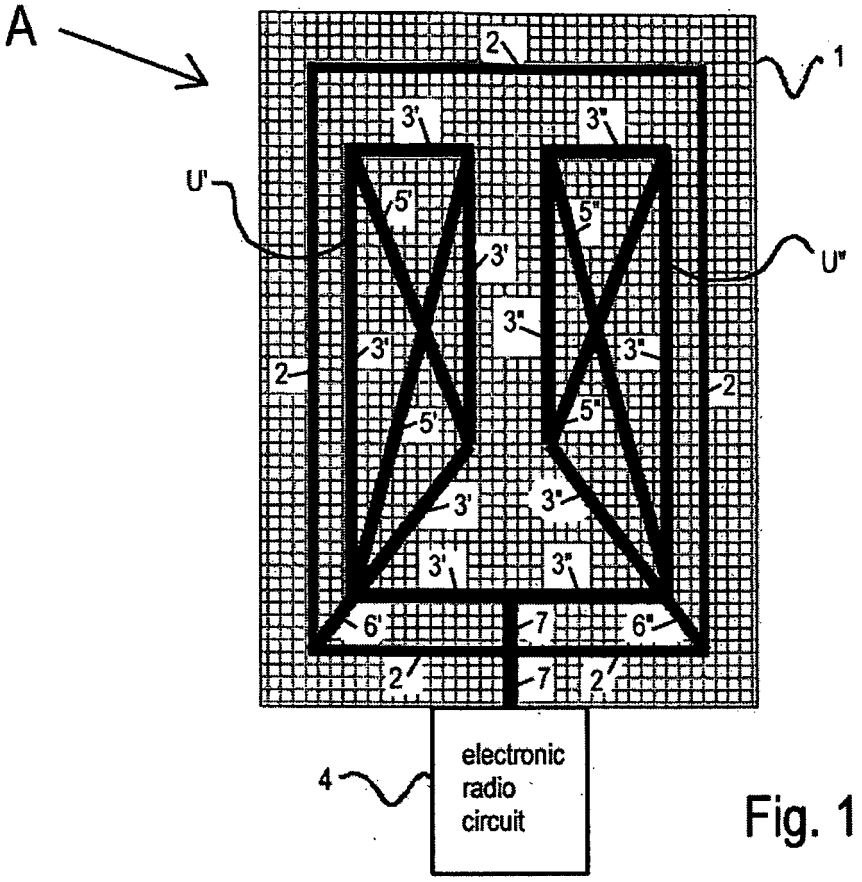

Fig. 1

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Description

[0001] The present invention relates in general to a UHF antenna which is intended to be used in digital video broadcasting terrestrial system (DVB-T system).

[0002] For use in a DVB-T system, which operates from about 450 MHz to about 850 MHz, a UHF antenna must have an operational bandwidth of about 400 MHz.

[0003] Thus, it is an object of the present invention to provide a UHF antenna for use in a DVB-T system on automobiles, which UHF antenna is adapted to have two resonance frequencies between about 450 MHz and about 850 MHz located close together to achieve the necessary bandwidth of about 400 MHz.

[0004] A further object of the present invention is to provide a UHF antenna which is adapted to generate two resonance frequencies between about 450 MHz and about 850 MHz to achieve the necessary bandwidth of 400 MHz for a VSWR (voltage standing wave ratio) of less than 2 and a reference impedance of about 50 Ohm.

[0005] It is an additional object to achieve a simple structure of the UHF antenna making it possible to manufacture the UHF antenna on a supporting material. Finally, the UHF antenna should offer a great "see-through" ability allowing the UHF antenna to be mounted on the front windshield of the car.

[0006] These and other objects are achieved by a UHF antenna for use in a DVB-T system having the features as claimed in claim 1. Preferred embodiments are defined in the dependent claims.

[0007] The UHF antenna of the invention has an antenna structure which comprises a loop antenna, and a U-shaped monopole antenna coupled to the loop antenna and arranged inside the loop antenna.

[0008] Preferably, the loop antenna is used for the lower resonance frequency of about 500 MHz, and the U-shaped monopole antenna is designed to resonate at a higher frequency band of about 850 MHz.

[0009] Further, the antenna structure is constructed to have a voltage standing wave ratio (VSWR) less than 2 with a reference impedance of about 50 Ohm.

[0010] Embodiments of the present invention will now be described in connection with the drawings, in which:

Figure 1 shows the general structure of a UHF antenna according to the invention;

Figure 2 shows a possible block diagram of the electronic radio circuit of Figure 1;

Figure 3 shows a cross sectional view of the UHF antenna of Figure 1;

Figure 4 shows a diagram of the measured voltage standing wave ratio (VSWR) of the UHF antenna of Figure 1;

Figure 5 shows a radiation pattern at 450 MHZ of the UHF antenna of Figure 1, presenting a peak gain of 2,2 dBi;

Figure 6 shows a radiation pattern at 650 MHZ of the UHF antenna of Figure 1, presenting a peak gain of 3 dBi; and

Figure 7 shows a radiation pattern at 850 MHZ of the UHF antenna of Figure 1, presenting a peak gain of 4 dBi.

[0011] The UHF antenna of the present invention is intended to be operated in the UHF range, i.e. in the frequency band between about 450 MHz and about 850 MHz, and will be used to receive digital video signals from the DVB-T system. It is preferred that the UHF antenna is printed or etched on a solid substrate material or, more preferred, is printed on a transparent plastic foil which will glue on the glass of a car with a special adhesive glue. This will give to the UHF antenna a good degree of transparency.

[0012] Further, the structure of the present UHF antenna comprises thin and narrow metal traces with large gap between them to produce a king of grid in order to have a "see through" effect.

[0013] As shown in Figure 1, a plurality of metal traces 2, 3, 5, 6 and 7 is printed or etched to a solid substrate or to a flexible transparent plastic foil element 1 (hereafter also referred as "carrier 1"). The complete antenna unit A is connected to an electronic radio circuit 4 (printed circuit board) which is shown in Figure 2 more detailed.

[0014] The solid substrate or flexible transparent plastic foil 1 can be any supporting material, which will be able to support the antenna elements 2, 3, 5 and 6. The kind of material will depend on the degree of transparency and the degree of flexibility needed as well as the material properties etc.

[0015] A possible material for the carrier 1 is a dielectric substrate, such as FR4, which (although not transparent) can provide a cheap manufacturing solution and good mechanical stability with good material properties.

[0016] On the other hand, if transparency is an issue, then the carrier 1 must be made out of a very thin transparent plastic foil, such as PET plastic or ABS. Due to its small thickness, the carrier foil is flexible with a high degree of transparency, and the antenna elements 2, 3, 5, 6 and 7 can be easily and cheaply printed or etched on the carrier foil 1. This is a very good solution if the antenna is to be used for an automobile where it will be glued on the front windshield of the car.

[0017] Figure 3 shows a cross sectional view of the complete antenna A, including the supporting carrier material 1 and a layer of glue 13 provided on the bottom surface of the carrier 1. The metal traces 2, 3, 5, 6, 7 are provided on the top surface of the carrier 1.

[0018] As mentioned above, for a system such as a DVB-T system, which operates from about 450 MHz to about 850 MHz, the UHF antenna must have an opera-

tional bandwidth of about 400 MHz. Further, a VSWR (voltage standing wave ratio) of less than 2 and a reference impedance of 50 Ohm are desired, which is accomplished by the presence of a small ground plane such as the small electronic circuit 4 (see Figures 1 and 4).

[0019] The UHF antenna of the present invention is adapted to generate two resonance frequencies between about 450 MHz and about 850 MHz close together to achieve the necessary bandwidth of about 400 MHz for VSWR (voltage standing wave ratio) of less than 2, which is accomplished by using two main antenna elements 2, 3.

[0020] The first main element 2 is a rectangular loop antenna, which goes all around the structure near the circumference of the carrier 1. However, variations of the rectangular shape of the loop antenna are possible, for example, the loop antenna element 2 can also have a circular or polygonal shape. The loop antenna element 2 is used for the lower resonance frequency of about 500 MHz, and consists of four main metal traces, denoted as elements 2 in Figure 1, to form the rectangular shape of the loop antenna element 2. As already mentioned, the metal traces 2 may have a different shape to form, for example, a rectangle having rounded corners, an oval, a circle or a polygon.

[0021] The second main element 3 is a U-shaped monopole antenna, which is a simple monopole in a U-shape having two main parts U' and U", for size reduction purposes, as shown in Figure 1. This U-shaped monopole antenna element 3 is arranged inside the loop antenna element 2 and designed to resonate at a higher frequency band of about 850 MHz. Each of the U-shaped monopole antenna element main parts U', U" comprises a loop-shaped portion formed by a plurality of metal traces 3', 3". A preferred shape of the loop-shaped potions is shown in Figure 1, however, variations are possible (circular or polygonal).

[0022] As further shown in Figure 1, additional elements, i.e. metal traces 5' and 5", are provided to connect the corners of both loop-shaped monopole antenna element main parts U' and U" in order to increase the bandwidth of the higher resonance frequency and thus the bandwidth of the overall antenna A.

[0023] Additionally, elements (metal traces) 6' and 6" are strategically arranged to connect the U-shaped monopole antenna element main parts U' and U" with the loop antenna element 2 to achieve a better impedance matching and bandwidth optimization.

[0024] Finally, the loop antenna element 2 and the U-shaped monopole antenna element 3 are connected by means of the feed line element (metal trace) 7, which in turn connects the complete antenna system A to the electronic circuit 4.

[0025] The electronic circuit 4 comprises various electronic parts to improve the reception of the signals, as shown in Figure 2. The electronic radio circuit 4 will provide the necessary filtering by passing through the signals of interest and rejecting the rest, by using a notch filter or band-pass filter 8. Thereafter, these filtered signals will be amplified by using a low noise amplifier (LNA) 9. The DC power for this amplifier 9 is provided from a bias-T element 10 which will pass-in the DC to the circuit and pass out the RF signals received. Finally, the signals will be guided through the coaxial cable 11 to the DVB-T receiver/tuner box 12 (see Figure 2).

[0026] In the following, the details of a possible block diagram of the electronic circuit 4 are described. First, a notch filter 8 operating as a band-stop filter for the GSM (group special mobile) frequency band of about 900 MHz is connected to the feed line element 7 of the antenna. The GSM signals are very close to the upper frequency limit of about 850 MHz, and these GSM signals will be received from the antenna A itself. Thus, these signals have to be reject by use of the notch or band-stop filter 8 since they are not of interest. Furthermore, element 8 can be also a band-pass filter 8, which will pass through only the DVB-T signals and reject the rest.

[0027] Further, a low noise amplifier (LNA) 9 is connected to element 8. The LNA 9 amplifies the incoming signals from element 8 by introducing a very low noise itself and so compressing the overall noise of the complete receiving system. Thus, the reception more error-free.

[0028] Element 10 is a bias-T, which is connected to the LNA 9 and which passes in direct current (DC) power to power up the active components, such as the LNA 9, and passes out the RF signals received.

[0029] Element 11 is a low loss coaxial cable with 50 Ohm reference impedance which is used to connect the active antenna (i.e. antenna A and elements 8, 9, 10) to the DVB-T tuner box 12. The DVB-T tuner box 12 demodulates the digital signals and extrapolates the analog information, such as audio and analog video.

[0030] Figure 4 shows the measured VSWR of the UHF antenna of this invention. In the depicted frequency range from 450 MHz to 950 MHz, the measured VSWR is less than 2.

[0031] Figures 5, 6 and 7 show radiation patterns at 450 MHz, 650 MHz, and 850 MHz, respectively. These figures also show the peak gain values of 2,2 dBi, 3 dBi, and 4 dBi, respectively.

[0032] Although at the moment DVB-T on automobiles is quite new, the UHF antenna of the present invention has several advantages:

First, the simple structure of the UHF antenna makes it possible to manufacture the UHF antenna on a supporting material.

Second, the UHF antenna offers a great "see-through" ability, since it is designed from thin narrow metal traces, spaced apart and not from a solid metal block or sheet.

Third, it has a great bandwidth performance of more than 400 MHz by using only a very small ground

plane (Element 4).

[0033] Although the antenna of the present invention is small and has a compact size, its radiation characteristic and peak gain values are kept to a good level.

Claims

1. UHF antenna for use in a digital video broadcasting terrestrial system (DVB-T system) comprising a loop antenna element (2), and a U-shaped monopole antenna element (3) coupled to the loop antenna element and arranged inside the loop antenna element (2).

2. UHF antenna according to claim 1, **characterized in that** UHF antenna is printed or etched on the top surface of a solid substrate material (1) or a dielectric substrate, such as FR4.

3. UHF antenna according to claim 1, **characterized in that** UHF antenna is printed on the top surface of a transparent plastic foil (1).

4. UHF antenna according to claim 2 or 3, **characterized in that** the bottom surface of the solid substrate material or the transparent plastic foil (1) is provided with an adhesive (13) for being attached on the glass surface of a car.

5. UHF antenna according to any of the claims 1 to 4, **characterized in that** the loop antenna element (2) and the U-shaped monopole antenna element (3) being formed by a plurality of thin and narrow metal traces 2, 3', 3", 5', 5", 6', 6" and 7 with large gaps therebetween.

6. UHF antenna according to any of the claims 1 to 5, **characterized in that** the loop antenna element (2) has a rectangular shape, the U-shaped monopole antenna element (3) is a monopole in a U-shape having two main parts (U', U") arranged inside the loop antenna element (2)

7. UHF antenna according to claim 6, **characterized in that** the each of the U-shaped monopole antenna element main parts (U', U") comprises a loop-shaped portion formed by a plurality of metal traces (3', 3").

8. UHF antenna according to claim 7, **characterized in that** additional metal traces (5', 5") are provided to connect corner sections of each of the loop-shaped monopole antenna element main parts (U', U").

9. UHF antenna according to any of the claims 6 to 9, **characterized in that** additional metal traces (6', 6") are arranged to connect the U-shaped monopole antenna elements (U', U") with the loop antenna element 2.

10. UHF antenna according to any of the claims 1 to 9, **characterized in that** the loop antenna element (2) and the U-shaped monopole antenna element (3) are connected by means of a feed line metal trace (7), which in turn connects the complete antenna system A to an electronic circuit (4).

11. UHF antenna according to any of the claims 1 to 10, **characterized in that** the loop antenna element (2) is designed for a resonance frequency of about 500 MHz, and the U-shaped monopole antenna element (3) is designed for a frequency band of about 850 MHz.

12. UHF antenna according to any of the claims 1 to 11, **characterized in that** the UHF antenna is constructed to have a voltage standing wave ratio (VSWR) less than 2 with a reference impedance of about 50 Ohm.

13. UHF antenna according to any of the preceding claims, **characterized in that** the UHF antenna is couple to an electronic circuit (4) comprises a notch filter or band-pass filter (8), a low noise amplifier (9), and a bias-T element (10) which is connected via a coaxial cable (11) to a DVB-T receiver/tuner box (12).

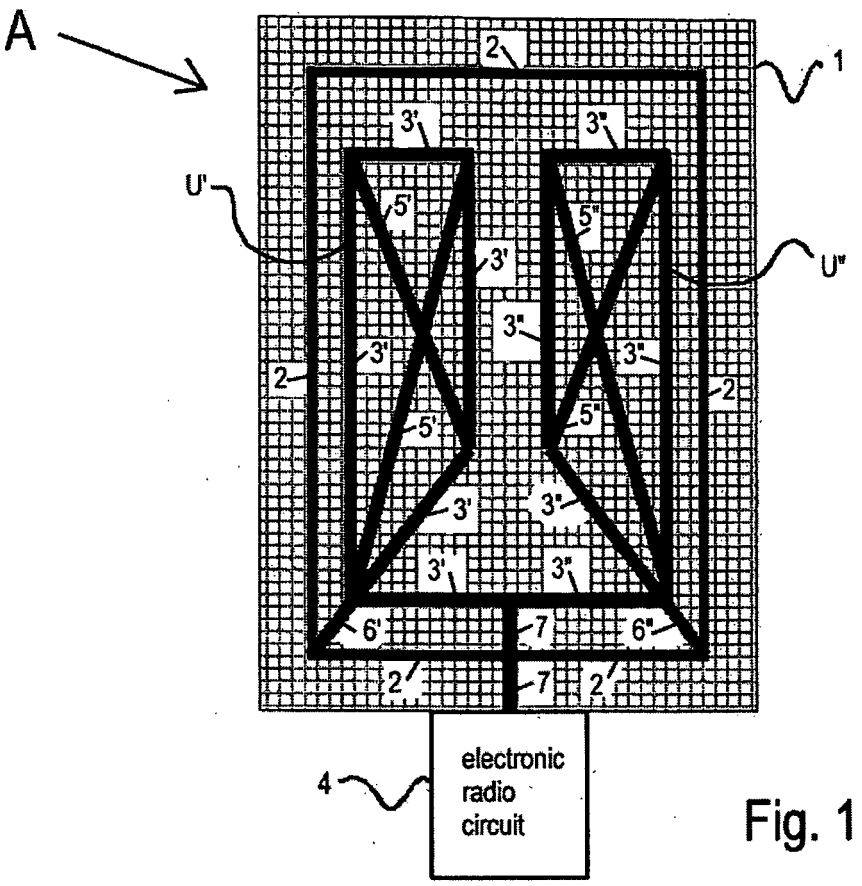
A
2
1
3'
3"
U'
5'
5"
3'
U"
3"
3'
3'
2
2
5'
5"
3'
3"
3'
3"
6'
7
6"
2
7
2
4
electronic
radio
circuit

Fig. 1

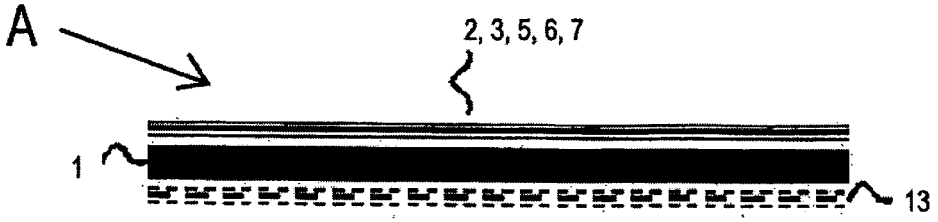
A
2, 3, 5, 6, 7
1
13

Fig. 3

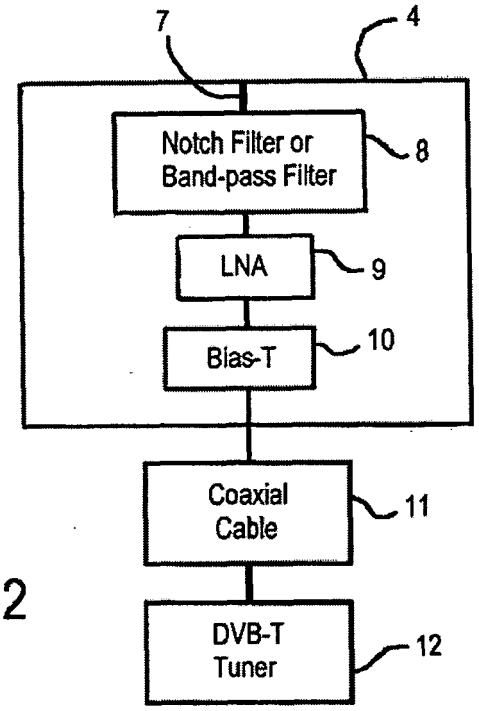
7
4
Notch Filter or Band-pass Filter
8
LNA
9
Bias-T
10
Coaxial Cable
11
DVB-T Tuner
12

Fig. 2

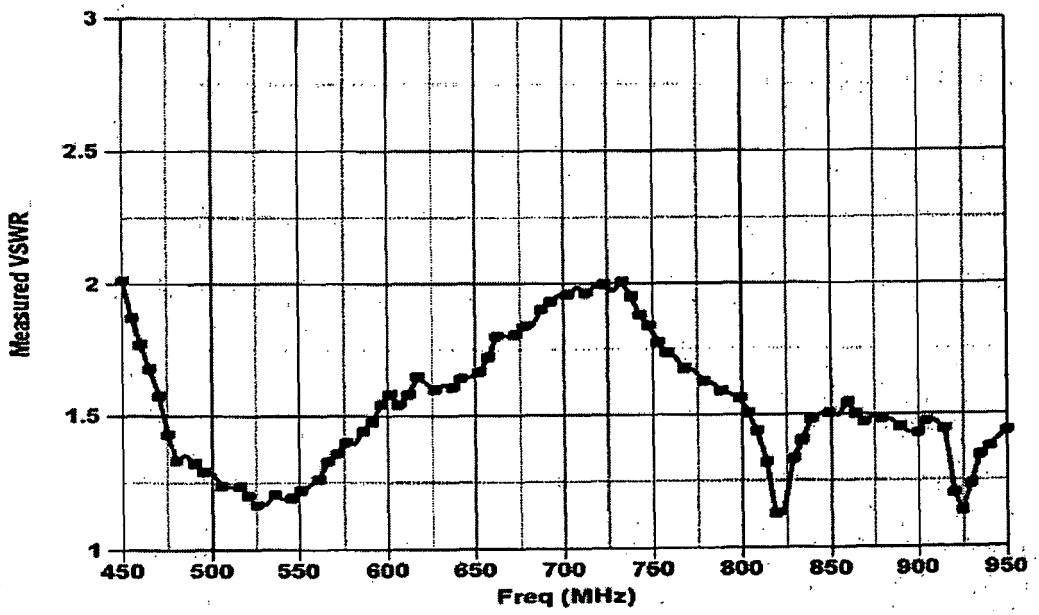
Measured VSWR
3
2.5
2
1.5
1
450
500
550
600
650
700
750
800
850
900
950
Freq (MHz)

Fig. 4

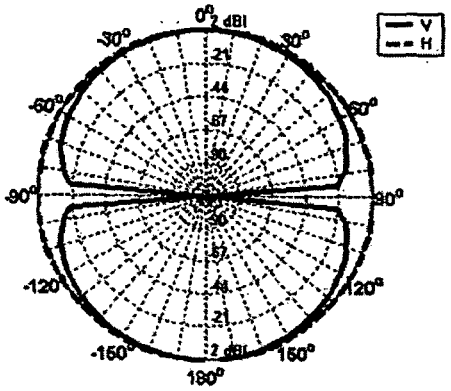

Fig. 5

Radiation Pattern at 450 MHz, Peak Gain 2.2 dBi

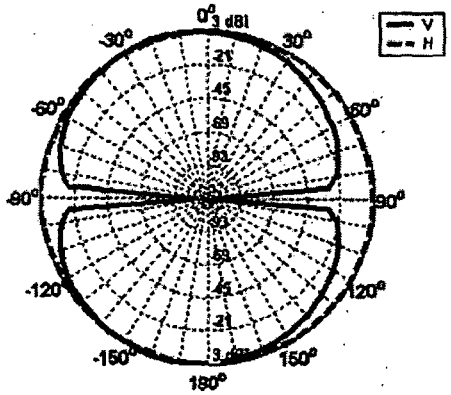

Fig. 6

Radiation Pattern at 650 MHz, Peak Gain 3 dBi

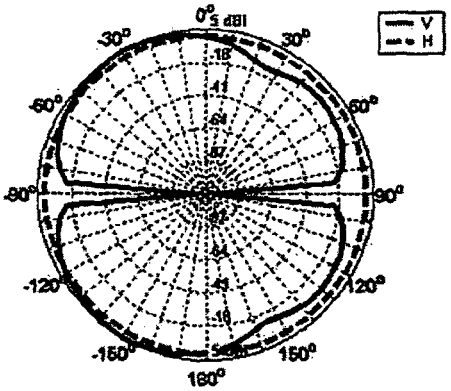

Fig. 7

Radiation Pattern at 850 MHz, Peak Gain 4 dBi

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EUROPEAN SEARCH REPORT

Application Number
EP 05 01 2530

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)
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A	GB 1 561 742 A (SOC ITALIANA VETRO SIV SPA) 27 February 1980 (1980-02-27) * page 2, line 89 - page 3, line 24; figures 1,2 *	1	
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A	EP 1 450 438 A (NIPPON ANTENA KABUSHIKI KAISHA) 25 August 2004 (2004-08-25) * abstract *	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7) H01Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	7 July 2005	La Casta Muñoa, S

CATEGORY OF CITED DOCUMENTS

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07-07-2005

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