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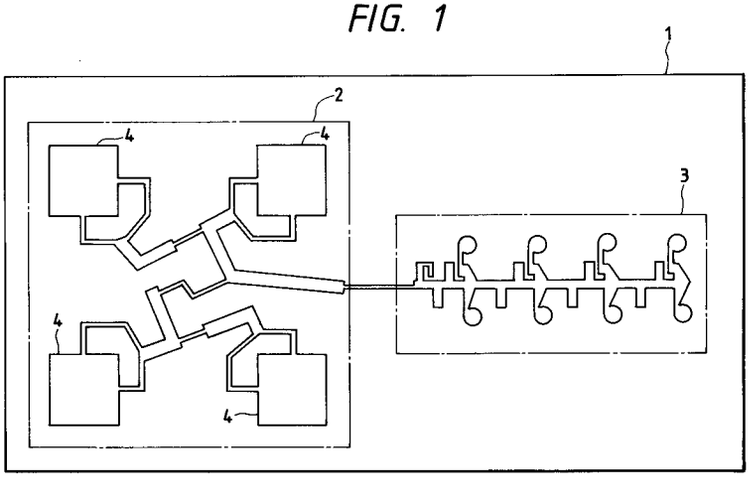
(54) Receiver device.

(57) A receiver device for receiving a microwave, having an antenna (2) and a receiving circuit (3), in which a plane antenna comprising at least one antenna element (4), and a receiving circuit connected to the plane antenna are formed on one and the same semi-insulating compound semiconductor substrate. Therefore, the antenna and the signal receiving circuit can be connected with a microstrip line, and the resultant receiver device is reduced both in size and in wight. Furthermore, the plane antenna, the receiving circuit, and the microstrip line can be integrated by ordinary IC manufacturing process.

FIG. 1



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BACKGROUND OF THE INVENTION

This invention relates to a plane antenna for receiving microwave signals from communications satellites or broadcasting satellites.

While information network systems are being developed rapidly, there has been a sharp rise in demand for use of satellite communication systems, and in the communications systems, there is a tendency to use higher frequency bands. A Schottky barrier type field-effect transistor (MESFET) using a compound semiconductor such as GaAs has been put in practical use as a high frequency field-effect transistor. Furthermore, there have been demands for minimization, reduction in manufacturing cost, and improvement in performance of the system. In order to meet those demands, intensive research has been made on employment of microwave monolithic integrated circuits (MMIC) for a down converter initial stage amplifier section for converting high frequency signals into low frequency signals.

On the other hand, a plane antenna is being put in practical use as an antenna for receiving microwave signals from communication satellites or broadcasting satellites. The plane antenna is made up of a number of antenna elements which are arranged in a plane, and conductors to combine signal powers received by those antenna elements. A microwave receiving plane antenna was much inferior to a parabolic antenna both in performance and cost; however, it is now sufficiently practical in use owing to the research on a microstrip antenna which has been made since the latter half of 1970, and to improvement of a microwave printed circuit board.

However, it cannot be said that research on a method of connecting a receiving system in the form of an MMIC to a plane antenna has been made sufficiently. For instance, there is available a method in which ordinary means for transmitting microwaves, namely, a waveguide is employed for connection of them. However, the method is disadvantageous in the following points: That is, when the method is employed, it is difficult to reduce the size and weight of the signal receiver; that is, minimization of the signal receiving system and planation of the receiving antenna are not sufficiently effected.

SUMMARY OF THE INVENTION

Accordingly, an object of this invention is to eliminate the above-described difficulties accompanying a conventional signal receiver.

The foregoing object of the invention has been achieved by the provision of a signal receiver in which a plane antenna comprising at least one antenna element, and a receiving circuit connected to the plane antenna are formed on one and the same semi-insulating compound semiconductor substrate.

In the signal receiver of the invention, the plane antenna and the receiving circuit 3 are formed on one and the same semi-insulating compound semiconductor substrate. Therefore, the antenna and the receiving circuit can be connected with the microstrip line, and the resultant signal receiver is reduced both in size and in weight. Furthermore, the plane antenna, the receiving circuit, and the microstrip line can be integrated by ordinary IC manufacturing process.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view showing the arrangement of an example of a signal receiver which constitutes a first embodiment of this invention.

FIG. 2 is a plan view showing the arrangement of another example of the signal receiver, which constitutes a second embodiment of the invention.

FIG. 3 is a plan view showing the arrangement of another example of the signal receiver, which constitutes a third embodiment of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

FIG. 1 is a plan view showing a first embodiment of this invention. As shown in FIG. 1, a plane antenna section 2 and a receiving circuit section 3 are provided on a semi-insulating compound semiconductor substrate (a GaAs substrate in this case) on the surface of which a semiconductor layer has been formed by epitaxial growth. Those sections 2 and 3 are electrically connected to each other. The plane antenna section 2 is made up of four antenna elements 4. Each of the antenna elements 4 is a conventional microstrip patch antenna of two-point feed type. The feeders of the four antenna elements 4 are commonly connected to the receiving circuit section 3. The receiving circuit section 3 is a low-noise amplifier which is formed by integrating MESFETs which are formed by using the epitaxial growth semiconductor layer on the semiconductor substrate. That is, a plurality of antennas and a receiving circuit are formed on one and the same substrate. Hence, the resultant signal receiver is small in size and light in weight, and can therefore be handled with ease.

In the above-described embodiment, the receiving circuit section 3 is the low-noise amplifier as was described above. However, in addition to the low-noise amplifier, a frequency converter circuit for down-converting the frequency of the output signal thereof, and a circuit for amplifying the

output signal of the frequency converter circuit may be integrated on the substrate. In the case where it is required to mount the receiver device of the invention on a moving object such as an automobile, it is desirable to add to the receiving circuit section 3 means for electronically tracking a communications satellite or broadcasting satellite to receive microwave signals therefrom, namely, a phase shifter circuit for shifting the phase of a microwave signal received. Furthermore, in the embodiment, the patch antenna are employed as the antenna elements 4; however, they may be replaced with other printed antennas such as line antennas and spiral antennas.

FIG. 2 is a plan view showing a second embodiment of the invention. The second embodiment has more antenna elements 4 than the above-described first embodiment. That is, the number of antenna elements 4 can be increased as much as permitted by the area of the substrate.

FIG. 3 is a plan view showing a third embodiment of the invention. In the third embodiment, a plurality of antenna element arrays 11 (four antenna element arrays in this case) are arranged on a semiconductor substrate 10. Each of the antenna element arrays 11 comprises four antenna elements 4. The antenna element arrays 11 are connected to low-noise amplifiers 12, respectively. The output terminals of the low-noise amplifiers 12 are commonly connected to a microstrip line 13. In general, one of the causes which make it difficult to increase the efficiency of a plane antenna is a large loss in its feeder system. However, in the embodiment the low-noise amplifiers 12 are provided for the antenna element arrays 11, respectively, and therefore the noise factor is greatly improved.

In the embodiment, all the antenna element arrays 11, and all the low-noise amplifiers 12 are monolithically integrated on one semi-insulating compound semiconductor substrate 10. However, a signal receiver equivalent in arrangement to the above-described one may be formed by hybrid integration as follows: One antenna element array 11 and one low-noise amplifier 12 are monolithically formed on one semi-insulating compound semiconductor substrate, to form a signal receiver unit. A plurality of the signal receivers units thus formed are mounted on a substrate such as a foamed polyethylene substrate which is suitable for a plane antenna and low in dielectric constant and small in tan δ, and the output terminals of the low-noise amplifiers 12 are commonly connected to a microstrip line.

The above-described embodiments are the receiver devices for directly receiving microwave signals from communications satellites or the like; however, each of those signal receivers may be used as a primary horn for a parabolic antenna.

As was described above, in the signal receiver according to the invention, the plane antennas and the receiver circuits are formed on one and the same semi-insulating compound semiconductor substrate, and therefore they can be connected with the microstrip lines. Therefore, the resultant signal receiver is smaller both in weight and in size. Furthermore, since the plane antennas, the receiving circuits, and the microstrip lines can be integrated by ordinary IC manufacturing process, the receiver device of the invention is considerably low in manufacturing cost.

Claims

1. A receiver device for receiving microwave signals from satellites, comprising:

a plane antenna comprising at least one antenna element, formed on a semi-insulating compound semiconductor substrate; and

a receiving circuit connected to said plane antenna, also formed on said semi-insulating compound semiconductor substrate.

2. A receiver device as claimed in claim 1, wherein said receiving circuit includes a low-noise amplifier circuit for amplifying a signal received by said plane antenna.

3. A receiver device as claimed in claim 2, wherein said receiving circuit further includes a frequency converter circuit for down-converting the frequency of an output signal provided by said low-noise amplifier.

4. A receiver device as claimed in claim 3, wherein said receiving circuit further includes a circuit for amplifying an output signal provided by said frequency converter circuit.

5. A receiver device as claimed in claim 1, wherein said receiving circuit includes a phase shifter circuit for shifting a phase of a microwave signal received in order to track said satellite.

6. A receiver device for receiving microwave signals from satellites, comprising:

a plurality of antenna element arrays each comprising at least two antenna elements; and

a plurality of low-noise amplifiers connected to said plurality of antenna element arrays, respectively,

said plurality of antenna element arrays and said plurality of low-noise amplifiers being formed on one and the same semi-insulating compound semiconductor substrate,

said plurality of low noise amplifiers having

output terminals which are commonly connected to a microstrip line.

7. A receiver device for receiving microwave signals from satellites, comprising:

a plurality of semi-insulating compound semiconductor substrates on each of which an antenna element array comprising at least two antenna elements, and a low-noise amplifier connected to said antenna element array are formed, said semi-insulating compound semiconductor substrates being arranged on a dielectric substrate, and

said low-noise amplifiers have output terminals, respectively, which are commonly connected to a microstrip line formed on said dielectric substrate.

FIG. 1

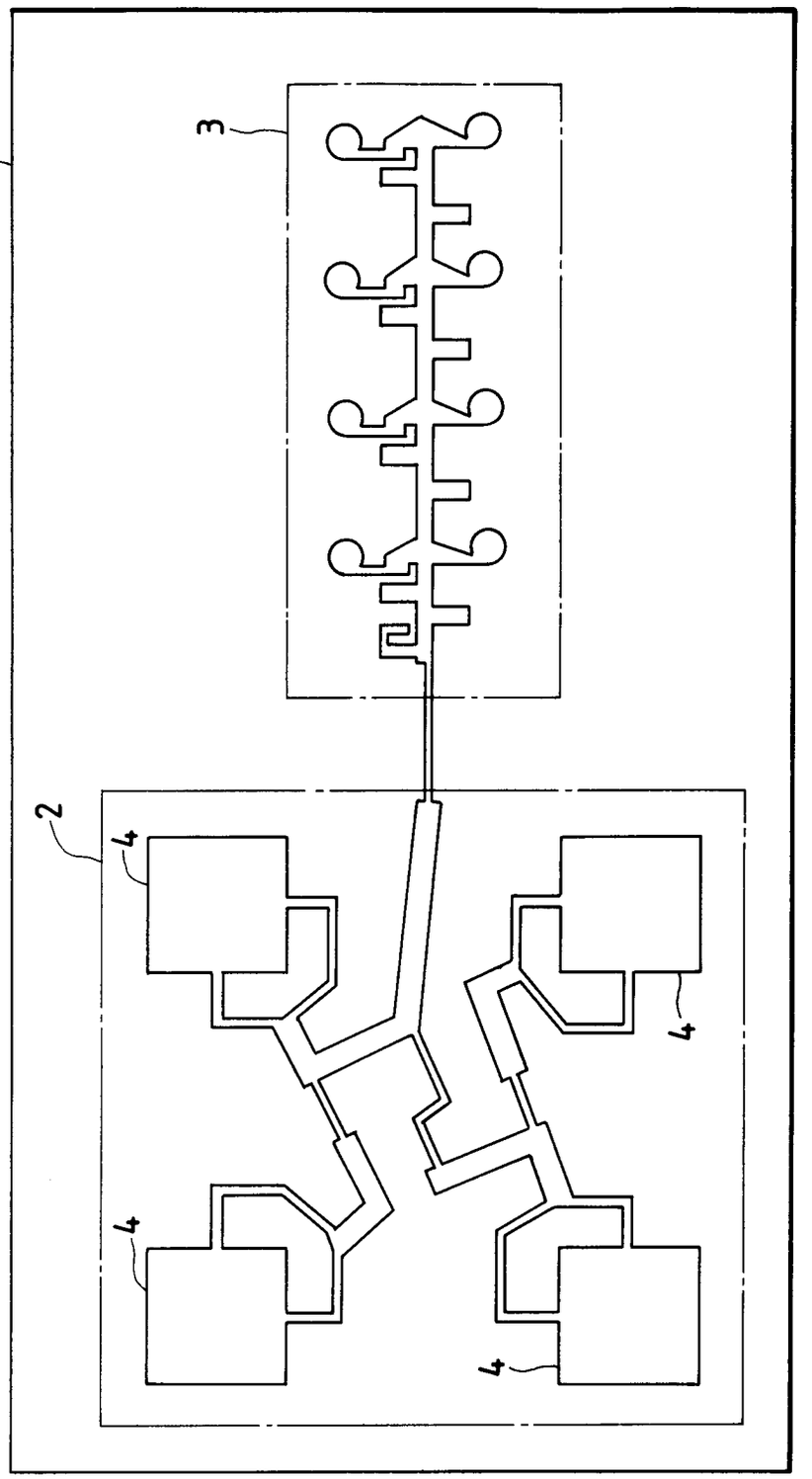


FIG. 2

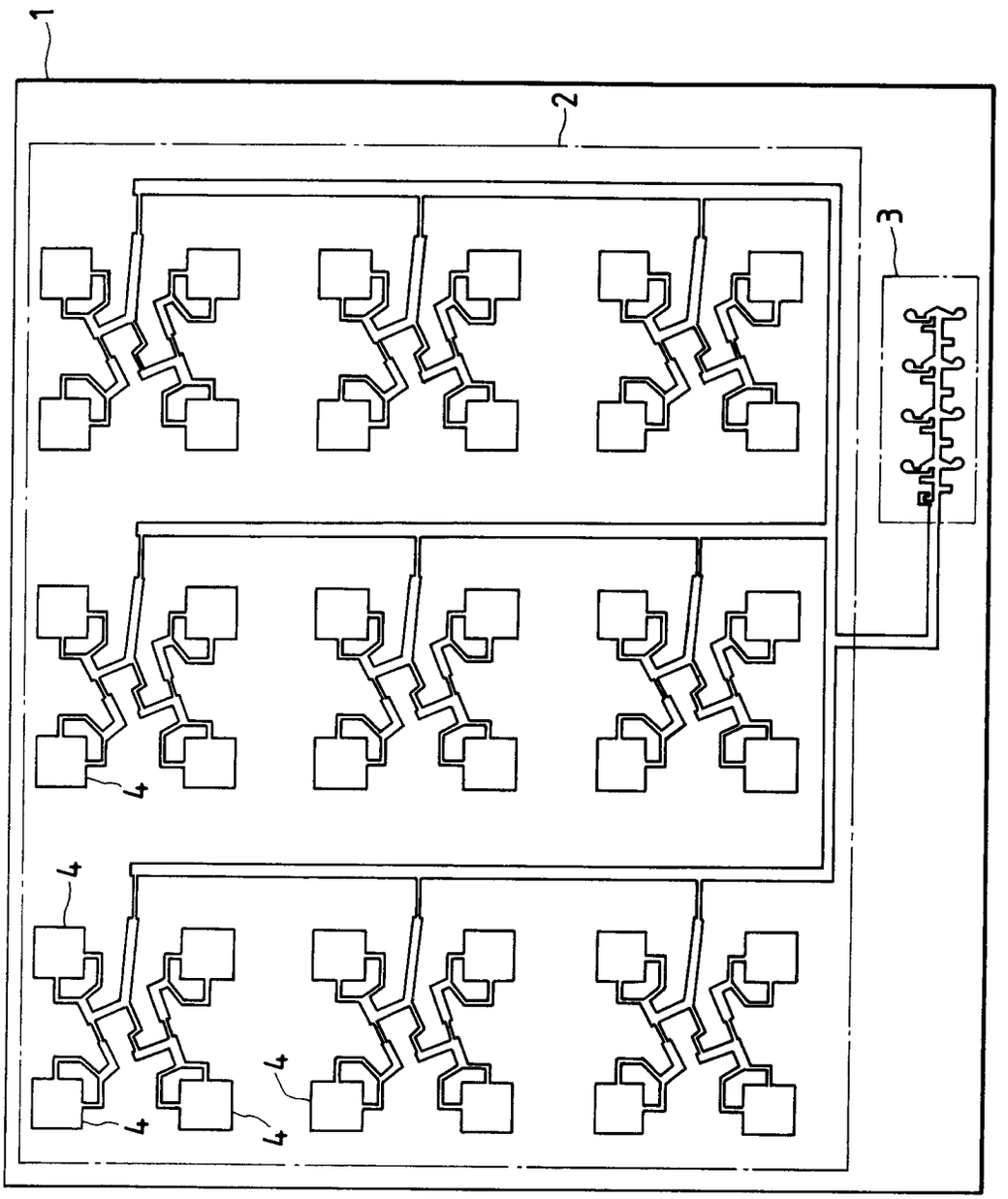
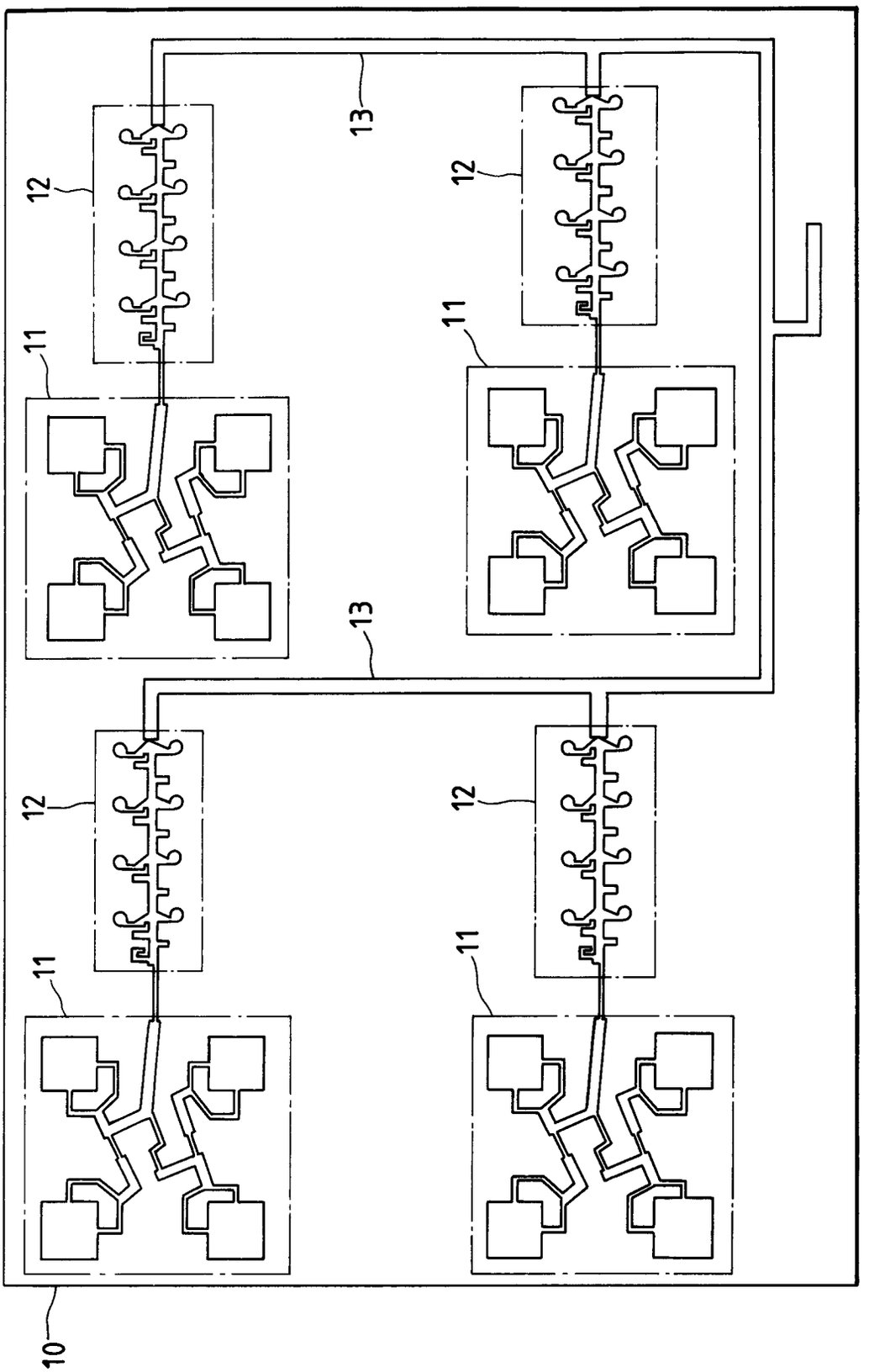


FIG. 3



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EUROPEAN SEARCH REPORT

Application Number

EP 92 10 9486

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)
X	EP-A-0 346 125 (NEC CORP.) * abstract; figures 1,3,4,5D,5E * * column 3, line 20 - line 57 *	1-4	H01Q23/00
Y	US-E-32 369 (STOCKTON ET AL.) * abstract; figure 1 * * column 3, line 44 - column 4, line 5 *	1,2	
A	*Idem*	5,6	
Y	PATENT ABSTRACTS OF JAPAN vol. 015, no. 459 (E-1136)21 November 1991 & JP-A-31 96 705 (HITACHI LTD.) 28 August 1991 * abstract *	1,2	
A	PATENT ABSTRACTS OF JAPAN vol. 014, no. 278 (E-941)15 June 1990 & JP-A-20 87 703 (NEC CORP.) 28 March 1990 * abstract *	3	
A	PATENT ABSTRACTS OF JAPAN vol. 016, no. 188 (E-1198)7 May 1992 & JP-A-40 25 046 (NEC CORP.) 28 January 1992 * abstract *	7	TECHNICAL FIELDS SEARCHED (Int. Cl.5) H01Q H04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	04 FEBRUARY 1993	DANIELIDIS S.

CATEGORY OF CITED DOCUMENTS

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