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(54) **Jemcy conical receiving antenna.**

(57) An antenna having high gain and narrow beamwidth over broadband VHF and UHF portions of the electromagnetic spectrum comprises a biconical radiator/receiver (2) mounted substantially at the focal point of a parabolic reflector (3). Typically, the biconical radiator/receiver and the parabolic reflector are mounted on a supporting rod (1). Director rods (4,5) may also be provided on the supporting rod, the director rods being mounted on the side of the biconical radiator/receiver opposite to the reflector. The invention provides a low-cost high-gain antenna particularly suitable for television reception.

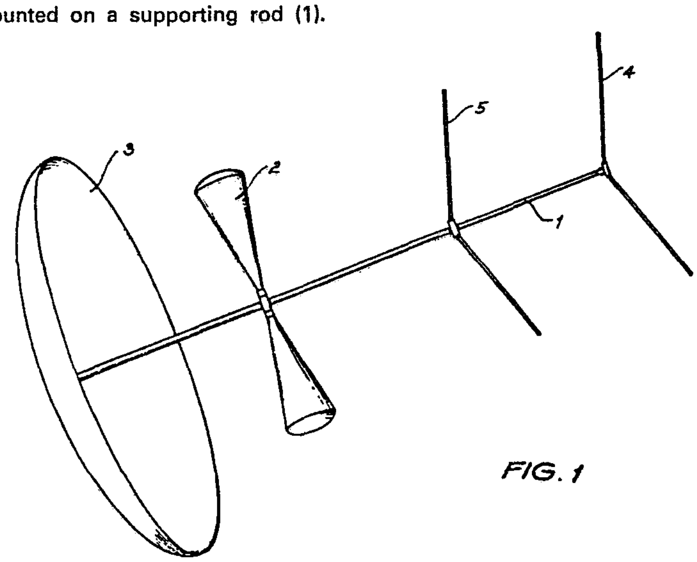

FIG. 1

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Croydon Printing Company Ltd

"JEMCY CONICAL RECEIVING ANTENNA"

The present invention relates to a high gain wide band antenna. In particular, the invention is directed to an antenna for receiving television signals in the VHF(Very High Frequency) and UHF (Ultra High Frequency) frequency ranges, although it is not limited thereto.

At the present time, most television stations broadcast in the VHF frequency band. However, there is an increasing number of television stations now broadcasting in the UHF band. Accordingly, many of the television receivers being produced at this time are adapted to receive both VHF and UHF transmissions. Many VHF/UHF antennas, such as the "rabbit ears" indoor antenna, are not ideally suited for receiving VHF/UHF transmissions owing to high rise buildings blocking line of sight and causing reflections (ghosts) and it is desired therefore to install antennas for the reception of both VHF and UHF TV channels having high gain, narrow beam width and wide band response.

Most outdoor TV antennas are of the Yagi or Yagi-Uda type. The Yagi or Yagi-Uda antennas are generally fixed frequency narrow band antennas, i.e. they exhibit high gain only over a single frequency band. This frequency band is designed to cover the particular broadcast frequency which is to be received. However, due to the allocated frequency spacing of TV channels, particular TV channels will lie outside the resonance curve of any one Yagi dimension and consequently, the antenna exhibits low gain at the frequencies of these TV channels. This results in poor reception at these channels.

In built up areas and in rugged terrain, many objects act as screens and/or "passive" repeators, changing wave patterns, phase and general characteristics of the radiated television signals. Since the receiving antenna cannot change the intervening space between the transmitter and the receiver, every effort must be made in the receiving antenna to restrict reception to a narrow beam (line of sight) and to obtain the maximum gain of the signal required, rejecting unwanted reflection images. The antenna of the present invention provides a very narrow beam in the horizontal and vertical planes, thereby giving very high rejection of radiation outside the beam width caused, for example, by re-radiation from intervening objects, and eliminating ghosting to a large degree.

Antennas of conical shape are known, although these are not generally used for TV reception. The conical antenna is one of a large number of special antennas which have been developed to operate satisfactorily over a wide frequency band. Australian Patent No. 119,117 discloses a bi-conical double disc antenna adapted for orientation in the vertical plane. Australian Patent No. 107,639 discloses a biconical antenna which also utilises the wide band effect by using an "hour-glass" antenna in the vertical plane. The vertical antennas act as isotropic sources of radiation in the horizontal plane. These antennas have not found widespread use for the reception of vertically polarised television signal transmissions.

The Yagi-Uda antenna is generally orientated horizontally and therefore is suited to reception of horizontally polarised television signals. Any dipolar array may be mounted in the horizontal plane or the vertical plane or even in certain difficult situations may be used in diversity - one on the vertical plane separated by 5 λ from the other on the horizontal plane. The Yagi-Uda antenna usually comprises a half-wave dipole with reflector and director rods orientated parallel thereto and spaced therefrom by predetermined distances. By using undriven reflector rods, gains of about 3 db can be realised with these antennas. However, the impedance of these antennas will be 72 ohms for a single radiator and 300 ohms for a folded dipole. A parasitic element may be behind the driven element in relation to the desired direction of maximum gain, in which case it is called a reflector, or it may be in front of the driven element, in which case it is called a director. Reflectors and directors may both be used to obtain even more gain. This is the principle which forms the basis of the Yagi or Yagi-Uda antenna. Increased gain can be achieved by adding further parasitic elements suitably spaced parallel to the dipole, usually as directors. However, it has been found that any increase beyond 11 elements does not appreciably affect the gain. The maximum gain for an 11 element Yagi antenna is of the order of 10db (theoretical).

A multi-element Yagi antenna becomes very heavy and very cumbersome when used in the VHF band. Another antenna, the corner reflector antenna has been found to be as efficient as, or more efficient than, the multi-element Yagi antenna. The corner reflector antenna comprises a half-wave dipole placed parallel to the intersection of two conducting planes which provide considerable directivity if the angle between the planes and the position of the dipole are chosen correctly. Gains of up to 12db can be achieved but in practice the actual gain obtained from a corner reflector antenna is usually of the order of 9.4db to 10.3db.

One of the main disadvantages of the corner reflector antenna is that it has a critical narrow band resonant frequency, and it cannot be classed as a broad band antenna.

In radar applications, considerable use has been made of the mirror effect of radio waves to concentrate transmissions in very narrow beams by a means of reflectors constructed on the principles of search light reflectors. In general, the dimensions necessary for high efficiency in such systems are of the of order of several wavelengths and at very high frequencies this does not present a problem. However, little use has been made of this principle in VHF and UHF bands, due principally to the larger wavelengths involved.

It is an object of the present invention to overcome or substantially ameliorate the above described disadvantages by providing an antenna for receiving television broadcasts, said antenna having a relatively high gain over a wide frequency bandwidth.

According to the present invention, there is disclosed an antenna for receiving or transmitting electromagnetic radiation, said antenna comprising an elongate support member; said support member having thereon (a) biconical radiator/receiver means for transmitting or receiving said radiation, and (b) reflector means spaced a predetermined distance from said biconical means, said reflector means comprising a parabolic reflector having its focal point substantially at the location of said biconical means.

Preferably, the antenna also comprises two pairs of director rods mounted on the support member and spaced a pre-determined distance from each other and from the biconical means, the director rods being mounted on that side of the biconical means remote from the reflector means, and orientated parallel to the biconical means.

Notwithstanding any other forms that fall within its scope, one preferred form of the invention will now be described by way of example only with reference to the drawings, in which:-

Fig. 1 is a perspective view of an antenna according to the preferred embodiment of the present invention;

Fig. 2 is a plan view of the antenna of Fig. 1;

Fig. 3 is a side elevational view of the antenna of Fig. 1;

Fig. 4 is an end elevational view of the antenna of Fig. 1. looking into the reflector;

Fig. 5 is an exploded plan view of the antenna of Fig. 1;

Fig. 6 is a partially exploded plan view of the bi-conical radiator of the antenna of Fig. 1; and

Fig. 7 is a plan view of a director of the antenna of Fig. 1.

Fig 8 is a frequency response curve for the preferred embodiment.

Turning to Fig. 1, the preferred embodiment comprises an elongated support member which is preferably a rod 1, upon which other components of the antenna are mounted. Typically, the rod 1 is a hollow PVC rod but any other suitable material will suffice providing that if metal is used the radiator must be insulated from it. Bi-conical radiator/receiver means such as the biconical radiator 2 are mounted on the rod 1 as shown in Figs 1 to 4. (Although the biconical means are referred to as a biconical "radiator", it is to be understood that the radiator can be used for receiving or transmitting electromagnetic radiation).

At one end of the rod 1 there is mounted reflector means such as the parabolic reflecting dish 3 shown in Fig. 1. Two pairs of director rods 4 and 5 are mounted on the rod 1 on the side of radiator 2 remote from reflector 3. The director rods 4 and 5, the radiator 2 and the longitudinal axis of reflector 3 are aligned as shown in Figs. 2 to 4. The antenna shown in Fig. 1 uses the combination of the biconical radiator 2, the director rods 4,5, and the reflector 3 which interact synergistically to produce a wide band high gain antenna.

The antenna utilizes the principle of maximum radiation efficiency of a half-wave radiator whose mechanical length has been reduced, yet maintaining an electrical length enabling a single radiator to be used for a number of frequencies without serious detrimental loss in gain. In most instances, one length is sufficient providing that the correct centre frequencies are selected. However, in the case of VHF reception in difficult areas, two lengths can be used instead of overtone channels.

If the conical radiator 2 is to operate as a half-wave antenna, its overall length is shorter than the free space half wavelength. This is the result of the large "end effect" produced by the bases of the cones forming the biconical radiator 2. The bases of the cones are curved to match the corona field lines around the ends of the biconical radiator. As the apex angle θ , is increased, the length of the biconical radiator is decreased. For example if angle θ is 10^{o} the overall length required is approximately 75% of the free space half wavelength. With at 20^{o}, the length is only about 70% of a free space half wavelength. When such short lengths are used, the input impedance of the biconical radiator is approximately 40 ohms. When the conical antenna is operated as a full wave antenna, as in the case of UHF reception, the overall length is usually 73% of a free space wavelength. The input impedance increases with decreasing length of the biconical radiator. With an apex angle θ of 10^{o}, the input impedance is approximately 950 ohms; with an apex angle of 20°, the input impedance is approximately 60 ohms; and with an apex angle of 30°, the input impedance is approximately 300 ohms. Lower impedances can be obtained by increasing the apex angle θ and reducing the radiator length accordingly.

The inductance and capacitance of the biconical radiator 2 vary along the length thereof, thereby resulting in a broad resonance rather than a narrow resonant peak. Further, there is a corona around the outer ends of the cones of the biconical radiator 2. This corona is enhanced by reflection of incident radiation by the reflector 3. The radiator has a fairly large capacity but a small inductance per unit length which reduces the effective "Q" of the antenna and causes its characteristics to change more slowly as the frequency is varied away from resonance thereby providing a broad band response.

As the apex angle θ increases, the band width of the biconical radiator increases, but as the gain also decreases, the width of the frequency band must be kept to certain limits in order to obtain useful input signal strength.

The biconical radiator 2, when used for transmitting, radiates its maximum energy at right angles to the longitudinal axis of the radiator, and little energy is radiated in the direction of the longitudinal axis. When the radiator 2 is used for reception, it receives maximum energy at right angles to the cones and negligible energy is received in the direction of the longitudinal axis. When the biconical radiator 2 is mounted with its longitudinal axis vertical, (without directors or reflectors), it will radiate equally in all horizontal directions. When mounted horizontally, its radiation pattern will resemble a vertical donut where the maximum radiation will be at right angles to the longitudinal axis of the radiator 2.

The assembly construction of the biconical radiator 2 is shown in Fig. 6. The radiator 2 comprises a pair of cones 21 and 22. Referring to the bottom cone, the cone 22 is connected at its apex to a metal connector 10 which engages in a four way junction box 15. A wire connector 12, which forms one terminal of the antenna lead, is connected to the cone 22 by being sweated into the metal connector 10. Fig. 6 shows the top cone 21 when assembled with the junction box 15. The cones 21 and 22 are terminated on "two way" electrical connectors in the junction box 15 which enables connection to the 300 ohm TV ribbon lead in (to the transmitter or receiver). The assembly construction described above is given by way of example only and other suitable constructions can be used.

The parabolic reflector dish 3 is mounted at one end of the rod 1 with its concave surface facing the biconical radiator 2, as shown in Fig. 1. The design of the reflector 3 follows the fundamental rules of optics since both light and radio/TV signals are propagating electromagnetic waves. It has been found that the parabola is the most efficient shape for a reflector in order to obtain maximum gain and maintain in phase reflective components at the radiator. The parabolic reflector has the important property that it directs parallel rays from different sources onto its focal point, and conversely, it concentrates rays from a source at its focal point into an intense beam parallel to the axis of the parabola. This results in considerable gain determined by the size of the parabola in terms of wavelength. Although known parabolic reflectors generally have been applied to frequencies above the microwave region, it has been found that the same principles can be applied to VHF. With VHF, the actual wavelength approximates the dimensions of the reflector, with the result that losses are experienced due to resonance, noise, and phase variations. Nevertheless, significant gain can be obtained. The degree of gain and the narrowness of the beam will be determined by the dimensions of the parabolic reflector in terms of the wavelengths being used. Increasing the width and/or length of the parabolic reflector increases the gain; increasing or decreasing the focal length (radiator-reflector distance) increases or decreases the beam width, respectively. However, with VHF applications the dimensions are limited by considerations of physical size. Increased gains can be obtained at the higher UHF frequencies. (See Table A)

TABLE A

PARABOLIC REFLECTOR GAIN FOR VARIOUS DIAMETERS

BAND	GAIN				
(MHz)	10db	15db	20db	25db	30db
150	1000mm	1500mm	3000mm	2400mm	9000mm
1000	305mm	610mm	1100mm	1800mm	3600mm
2000	-	305mm	610mm	900mm	1200mm
10,000	-	-	-	-	450mm

It is not always necessary to use the whole parabola since this is sometimes too large and cumbersome. The same principles will still apply if a section known as an "orange peel" shape is used. The reflector dish shown in the antenna of Fig. 1 has this "orange peel" shape.

Preferably, the length of the reflector 3 is approximately twice the length of the biconical radiator 2, (i.e. λ) and the maximum width of the reflector 3 is approximately twice the maximum diameter of the biconical radiator 2 (i.e. $\lambda/2$).

The reflector 3 may be made from solid copper, brass, aluminium or "fly-screen" mesh of these materials, or of expanded metal of these materials, provided the diameter of the mesh holes does not exceed $\lambda/12$. Other suitable conductive materials can also be used. In order to maintain the parabolic shape, some form of rigid skeleton (such as 2mm brass or bronze rod) is provided when flexible mesh is used. As shown in Fig. 5 the reflector 3 is mounted to the support rod 1 by means of a "plug" bolt or nipple 30 extending through a hole at the centre of the parabolic reflector 3, and into the support rod 1. The "plug" bolt 30 may be made of brass, bronze, aluminium or other suitable material. If a non-rigid construction (mesh) is used or if the unit may be subjected to high stress, horizontal and vertical cross ribs of plastic sheeting (not shown) can be added inside the reflector 3.

Two sets of director rods 4 and 5 are mounted on the supporting rod 1 as indicated in Fig. 1. As can be seen from Figs. 2 to 4, the director rods 4 and 5 are aligned with the biconical radiator 2 and the longitudinal axis of the reflector 3. Each director set can comprise a single rod mounted at its centre point on the support rod 1, or a pair of rods end-mounted on the support rod 1.

The purpose of the directors 4 and 5 is two-fold. First, they act as parasitic re-radiators reflecting back to the radiator 2 any re-radiation from radiator 2, and secondly, they act as a lens directing the incoming radiation. The directors can be likened to passive radiators acting as amplifiers to the incoming signal. Preferably, the length of each director is slightly less than half a wavelength, i.e. longer than the raditor but shorter than the reflector. Further, the directors should be spaced at correct distances from the radiator 2 in order to achieve an in phase relationship. Spacing considerations will be considered hereinafter.

Better results are obtained by setting the directors at an angle to the supporting rod 1. Preferably, the forward angle of the directors 4 and 5 is equal to the forward angle of the surface of the radiator cones. The directors can be made of brass, copper or aluminium rod, or other suitable material.

The assembly construction of the directors 4 and 5 is shown in Fig. 5 and 7. Typically, the directors are metal rods of 3 - 4 mm diameter. The halves of the second director 4 are fitted into holes drilled into a metal connector 16 which is then inserted into the hollow supporting rod 1 (Fig. 7). The halves of the first director 5 are fitted to a double-ended metal connector 17 which fits into respective portions of the supporting rod 1.

Although two pairs of directors have been shown in the preferred embodiment, the invention will function with one pair of directors. More than two pairs of directors can be used. However, with increasing numbers of directors, the antenna weight increases and it becomes cumbersome.

The biconical radiator 2, the reflector 3 and the directors 4 and 5 are spaced at predetermined distances from each other. In order to preserve an in phase relationship between the direct and reflected signals, the spacing between the radiator 2 and reflector 3 is a quarter of a wavelength. The directors 4 and 5 are spaced one-eighth of a wavelength apart and the distance between the radiator 2 and the reflector 5 is one-eighth of a wavelength also.

With a reflector length of three-quarters of a wavelength and a width of one-quarter of a wavelength, the antenna has an overall gain of approximately 11db and a beam width in the horizontal of 15^{o} and in the vertical plane of 25^{o}.

Fig. 8 shows frequency response curves for the preferred embodiment known as the Jemcy antenna, and individual components thereof.

The preferred embodiment will be described with reference to reception of television transmissions in the Sydney metropolitan region of Australia. However, the invention can be applied to other regions by suitable choice of antenna dimensions. For VHF reception in Sydney, the lengths of the cones are chosen so that the radiator has a high gain response over the band of frequencies between 174 and 229 Mhz, with a resonance in the centre of the band at 193.55 Mhz, which gives a full wavelength of 1.55 metres. This band covers Australian VHF TV channels 6 to 12 as shown in Table 1.

It has been found that at these dimensions, resonance also occurs in the frequency band of 47 to 140 Mhz, whose centre frequency is 96.7 Mhz, which gives a full wavelength of 3.10 metres. This lower resonant band covers Australian VHF TV channels 0 to 5A. The radiator 2 has a slightly lower efficiency at this lower resonance since it operates as a quarter wavelength instead of a half wavelength antenna, which means that it is operating on an overtone.

The provision of a second radiator cut to dimensions providing a resonance at 96.7 MHz, and mounted below the first radiator with a spacing of half a wavelength therebetween is recommended in very difficult (far distant or badly screened) locations. For the vast majority of situations in the Sydney and most rural areas within line of sight of the transmitting antenna, the single radiator will give good results.

For Sydney UHF (Band 4 and 5) reception (see Tables 2 and 3), the dimensions are chosen preferably to provide a resonant bandwidth from 526 to 582 Mhz with a centre resonance of 558 MHz, but this can be varied to suit particular local channels.

TABLE 1

CHANNEL NUMBER	FREQ (MHZ) BAND	MEAN	WAVELENGTH (M)
0	45-52	49	6.383
1	56-63	60	5.000
2	63-70	67	4.478
3	85-92	89	3.371
4	94-101	98	3.061
5	101-108	105	2.857
5A	137-144	141	2.128
6	174-181	178	1.685
7	181-188	185	1.622
8	188-195	192	1.563
9	195-202	199	1.508
10	208-215	212	1.415
11	215-222	219	1.370
12	222-229	226	1.328

TABLE 2

UHF FREQUENCY (MHz) BAND	MEAN	WAVELENGTH (M)
526 - 533	530	.566
533 - 540	537	.559
540 - 547	544	.551
547 - 554	551	.544
554 - 561	558	.538
561 - 568	565	.531
568 - 575	572	.524
575 - 582	579	.518

TABLE 3

UHF FREQUENCY (MHz) BAND	MEAN	WAVELENGTH (M)
614 - 621	618	.4854
621 - 628	625	.480
628 - 635	632	.4847
635 - 632	639	.4695
642 - 649	646	.4644
649 - 656	653	.4615
656 - 663	660	.4545
663 - 670	667	.4498
670 - 677	674	.4451
677 - 684	681	.4405
684 - 691	688	.436
691 - 698	695	.4317
698 - 705	702	.4274
705 - 712	709	.4231
712 - 719	716	.419
719 - 726	723	.415
726 - 733	730	.411
733 - 740	737	.407
740 - 747	744	.4032
747 - 754	751	.3995
754 - 761	758	.3958
761 - 768	765	.3922
768 - 775	772	.3886
775 - 782	779	.385
782 - 789	786	.3817
789 - 796	793	.3783
796 - 803	800	.375
803 - 810	807	.3717

The dimensions of the preferred embodiment which has the above described response for VHF and UHF reception are listed below.

Radiator angle θ	Radiator length Lc	Impedance
As a rod	$.475\lambda$	Z= 72 ohms
60°	65% of $\lambda/2 = .325\lambda$	Z= 95 ohms
30°	68% of $\lambda/2 = .34\lambda$	Z= 300 ohms
20°	70% of $\lambda/2 = .35\lambda$	Z= 630 ohms
10°	75% of $\lambda/2 = .375\lambda$	Z= 950 ohms

Director Length L_D

Length = 87% of $\lambda/2 = .435\lambda$

Reflector Length L_R

As a rod, length = 97% of $\lambda/2 = .485\lambda$

As a VHF Parabola, centre length = $3\lambda/4 = .75\lambda$

As a UHF Parabola, centre length $= n\lambda$, n=1,2,3...

Spacing

Reflector - radiator $=\lambda/4 = .25\lambda$

Radiator - Director $= \lambda/8 = .125\lambda$

Director - Director $= \lambda/8 = .125\lambda$

Cone Diameter D

$D = 2 L_c \tan \theta/2 = .085\lambda$ (for 30° radiator)

Cone Dome radius

radius $\approx 1/2\ L_c = .033\lambda$ (for 30° radiator)

Reflector width W_R

As a VHF Parabola, width $= \lambda/4 = .25\lambda$

As a UHF Parabola, width $= n\lambda/2$, n=1,2,3.... depending on the Parabola length.

Reflector Curve

This applies in both planes.

When used as a VHF Parabola, only a small part of the curve is utilised. Therefore since the radiator is at the focal point and the focal point is half the radius, the axis of the curve will be $\lambda/2$ when the distance radiator - reflector is $\lambda/4$.

When used as a UHF Parabola the curve follows the general equation for a parabola.

The above described embodiments of the invention have been shown by experiment to be the most efficient antennas. They can be used as transmitters or as receiver antennas, in any VHF or UHF applications where a wide frequency band and a high gain intense beam is required.

The foregoing only describes some embodiments of the present invention, and modifications, obvious to those skilled in the art, may be made thereto without departing from the scope of the present invention as defined in the claims appended hereto.

CLAIMS

1. An antenna for receiving or transmitting electromagnetic radiation within a predetermined frequency band having a centre frequency, said antenna comprising

an elongate support member, said support member having thereon

(a) biconical radiator/receiver means for transmitting or receiving said radiation, and

(b) reflector means spaced a predetermined distance from said biconical means, said reflector means comprising a parabolic reflector having its focal point substantially at the location of said biconical means.

2. An antenna as claimed in claim 1, further comprising at least one director rod mounted on said support member on the opposite side of said biconical means from said reflector.

3. An antenna as claimed in claim 2, wherein said reflector is of substantially oval outline and parabolic shape, the longitudinal axis of said reflector being coplanar with the longitudinal axis of said biconical means and said at least one director rod.

4. An antenna as claimed in any preceding claim, wherein said biconical means comprises two substantially conical metal members, each said conical member having its apex orientated towards the apex of the other conical member, and said conical members having their longitudinal axes aligned.

5. An antenna as claimed in any preceding claim, wherein the spacing between said reflector and said biconical means is approximately one-quarter of the wavelength of the centre frequency.

6. An antenna as claimed in claim 2 or 3, said antenna having two director rods, wherein said two director rods are spaced apart by approximately an eighth of the wavelength of said centre frequency, said biconical means being spaced from the nearest director rod by approximately an eighth of said wavelength, and from said reflector by approximately a quarter of said wavelength.

7. An antenna as claimed in any preceding claim,

wherein said centre frequency is in the VHF frequency band or the UHF frequency band.

8. An antenna as claimed in any preceding claim, wherein frequency response is substantially flat from 12-15% either side of the centre frequency.

9. An antenna as claimed in any preceding claim, wherein said biconical means has a length less than one-half of the wavelength of said centre frequency.

10. An antenna as claimed in any preceding claim, further comprising additional biconical radiator/receiver means mounted on said support member and spaced from the first biconical means by approximately one half of the wavelength of said centre frequency.

11. An antenna as claimed in any preceding claim, having a parabolic reflector whose overall gain ranges from 10db to 30db in dependence upon the ratio of perambular length/width to the wavelength in use.

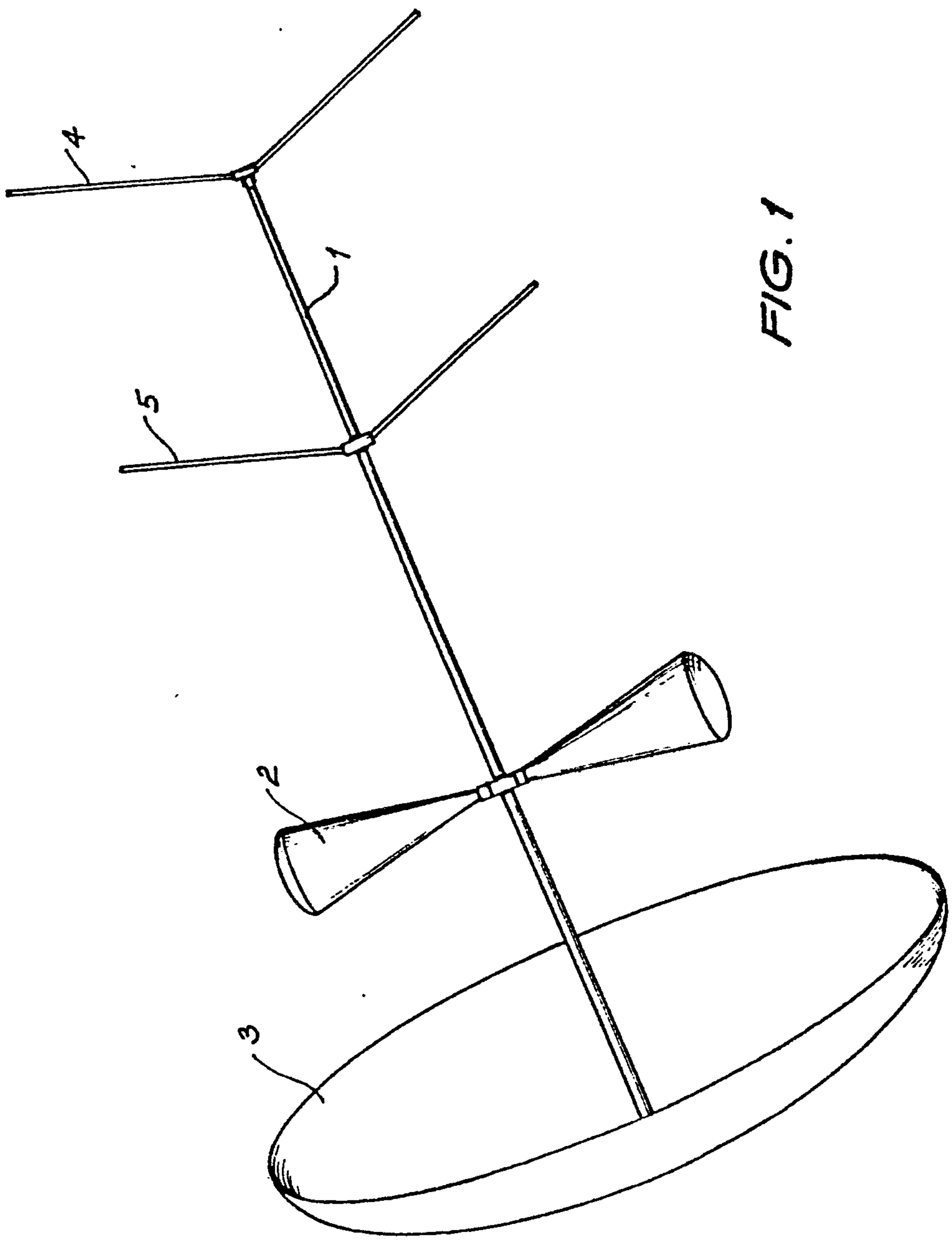


FIG. 1

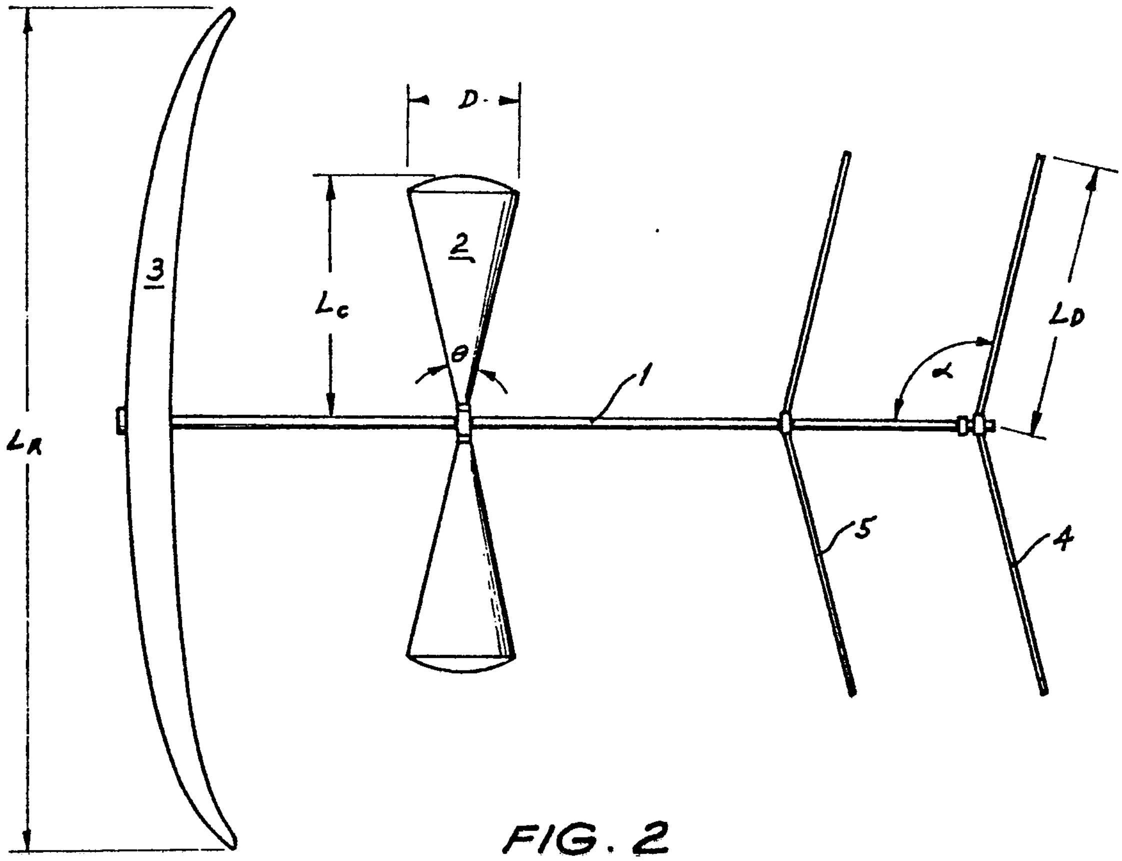


FIG. 2

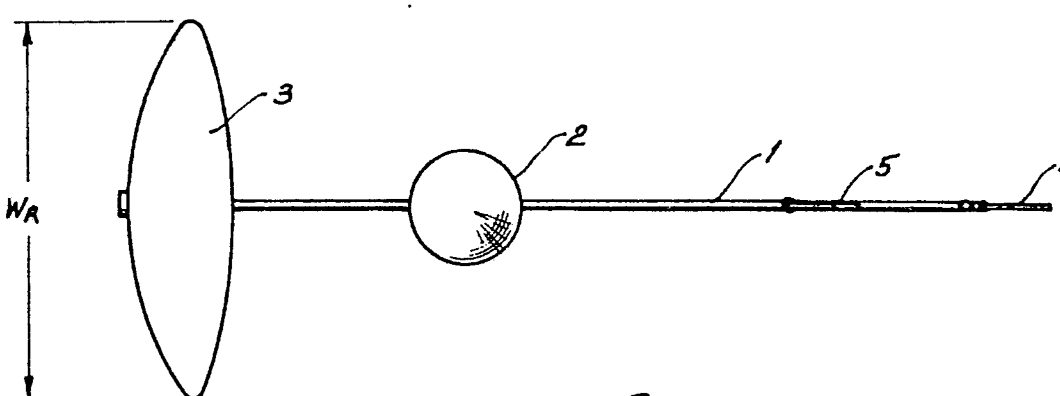


FIG. 3

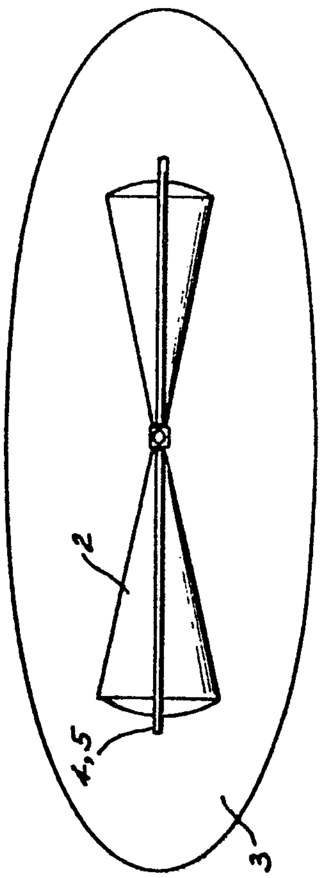


FIG. 4

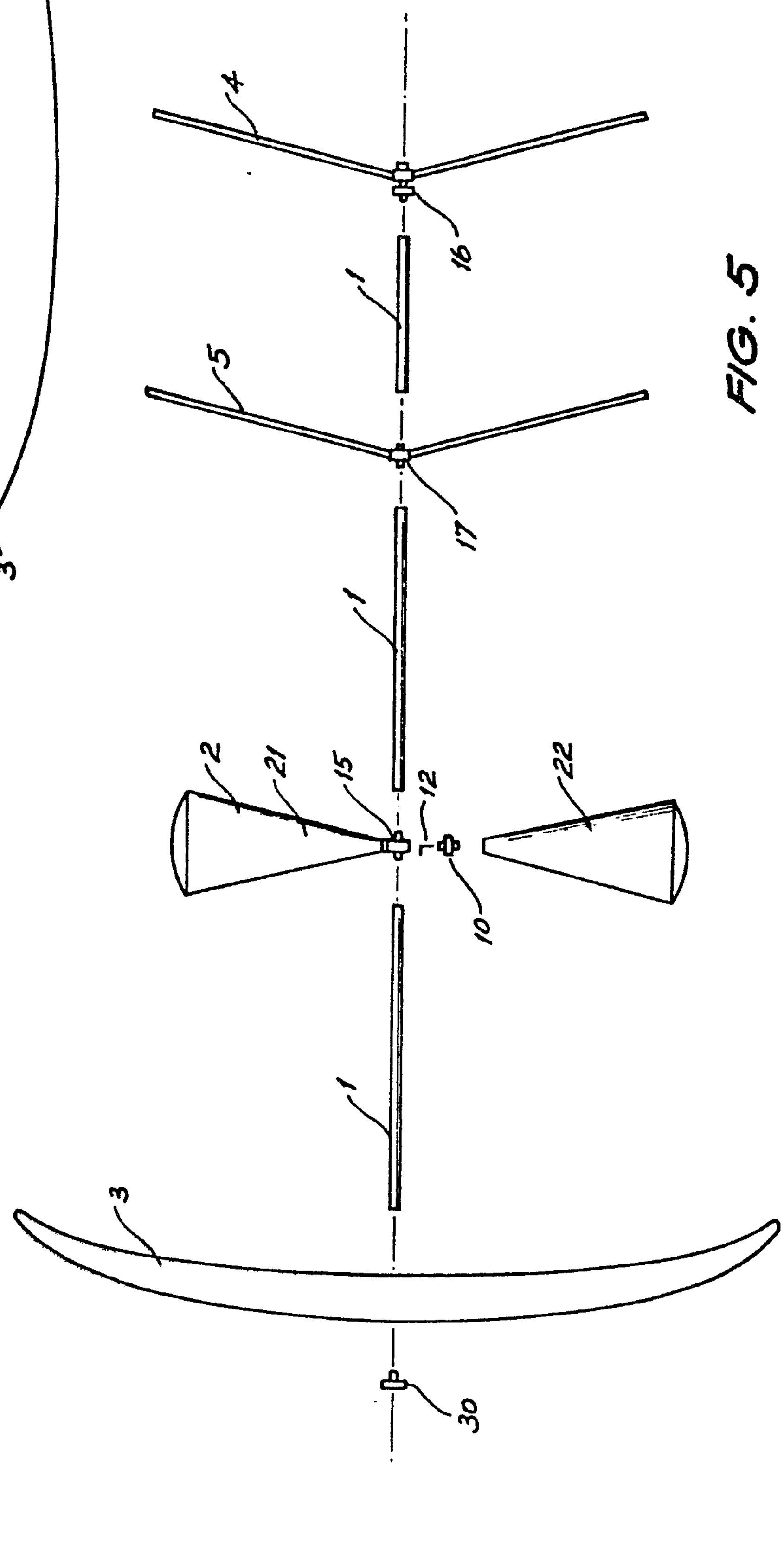


FIG. 5

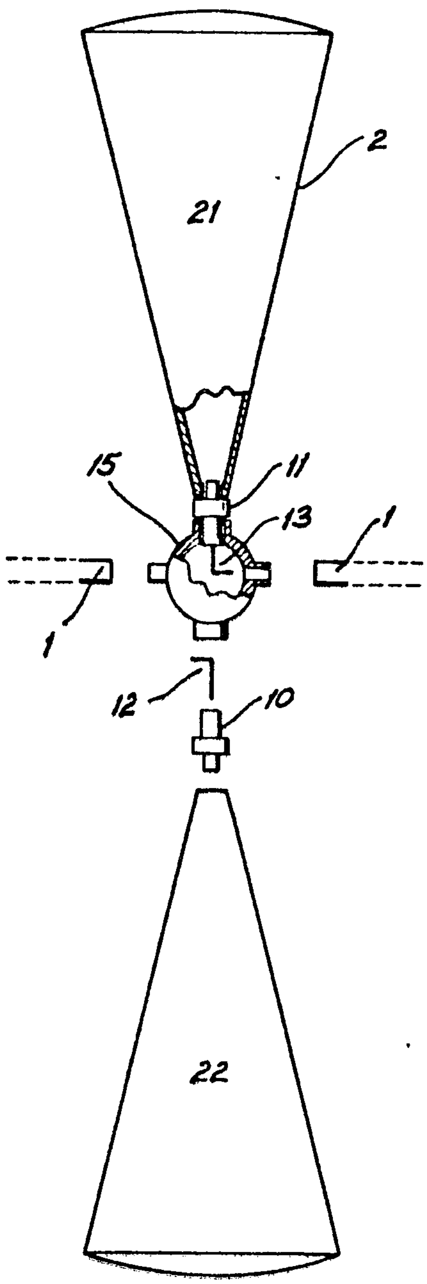


FIG. 6

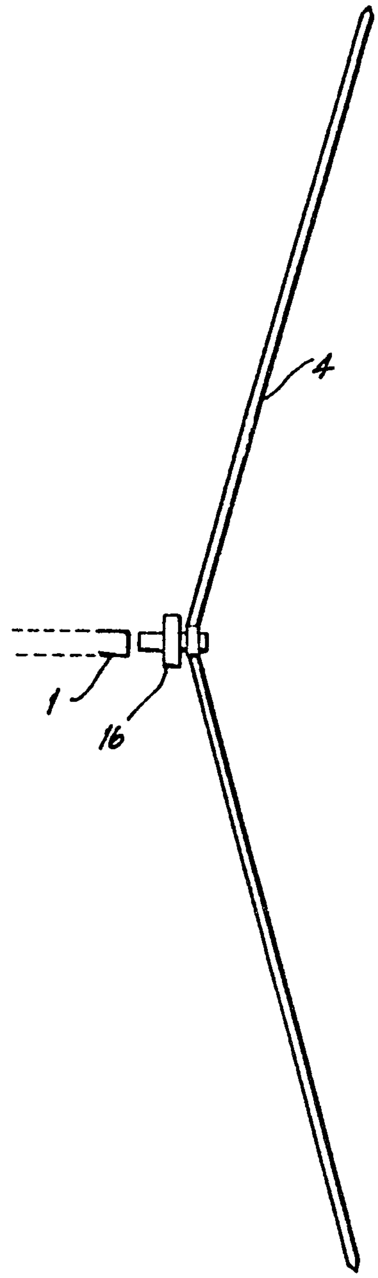
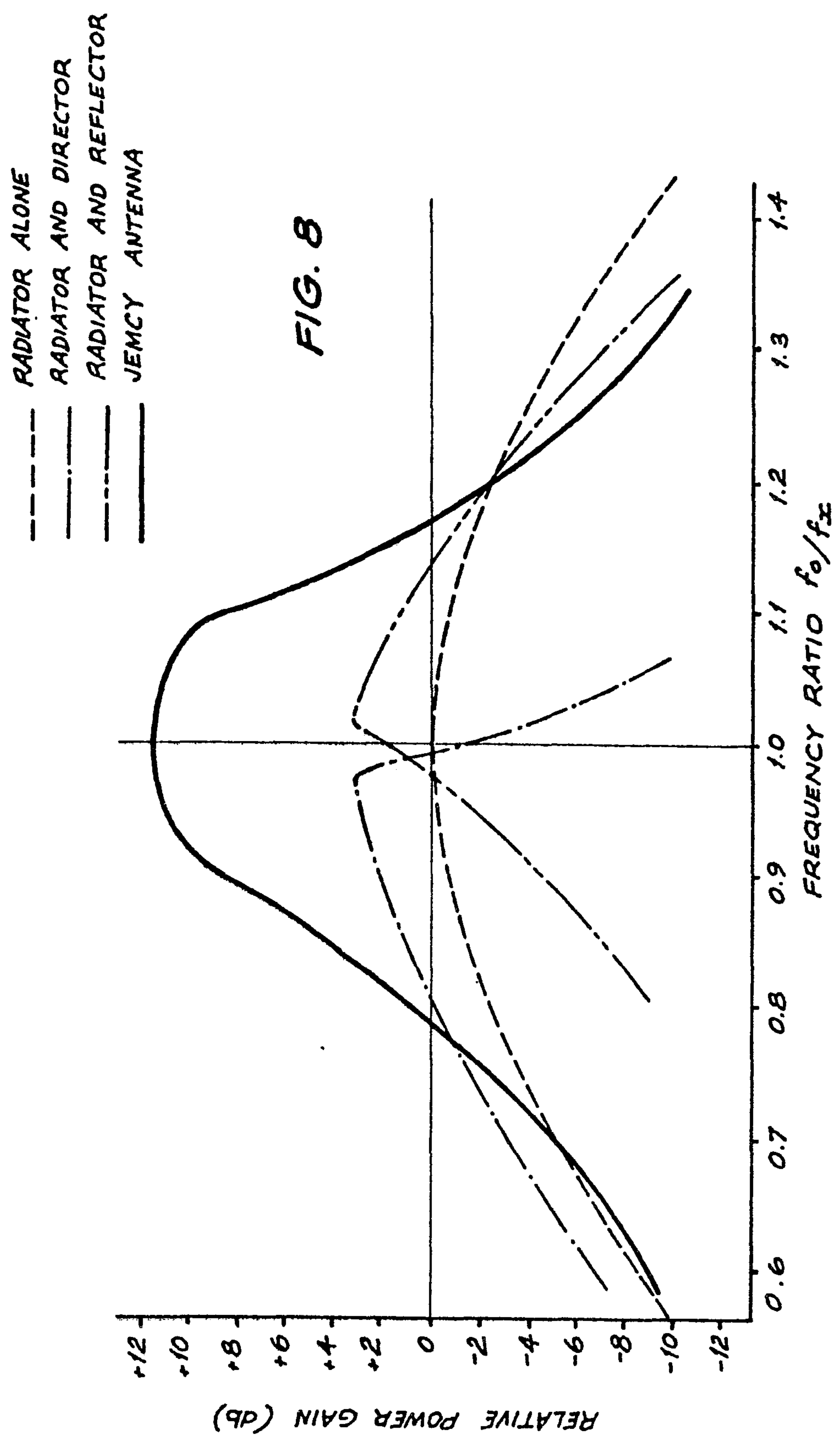


FIG. 7


RADIATOR ALONE
RADIATOR AND DIRECTOR
RADIATOR AND REFLECTOR
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+12
+10
+8
+6
+4
+2
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-4
-6
-8
-10
-12
RELATIVE POWER GAIN (db)
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
FREQUENCY RATIO f_o/f_x

FIG. 8

0055591

Application number

European Patent Office

EUROPEAN SEARCH REPORT

EP 81 30 6048.0

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
X	US - A - 3 369 245 (N.J. REA) * column 3, lines 10 to 22; fig. 6 * --	1
X	DE - A - 1 441 103 (SIEMENS) * fig. 4 * --	1,2,4
Y	US - A - 3 683 391 (J.D. CALLAGHAN) * fig. 1, position 15 * --	1
Y	DE - A1 - 2 642 282 (LICENTIA PATENT-VERWALTUNG) * fig. 1 * --	4
Y	DE - A1 - 2 850 492 (CSELT-CENTRO STUDI E LABORATORI TELECOMUNICAZIONI) * fig. 1 * --	3
D,A	AU - A - 107 639 (MARCONI) * fig. 1 to 3 * --	
D,A	AU - A - 119 117 (AMALGAMATED WIRELESS) * fig. 1 to 3 * --	
A	DE - U - 6 608 871 (M. LIEBICH) * fig. 8, 9 * --	
A	DE - C - 1 109 748 (SIEMENS) * fig. 1 to 5 * -- ./..	

CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)

H 01 Q 19/12
H 01 Q 9/28

TECHNICAL FIELDS SEARCHED (Int.Cl. 3)

H 01 Q 5/00
H 01 Q 9/28
H 01 Q 19/12
H 01 Q 19/13

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
Y: particularly relevant if combined with another document of the same category
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: earlier patent document, but published on, or after the filing date
D: document cited in the application
L: document cited for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	16-02-1982	BREUSING

EPO Form 1503.1 06.78

European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 81 30 6048.0

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	DE - C - 1 013 720 (SIEMENS) * fig. 1 * ----		
			TECHNICAL FIELDS SEARCHED (Int. Cl.³)