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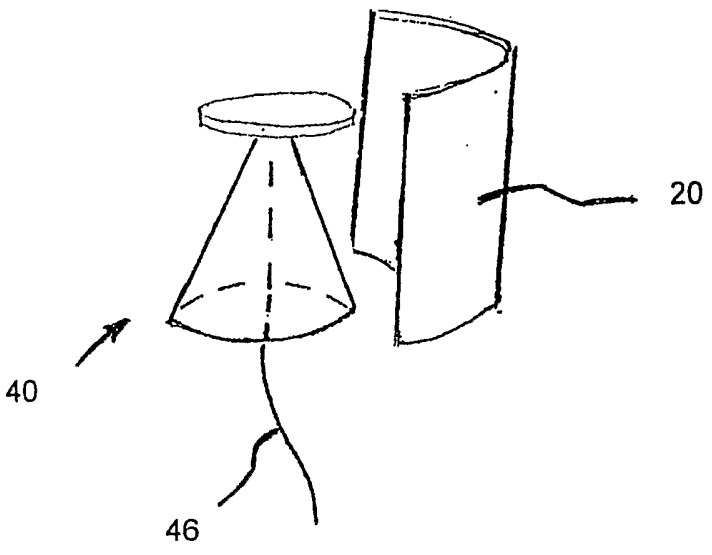
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(54) Title: METHOD AND APPARATUS FOR IMPROVING ANTENNA EFFICIENCY



(57) Abstract: A method and apparatus for improving antenna efficiency. A non-grounded conductive object is placed near an antenna. An insulative layer lies between the object and the antenna. The antenna used is preferably a multiband antenna, such as a discone type antenna.

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METHOD AND APPARATUS FOR IMPROVING ANTENNA EFFICIENCY

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to Japanese Patent Application Serial No. 2003-116664, entitled "*Antenna Device*", filed on April 22, 2003 and to U.S. Patent Application Serial No. 10/448,953, entitled "*Method and Apparatus for Improving Antenna Efficiency*", filed on May 30, 2003, and the specifications and claims thereof are incorporated herein by reference.

This application is also related to U.S. Patent Application Serial No. 10/412,371, entitled "*Antenna*", to Chadwick, filed on April 11, 2003; U.S. Patent Application No. 09/635,402, entitled "*In-Vehicle Exciter*", to Chadwick, filed on November 27, 2000; and U.S. Patent Application Serial No. 10/160,747, entitled "*Exciter System and Excitation Methods for Communications Within and Very Near to Vehicles*", to Chadwick, et al., filed on May 30, 2002, and the specifications and claims thereof are incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention (Technical Field):

The present invention relates to an antenna system that improves the Transmit / Receive (T/R) efficiency by improving the signal to noise (S/N) ratio in electromagnetic signal communications.

Description of Related Art:

Note that the following discussion refers to a number of publications by author(s) and year of publication, and that due to recent publication dates certain publications are not to be considered as prior art vis-a-vis the present invention. Discussion of such publications herein is given for more complete background and is not to be construed as an admission that such publications are prior art for patentability determination purposes.

Currently, antennas used in applications such as wireless Local Area Networks (LAN), Global Positioning Systems (GPS), TV, etc, are typically dedicated-use antennas with frequency bands ranging from MHz, to tens of GHz. Since the application, for example, free space TV, operates within a specified frequency band, these antennas are tuned to a specific and limited frequency band. For another example, IEEE802.11b (wireless LAN), uses a 2.4GHz frequency band. Reduced T/R efficiency of single-use antenna may result in limiting the reception area and thus require greater transmitting power.

Conventional antennas, which are used for a specific wavelength, such as the 1/4-wavelength grounded antenna, do not always have a sufficient S/N ratio. If the S/N ratio is improved, it will become possible to reduce the transmission power or, likewise, to increase the receiving distance.

Compared to limited frequency band antennas, discone type antennas have the outstanding characteristic of broadband capabilities. This makes it possible for one antenna to be used for multiple applications. However, the discone antenna gain is lower than a dedicated-use antenna; to date, this has prevented the practical use of discone antennas. The practical use of discone antennas for multiple applications could be achieved if the T/R efficiency is improved. This would have a dramatic effect on applications such as wireless LAN, GPS, etc. that provide different services to a single user (person or group) since they could all be served with just one antenna.

Although the discone antenna is typically used for broadband T/R frequencies, limiting a discone antenna to a specific wavelength results in a reduced S/N ratio, when compared with other antennas.

Various technologies have been developed to improve antenna S/N ratio, such as, electromagnetic wave radar equipment with improved reliability, which allows only a fixed frequency for transmitting and receiving to pass efficiently, thus controlling the influence of noise. See Japanese Patent Publication No. 11-248835 entitled *"Radio Wave Radar Apparatus"*. Such radar is equipped with an antenna system for transmitting and receiving an electromagnetic wave, as well as a conductive shield that is grounded and covers the antenna of the radar unit. The shield has a screen for frequency selection in the area facing the antenna. The screen is comprised of a conductive film having multiple holes uniformly arranged in two dimensions. The size and arrangement of the holes are chosen to allow a selected frequency to pass through. The shield and screen are optimized at a selected frequency. The screen intercepts the noise of frequencies lower than the selected frequency. The screen may comprise multiple conductive films with holes in stacked arrangement. The screen may also comprise a conductive wire mesh, or a conductive film having multiple parallel slits, etc.

Japanese Patent Publication No. 01-305606 entitled *"Antenna Device with Radome"*, describes an antenna system consisting of an antenna and a grounded radome that protects the antenna from its natural environment. The radome also provides frequency selectiveness.

Japanese Patent Publication No. 09-083238 entitled *"Antenna System for Multi-Wave Common Use"* describes a discone broadband antenna that can be made more frequency band selective by modifying the shape of the antenna.

U.S. Patent Application Serial No. 10/412,371 entitled *"Antenna"*, U.S. Patent Application Serial No. 10/160,747 entitled *"Exciter System and Excitation Methods for Communications Within and Very Near to Vehicles"* and U.S. Patent Application Serial No. 635,402, entitled *"In-Vehicle Exciter"*, which are incorporated herein by reference, disclose a modified discone exciter, which is used for communications within a vehicle. The present invention is applicable to modified discone antennas, as well as other types of antennas.

BRIEF SUMMARY OF THE INVENTION

The present invention is directed to the enhancement of antenna system efficiency. The invention comprises an antenna, a non-grounded conductive object, and free space lying between the antenna and the non-grounded conductive object. The free space provides electrical insulation between the object and antenna. The antenna used in the invention is preferably a discone type antenna comprising a disc, a cone including an apex and a base, the disc positioned at the apex of the cone, and a feed wire preferably disposed within the cone and extending outwardly beyond the cone.

The non-grounded conductive object is preferably made from aluminum or copper material. The object may be substantially flat, but is preferably curved. The curve may be simple, substantially spherical, or cylindrical in shape. A curved object having a subtended angle of between approximately 60 degrees and approximately 180 degrees is preferred. The non-grounded conductive object may, but preferably does not, completely enclose the antenna. The thickness of the non-grounded conductive object is preferably less than or equal to approximately ten millimeters.

The non-grounded conductive object may also be constructed with a double wall. The interstice between the double walls may be empty or may include insulative material, such as plastic. The interstice is preferably less than or equal to approximately 50 millimeters in thickness.

The present invention also relates to a method for improving antenna system efficiency. In the preferred embodiment, a non-grounded conductive object is placed in a selected position proximate the antenna. A discone type antenna, as discussed above is preferably utilized. The preferred non-grounded conductive object is the same as that discussed above.

A primary object of the present invention is to improve the efficiency of antenna systems.

A primary advantage of the present invention is that signal to noise ratio in antenna systems, including those currently in use, is improved in an efficient and cost effective manner.

Other objects, advantages and novel features, and further scope of applicability of the present invention will be set forth in part in the detailed description to follow, taken in conjunction with the accompanying drawings, and in part will become apparent to those skilled in the art upon examination of the following, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The accompanying drawings, which are incorporated into and form a part of the specification, illustrate one or more embodiments of the present invention and, together with the description, serve to explain the principles of the invention. The drawings are not to be construed as limiting the invention. In the drawings:

Fig. 1 is a perspective view showing one embodiment of the present invention of the improved antenna system where a discone antenna is partially surrounded by a curved non-grounded conductive object;

Fig. 2 is a perspective view showing another embodiment of the present invention comprising an open-ended, cylindrical, non-grounded, conductive object and a discone antenna placed at the open end of the cylindrical object;

Fig. 3 is a perspective view showing another embodiment comprising a different type antenna placed completely within a cylindrically shaped, open-ended, non-grounded, conductive object;

Fig. 4 is a perspective view showing another embodiment comprising an antenna positioned partially within the open-ended, non-grounded, conductive object;

Fig. 5 is a horizontal cross sectional view showing another embodiment of the invention comprising a three-wall, non-grounded, conductive object, placed around an antenna;

Fig. 6 is a horizontal cross-sectional view showing another embodiment comprising a curved, non-grounded, conductive object positioned around the antenna;

Fig. 7 is a horizontal cross-sectional view showing another embodiment having a shape similar to the embodiment shown in Figure 5 with thick walled non-grounded conductive object;

Fig. 8 is a horizontal cross-sectional view showing another embodiment of a double-walled non-grounded conductive object enclosing a non-conductive material;

Fig. 9 is a horizontal cross-sectional view showing another embodiment of a substantially spherically shaped non-grounded conductive object;

Fig. 10 is a diagrammatic view of a discone type antenna;

Fig. 11 is a dimensioned diagrammatic view of a discone type antenna;

Fig. 12 is a vertical cross-sectional view of an antenna system comprising a discone antenna and a non-grounded, conductive object;

Fig. 13 is a block diagram of a test system used to obtain results relating to the present invention;

Fig. 14 is a graph showing measurement results of electromagnetic wave intensity for an antenna system with and without a non-grounded conductive object;

Fig. 15 is a graph showing the change in S/N ratio when a non-grounded conductive object is used in conjunction with an antenna;

Fig. 16 is a graph comparing the S/N ratio for the current invention with several prior art antennas;

Fig. 17 is a graph comparing the signal power, in dBm, received by the antenna system of the current invention as well as two prior art antennas, as distance is increased from the transmitter;

Fig. 18 is a graph showing the S/N for Melco antennas at receiving and transmitting stations without a non-grounded conductive object;

Fig. 19 is a graph showing signal and noise measurements for Melco antennas without a non-grounded conductive object;

Fig. 20 is a graph showing the signal range for Melco antennas without a non-grounded conductive object;

Fig. 21 is a graph showing the S/N ratio for a discone antenna with a curved non-grounded conductive object;

Fig. 22 is a graph showing signal and noise measurements for a discone antenna with a curved non-grounded conductive object;

Fig. 23 is a graph showing the signal range for a discone antenna with a curved non-grounded conductive object;

Fig. 24 is a graph showing signal and noise readings for a communication PC card with no external antenna;

Fig. 25 is a graph showing the signal to noise ratio for a discone antenna with a curved non-grounded conductive object added; and

Fig. 26 is a graph showing signal and noise measurements for a Melco antenna without a non-grounded conductive object at a different time than the measurements taken for the graph in Fig. use 19.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to antenna systems, generally, and the problem of efficiency of the transmit and receive functions. It is particularly related to those antennas having broadband capabilities. The invention provides an antenna with improved T/R efficiency for applications where multiple frequency bands are used.

The term “antenna system” is used throughout the specification and is intended to mean a system or assembly for sending and receiving electromagnetic waves and to generate or produce an electric field. The terms "antenna" and "electromagnetic wave resonance component" are used interchangeably and are components or sub-assemblies that are part of the system. The term “discone” is intended to mean a particular type of antenna having disc and cone components; this term is also intended to cover “disc-cone” or other such exciters having this configuration. In both the claims and the description, the term “substantially flat” is meant to encompass not only those surfaces that are generally flat, but also those surfaces that are flat.

The present invention is an antenna system having at least two components or sub-assemblies: an electromagnetic wave resonance component and a non-grounded conductive object. The object lies in a selected position proximate the antenna. An insulated space lies between the antenna and the object. The non-grounded conductive object can completely or partially enclose the antenna, and is not electrically connected to the antenna.

While not completely understood, it is believed that the signal to noise ratio is improved by the present invention because an electric potential, similar to static induction, is created by interaction of the electromagnetic wave and the non-grounded conductive object when the object is placed in a selected position proximate the electromagnetic wave resonance component of the antenna, thus creating an electromagnetic wave interference that attenuates noise.

Various kinds of antennas may be utilized in the present invention. An improvement of the T/R efficiency, especially for multiband antennas, has substantial benefits. The discone is one example of a multiband antenna. Since the discone antenna functions acceptably with very wide bandwidth signals, it can be used for various applications, such as FM/AM radio, digital TV, GPS, Wireless LAN, RKE (Remote Keyless Entry), GDO (Garage Door Openers), cellular phones, and PHS (Personal Handy phone Systems). The discone antenna however suffers from its limited range at acceptable S/N ratios. This latter problem is overcome with the present invention.

The following is a description of the basic structure and operating characteristics of a discone type antenna relying on J.J. Nail's, *Designing Discone type antennas, Electronics*, August 1953, PP167-169.

The diagrammatic cross-section view of discone antenna **40** is shown in Fig. 10. Antenna **40** comprises disk **42**, truncated cone **44**, feeding cable **46** and central conductor **48** of feeding cable **46**. Electric power is fed to disk **42** through central conductor **48** of feeding cable **46**. The cone **44** is typically grounded.

The design parameters of a discone antenna are shown in Fig.11. C1 is the maximum diameter of cone **44**, C2 is the minimum diameter of truncated cone **44**, L is the slant height of cone **44**, φ is the flare angle of cone **44**, S is the disk- to-cone spacing, and D is the diameter of disk **42**.

The bandwidth of a discone type antenna can be determined by evaluating its Standing Wave Ratio (SWR). Frequencies in which the SWR is less than 2 are referred to as the bandwidth of the antenna. The lowest frequency of the discone antenna bandwidth has a wavelength of approximately 4 times the slant height of the cone.

Using a cone flare angle (φ) of 60 degrees can result, according to Nail, in a discone antenna with a bandwidth from 400 – 1300MHz or more. It is possible to reduce the minimum frequency of the bandwidth by increasing diameter C1 of cone **44**. Decreasing space S between disk **42** and cone **44** can increase the maximum frequency of the bandwidth.

Fig. 1 shows a preferred embodiment of the current invention. As shown therein, a discone antenna is used with a curved or arcuate (arc-shaped) non-grounded conductive object **20**. The arc may have any magnitude of subtended angle; however, a non-grounded conductive object with a smaller, rather than greater arc is preferred. An arc subtended by an angle of about 60 to about 180 degrees is preferred.

While any conductive material can be used, it is preferred that the non-grounded conductive object be formed of aluminum or copper. A thickness of about ten millimeters or less is preferred for the non-grounded conductive object. While holes may be placed in the non-grounded conductive object, the preferred embodiment uses an imperforate material. A non-grounded conductive object having a height greater than the antenna height is preferred; however, a non-grounded conductive object having a height less than the antenna also yields desirable results. A mounting base can be used to position the non-grounded conductive object relative to the antenna.

In the preferred embodiment the insulative material, which lies between the non-grounded conductive object and the antenna, is air; however, plastic or any other electrically insulative material may be used in the present invention.

Fig. 2 shows an embodiment of the present invention wherein the disk of the discone antenna is placed at the opening of a non-grounded, open-ended, cylindrically shaped, conductive object **20**.

Another embodiment of the present invention is shown in Fig. 3. The antenna system **10** is comprised of electromagnetic wave resonance component **12** and non-grounded conductive object **20** placed near component **12**. The antenna system signal feed **14** is electrically connected to electromagnetic wave resonance component **12**. Antenna **12** is positioned inside non-grounded conductive object **20**. Non-grounded conductive object **20** has a wall **24** that surrounds the electromagnetic wave resonance component **12**. Opening **22** is located at the bottom of the non-grounded conductive object **20** so as to receive antenna **12**. Wall **24** of non-grounded conductive object **20** is separated from electromagnetic wave resonance component **12** by air or another electrical insulator.

Fig. 4 is another example of antenna system **10**. In this example, electromagnetic wave resonance component **12** is partially positioned within non-grounded conductive object **20**.

Figs. 5-7 show cross-sectional views of various other embodiments of the present invention.

Fig. 5 shows a non-grounded conductive object **20** wherein wall **24** comprising three flat sections having a U-shape surrounding (on three sides) the electromagnetic wave resonance component **12**.

Fig. 6 shows a non-grounded conductive object **20** having a semi-circular cross-section positioned around electromagnetic wave resonance component **12**.

Fig. 7 shows a non-grounded conductive object **20**, having the shape as in Fig. 5, but with thick walls.

Fig. 8 shows a double-walled, non-grounded, conductive object **20** which is hollow and may be filled with a non-conductive material. As an alternative to the hollow object, the non-conductive material **28** may be adhered or attached to the inside of wall **24**.

Fig. 9 discloses another embodiment of a non-grounded conductive object **20** that is substantially spherically shaped having an opening formed by passing a plane through the spherical wall and removing the circular segment. However, it is also possible to completely enclose an antenna within a spherical non-grounded conductive object.

The non-grounded conductive object **20** of the present invention, in the presence of electromagnetic radiation, may generate an induced current or electric charge. Since the object **20** of the present invention is not grounded, the electric charge or current is confined in the wall **24**.

Generally, if an antenna wall is covered by a conductive substance and the conductive substance is grounded, the wall is shielded against external electromagnetic waves. The shielding effect is substantially different from that achieved by the present invention. The purpose of shielding is to protect the antenna from undesired electromagnetic waves. The present invention increases the T/R efficiency by placing a non-grounded conductive object near the antenna that results in an improved signal to noise ratio.

The present invention is suitable for radio communication systems, especially for wireless LAN with GHz band frequencies as well as systems utilizing the broadband capability of a discone antenna. The present invention is suitable for applications in which the antenna is mounted on a

vehicle, airplane, satellite, or other movable platform as well as on stationary platforms such as a building with a cellular base station or a residence for receiving digital television signals.

Industrial Applicability:

The invention is further illustrated by the following non-limiting examples.

Example 1

Fig. 13 shows a black box arrangement of a measurement or test system used to establish the superior efficiency of the invention. Transmitting equipment **100** included a transmitting circuit **102** and transmitting antenna **104**. Receiving equipment **120** comprised the receiving antenna **10,** the antenna component **122**, and receiving circuit **124**. Receiving circuit **124** included an Automatic Gain Control (AGC) circuit which stabilized and enhanced the received signal.

Fig. 12 is a vertical sectional view of the antenna systems **104**, **10** depicted in Figure 13. Antenna system **10** included a discone antenna **40** and non-grounded conductive object **20**. Insulation **26** within non-grounded conductive object **20** enclosed antenna **40**. Discone antenna **40** was mounted on insulating base **52**, and feed **46** of discone antenna **40** extended outside the system through base **52**.

In Fig. 13, the circuit of an IEEE 802.11b communication system (2.4GHz band) was used as transmitting equipment **100**, and a PC communication card with an output terminal was used as receiving equipment **120**.

In this example, a 2.4GHz discone type antenna was used in conjunction with a non-grounded conductive object which was a rectangular parallelepiped (aluminum foil lining) with inner dimensions of 8cm x 8cm x 10cm (height). The discone antenna was positioned so the cone axis was coaxial with the center line of the non-grounded conductive object.

Fig. 14 is a chart depicting time on the horizontal axis and electromagnetic wave intensity on the vertical axis. The graph shows the dramatic effect on noise and therefore S/N measurements at the moment the non-grounded conductive object was applied. As can be seen in Fig. 14, though the signal output remained virtually unchanged, the noise was reduced by 10dBm. As a result, the S/N ratio was improved.

Example 2

In the measurement experiment shown in Fig. 13, a sine wave signal from 50MHz to 30GHz was generated by transmitting circuit **102** and radiated from discone antenna **104** having a cone slant height of 3.8cm and a cone flare angle of 60 degrees. The receiver employed another discone

antenna of the same shape and size as that used for the transmitter. The received electromagnetic wave power was measured using a signal spectrum analyzer.

Two different non-grounded conductive objects were tested. Non-grounded conductive object A was cylindrically shaped, having a diameter of 25cm and a height of 10cm. Non-grounded conductive object B was also cylindrically shaped, however, its diameter was 8cm with a height of 10cm. Both of the conductive objects were made of aluminum. These conductive objects were then placed around the antenna and their effects recorded. The results are shown in Fig. 15 in which the horizontal axis shows frequency and the vertical axis shows signal to noise ratio in dB. One can see that for frequencies of less than approximately one GHz non-grounded conductive object A provides a better signal to noise ratio than object B; however, for frequencies that are greater than approximately one GHz, the S/N ratio for object B is greater than that of A.

Example 3

The S/N ratio was measured while varying the shape, material, and size of the non-grounded conductive object, using the same experimental communication setup described in Example 1. Results of this experiment are shown in Table 1.

TABLE 1

S/N Readings Obtained From Different Conductive Object Materials, Shapes, and Thicknesses

No.	Non-grounded conductive object				Change in S/N (dB)
	Material	Shape	I.D. (cm)	Thickness (mm)	
Ex. 3-1	aluminum foil	rectangular parallelepiped	8 x 8 x 10(h)	0.3	10
Ex. 3-2	Aluminum	cylinder	25φ x 10(h)	1	2
Ex. 3-3	Steel	cylinder	15φ x 17(h)	1	5
Ex. 3-4	Aluminum	rectangular parallelepiped	22 x 17 x 14(h)	30	1.5
Ex. 3-5	Brass	cylinder 1mm mesh	15φ x 17(h)	0.5 (diameter of brass wire)	5
Ex. 3-6	Polyethylene	cylinder	15φ x 17(h)	0.2	0

Example 4

The same setup was used as in Example 1, except that the S/N ratio was measured while raising the non-grounded conductive object above the discone type antenna. However, almost no

change was noticed, even when part of the discone was exposed from the lower end of the non-grounded conductive object.

Example 5

The same setup was used as in Example 1, except that an ordinary antenna for IEEE 802.11b system (2.4GHz band) was used instead of the discone type antenna. A rectangular parallelepiped of 8cm x 8cm x 10cm (height) was used for the non-grounded conductive object. This resulted in a 2dB improvement in the Signal to Noise ratio.

Example 6

Using the setup depicted in Fig. 13, three different antennas were tested. The first, labeled 11b, was the standard IEEE 802.11b personal computer communication PC card having only its internal antenna and no external antenna. The second set of measurements, labeled as Melco, were obtained by applying an external antenna, made by Melco, to the standard PC card of the first measurement. No conductive object was used in conjunction with the first two measurements. The third antenna system used was similar to that depicted in Fig. 1, i.e., a discone antenna having a curved non-grounded conductive object placed near it. Each receiving antenna was initially located next to the transmitter antenna. Each of the three receiving antennas was then moved to a distance of 230 meters from the transmitter, with multiple measurements of both S/N ratio and received power taken along the way. The results of these measurements were then plotted on graphs Fig. 16 and Fig. 17. Based on these graphs it is evident that the non-grounded conductive object resulted in a sizable increase not only in the received signal power, but also in the S/N ratio.

Example 7

The setup described in Example 6 was also tested. Maintaining a constant non-varying distance from the transmitter to the receiver, measurements for each of the three antennas were taken. These measurements consisted of signal, noise, signal to noise ratio, and signal range. The results of these measurements are depicted in Figs. 18-26.

Figs. 18 - 20 show a standard Melco antenna system, i.e. without the non-grounded conductive object, with measurements of S/N, signal and noise, and signal range.

Fig. 22 shows signal and noise readings obtained from a discone antenna with a curved non-grounded conductive object. Comparing the graph of this antenna with that of the Melco antenna (having no conductive object) and the PC card (also having no conductive object) with no external

antenna (Figs. 19 and 24 respectively), a definite advantage of the present invention can be seen. While the noise for each antenna system averaged around -90dBm, the signal reading for the discone type antenna with a curved non-grounded conductive object averaged signal readings of about 10dBm greater than the two antennas that had no conductive objects. These results are repeatable as evidenced by Figs. 25 and 26, which show the same results produced from the same setup but taken at a different time.

S/N readings for the Melco antenna, with no conductive object, and the discone antenna, having a curved non-grounded conductive object, are shown in Figs. 18 and 21 respectively. Looking at these readings, an increase in the S/N ratio of approximately 10dBm is readily detectable for the discone antenna having a curved non-grounded conductive object. Fig. 20 shows the signal range for the standard Melco antenna, while Fig. 23 shows the signal range for the discone antenna with a curved non-grounded conductive object. Based on these graphs, one can see that not only is the signal of the discone antenna with the non-ground conductive object, higher, but it also has less variation with time, hence an antenna with a non-grounded conductive object produces a smoother, more stable signal.

Although the invention has been described in detail with particular reference to these preferred embodiments, other embodiments can achieve the same results. Variations and modifications of the present invention will be obvious to those skilled in the art and it is intended to cover in the appended claims all such modifications and equivalents. The entire disclosures of all references, applications, patents, and publications cited above are hereby incorporated by reference.

CLAIMS

What is claimed is:

1. An antenna system comprising:
an antenna;
a non-grounded conductive object positioned proximate the antenna;
an insulated space lying between said antenna and said non-grounded conductive object.

2. The antenna system of claim 1, wherein said antenna comprises a discone antenna.

3. The antenna system of claim 2, wherein said discone antenna comprises:
a disc;
a cone including an apex and a base, said disc positioned above said apex of said cone; and
a feed wire disposed within said cone and extending outwardly beyond said cone.

4. The antenna system of claim 1, wherein said non-grounded conductive object is formed from aluminum material.

5. The antenna system of claim 1, wherein said non-grounded conductive object is formed from copper material.

6. The antenna system of claim 1, wherein said non-grounded conductive object is substantially flat.

7. The antenna system of claim 1, wherein said non-grounded conductive object is curved.

8. The antenna system of claim 7, wherein said non-grounded conductive object is substantially spherical.

9. The antenna system of claim 7, wherein said non-grounded conductive object is cylindrical.

10. The antenna system of claim 1 wherein said non-grounded conductive object has a thickness less than or equal to approximately ten millimeters.

11. The antenna system of claim 1, wherein said non-grounded conductive object includes two spaced apart walls.

12. The antenna system of claim 11, wherein the interstice is empty.

13. The antenna system of claim 12, wherein said interstice includes insulative material.

14. The antenna system of claim 12, wherein said insulative material is plastic.

15. The antenna system of claim 1, wherein said non-grounded conductive object completely encloses said antenna.

16. The antenna system of claim 1, wherein said non-grounded conductive object partially encloses said antenna.

17. The antenna system of claim 1, wherein said insulated space comprises air.

18. The antenna system of claim 1, wherein said insulated space comprises a plastic material.

19. The antenna system of claim 1, wherein said insulated space is less than or equal to approximately 50 millimeters in thickness

20. The antenna system of claim 7, wherein said curved non-grounded conductive object has an arc subtended between approximately 60 degrees and approximately 180 degrees.

21. A method for improving transmission and/or reception efficiency of an antenna, the method comprising the steps of:

providing an antenna; and

positioning a non-grounded conductive object completely or partially within the path of electromagnetic waves that are received by or transmitted from the antenna.

22. The method of claim 21 wherein the antenna is a discone antenna.

23. The method of claim 22 wherein the step of providing a discone antenna comprises a cone having an apex and a base and a disc positioned above the apex of the cone.

24. The method of claim 21 wherein the step of positioning the non-grounded conductive object comprises providing a curved non-grounded conductive object.

25. The method of claim 21 wherein the step of positioning the non-grounded conductive object comprises completely enclosing the antenna within the non-grounded conductive object.

26. The method of claim 21 wherein the step of positioning the non-grounded conductive object comprises partially enclosing the antenna within the non-grounded conductive object.

27. The antenna apparatus of claim 1, wherein said antenna comprises the antenna of a cellular telephone.

28. The method of claim 21 wherein the step of providing an antenna comprises the step of providing the antenna of a cellular telephone.

AMENDED CLAIMS

[received by the International Bureau on 11 October 2004 (11.10.2004);
original claims 1-28 replaced by new claims 1-24 (3 pages)]

CLAIMS

What is claimed is:

1. An apparatus for improving transmission and/or reception efficiency of a discone antenna comprising:

discone antenna;

a non-grounded conductive object positioned proximate the discone antenna; and

an insulated space lying between said antenna and said non-grounded conductive object.

2. The antenna system of claim 1 wherein said discone antenna comprises:

a disc;

a cone including an apex and a base, said disc positioned above said apex of said cone; and

a feed wire disposed within said cone and extending outwardly beyond said cone.

3. The antenna system of claim 1 wherein said non-grounded conductive object is formed from aluminum material.

4. The antenna system of claim 1 wherein said non-grounded conductive object is formed from copper material.

5. The antenna system of claim 1 wherein said non-grounded conductive object is substantially flat.

6. The antenna system of claim 1 wherein said non-grounded conductive object is curved.

7. The antenna system of claim 7 wherein said non-grounded conductive object is substantially spherical.

8. The antenna system of claim 7 wherein said non-grounded conductive object is cylindrical.

9. The antenna system of claim 1 wherein said non-grounded conductive object has a thickness less than or equal to approximately ten millimeters.

10. The antenna system of claim 1 wherein said non-grounded conductive object includes two spaced apart walls.

11. The antenna system of claim 11 wherein said insulated space is empty.

12. The antenna system of claim 12 wherein said insulated space includes insulative material.

13. The antenna system of claim 12 wherein said insulative material is plastic.

14. The antenna system of claim 1 wherein said non-grounded conductive object completely encloses said antenna.

15. The antenna system of claim 1 wherein said non-grounded conductive object partially encloses said antenna.

16. The antenna system of claim 1 wherein said insulated space comprises air.

17. The antenna system of claim 1 wherein said insulated space comprises a plastic material.

18. The antenna system of claim 1 wherein said insulated space is less than or equal to approximately 50 millimeters in thickness.

19. The antenna system of claim 7 wherein said curved non-grounded conductive object has an arc subtended between approximately 60 degrees and approximately 180 degrees.

20. A method for improving transmission and/or reception efficiency of a discone antenna, the method comprising the steps of:

providing a discone antenna; and

positioning a non-grounded conductive object completely or partially within the path of electromagnetic waves that are received by or transmitted from the antenna.

21. The method of claim 21 wherein the step of providing a discone antenna comprises providing a cone having an apex and a base and a disc positioned above the apex of the cone.

22. The method of claim 21 wherein the step of positioning the non-grounded conductive object comprises providing a curved non-grounded conductive object.

23. The method of claim 21 wherein the step of positioning the non-grounded conductive object comprises completely enclosing the antenna within the non-grounded conductive object.

24. The method of claim 21 wherein the step of positioning the non-grounded conductive object comprises partially enclosing the antenna within the non-grounded conductive object.

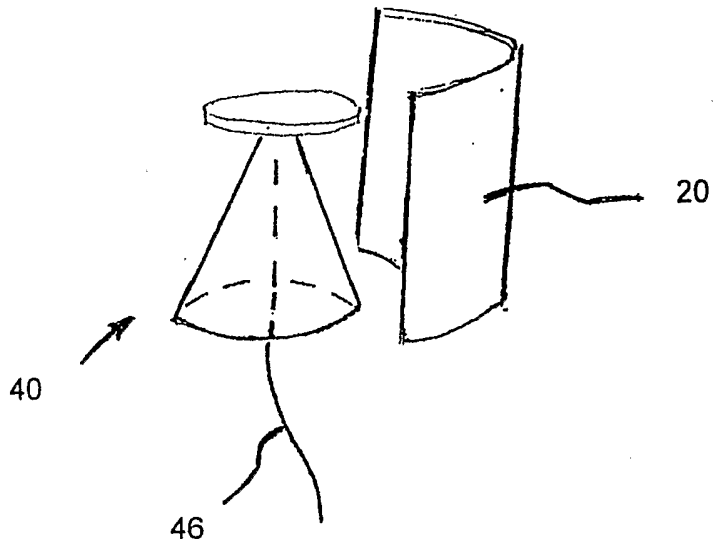


FIG. 1

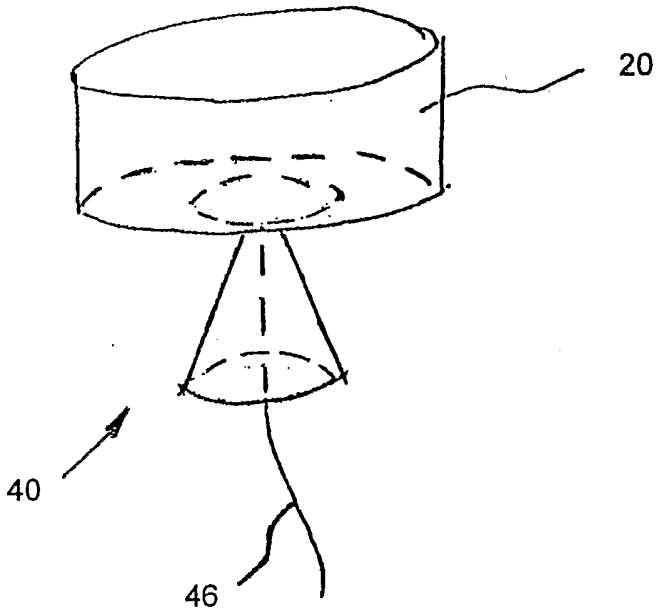


FIG. 2

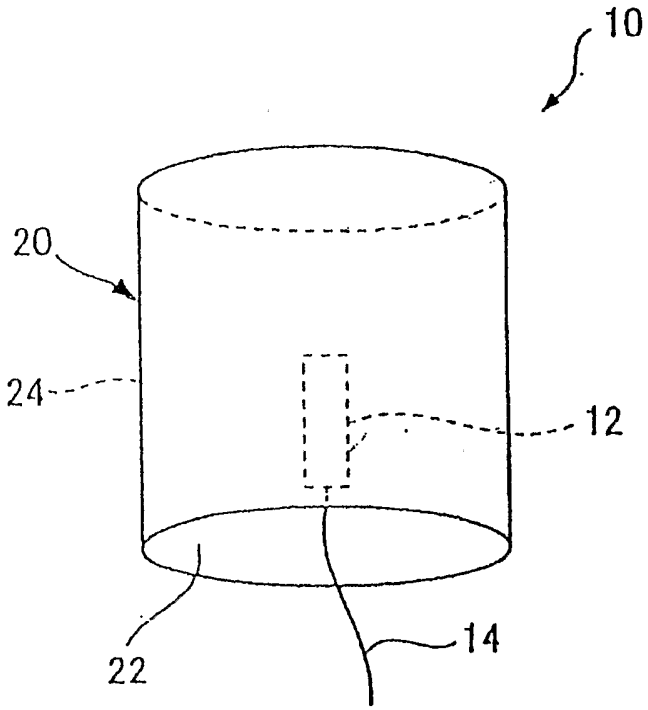


FIG. 3

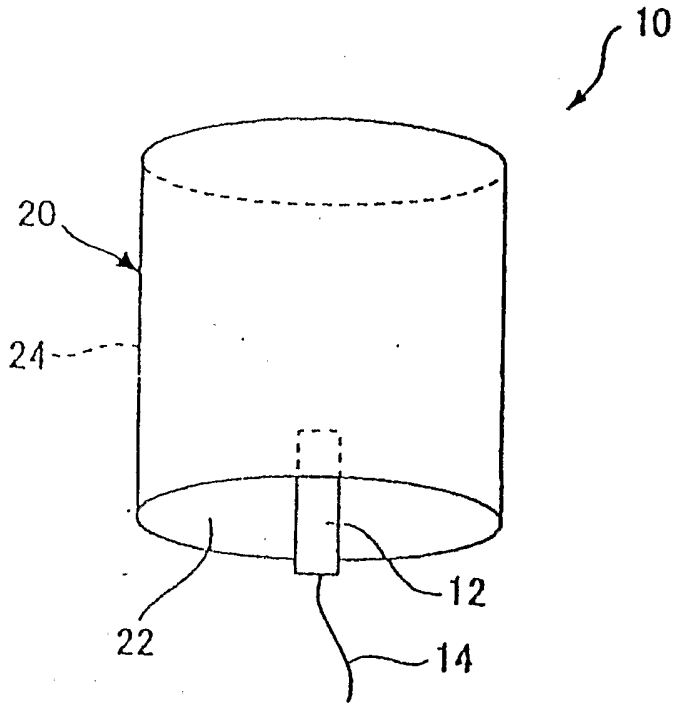


FIG. 4

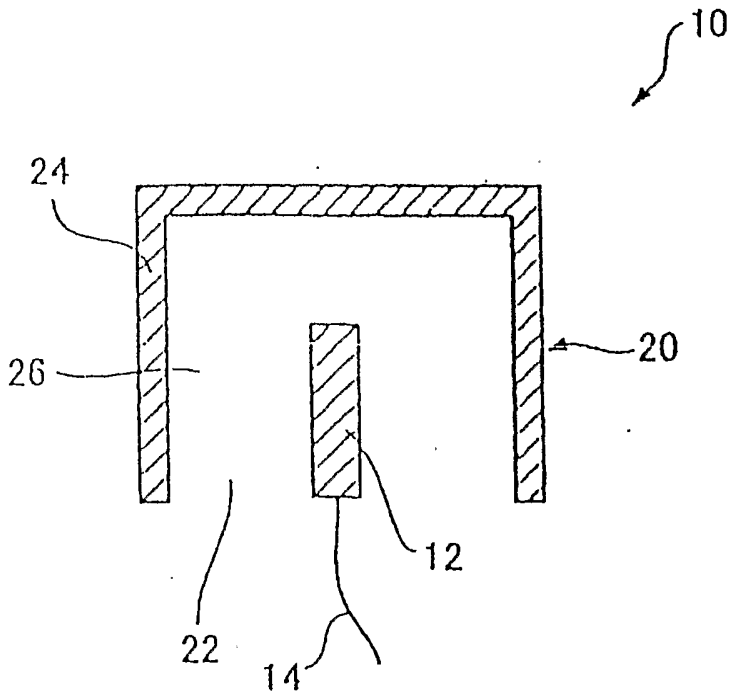


FIG. 5

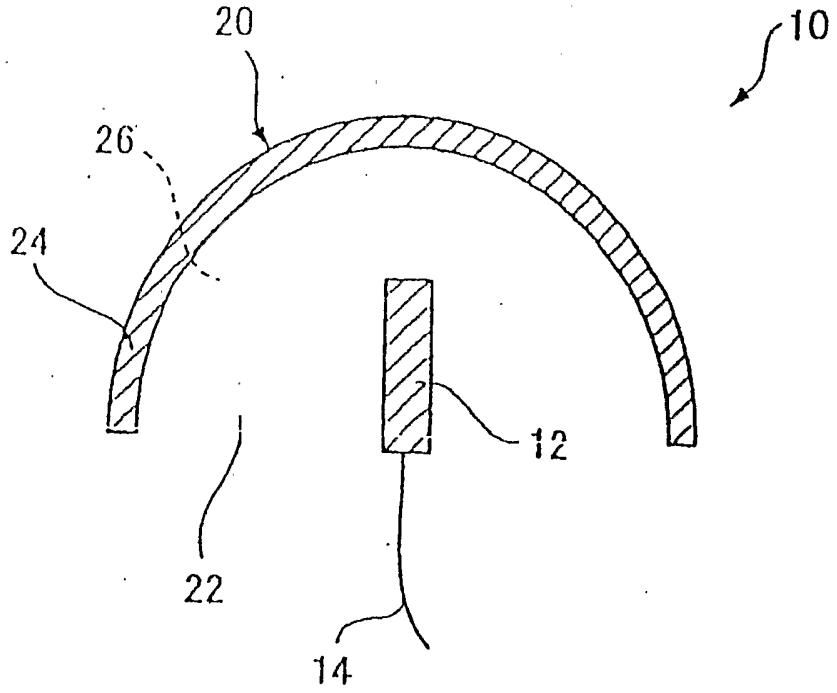


FIG. 6

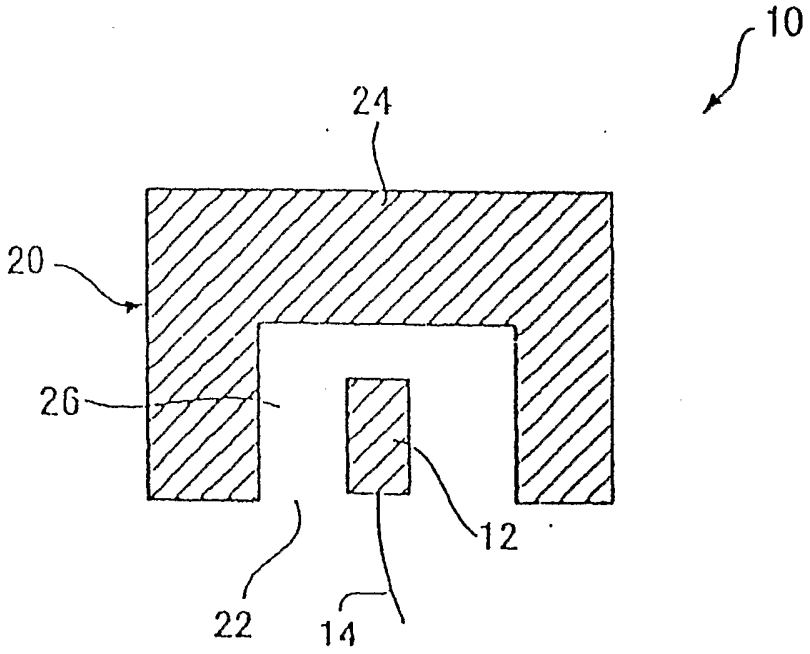


FIG. 7

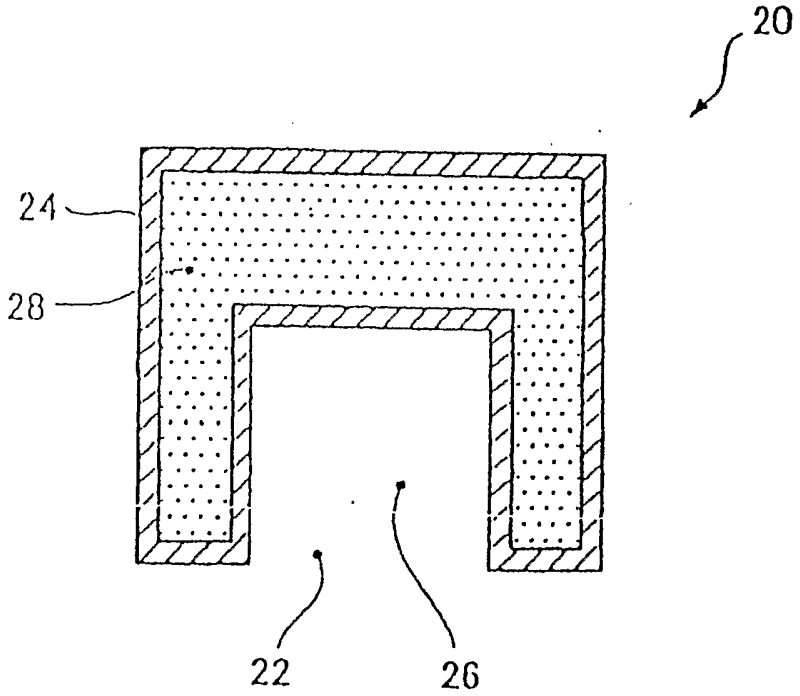


FIG. 8

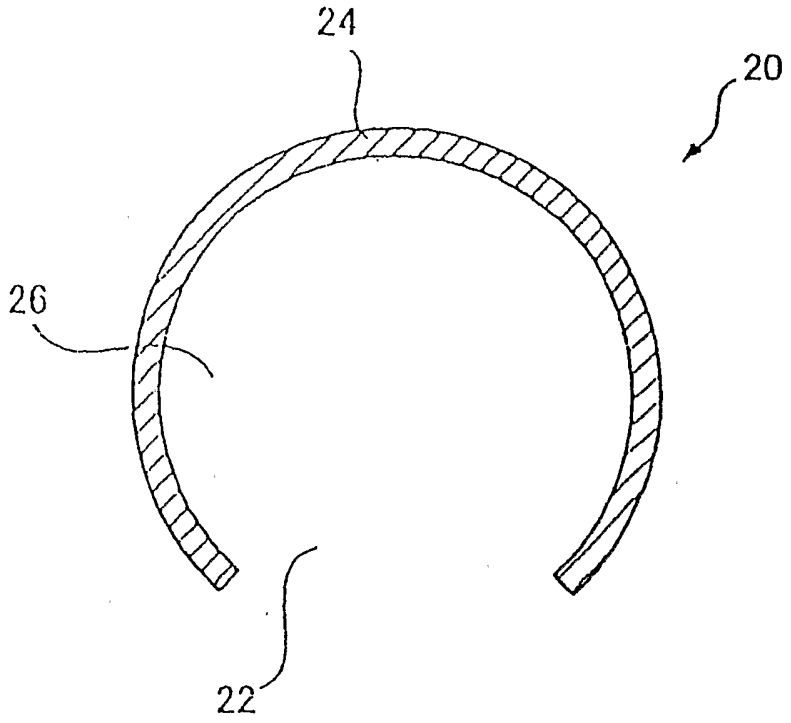


FIG. 9

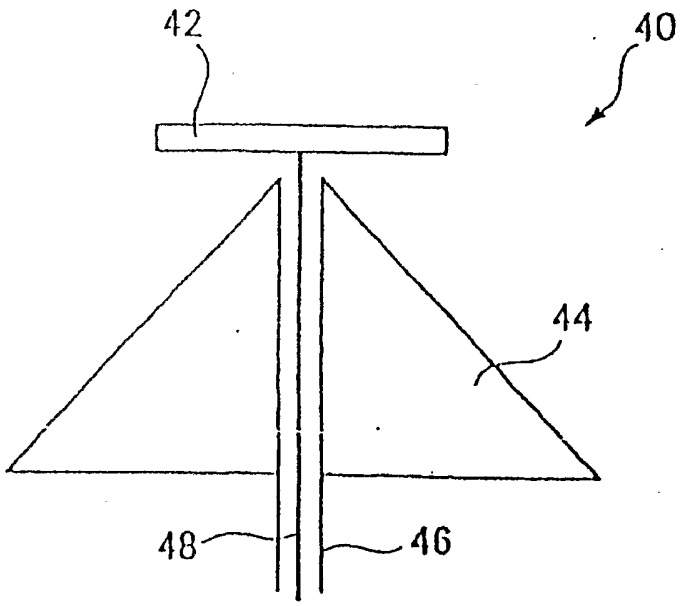


FIG. 10

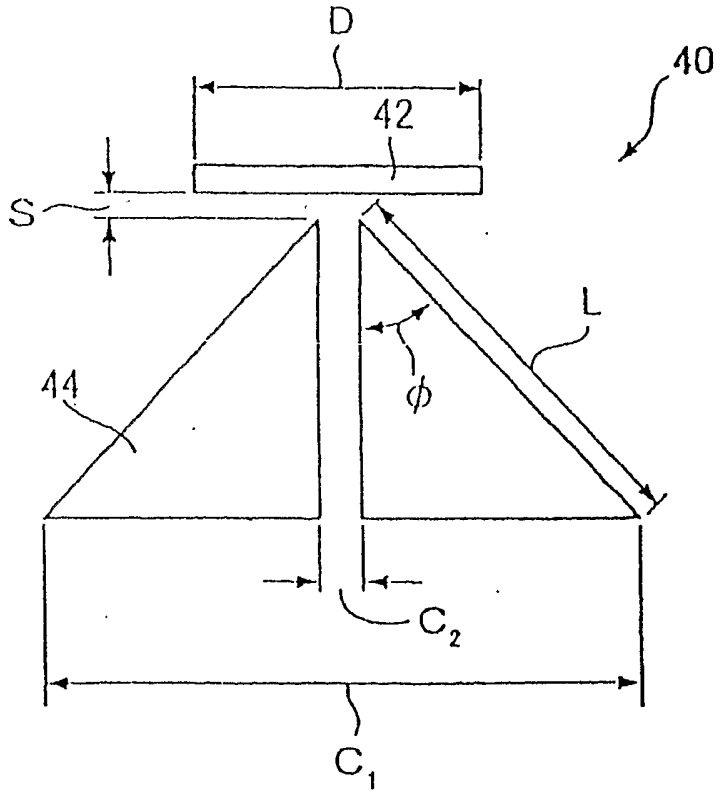


FIG. 11

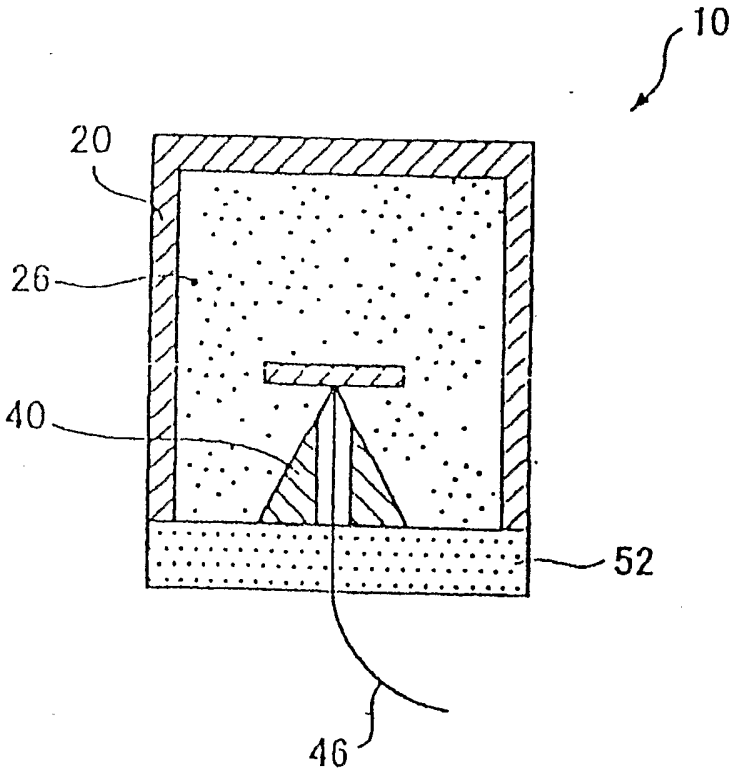


FIG. 12

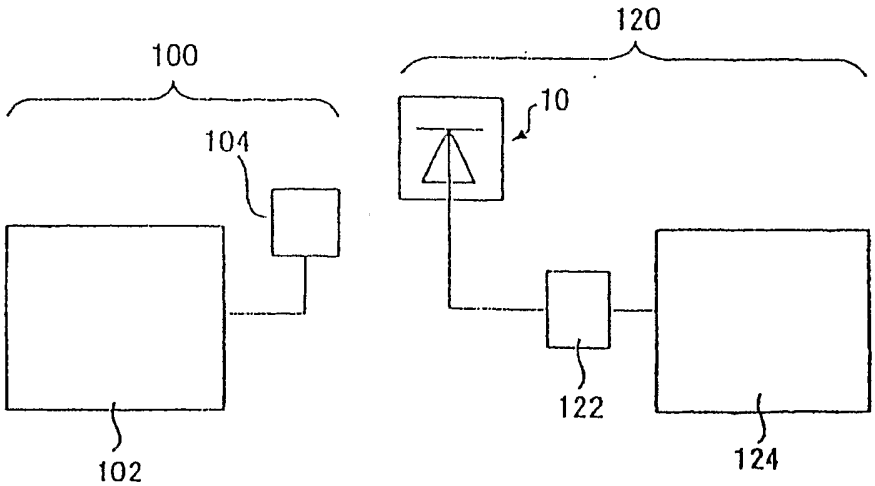


FIG. 13

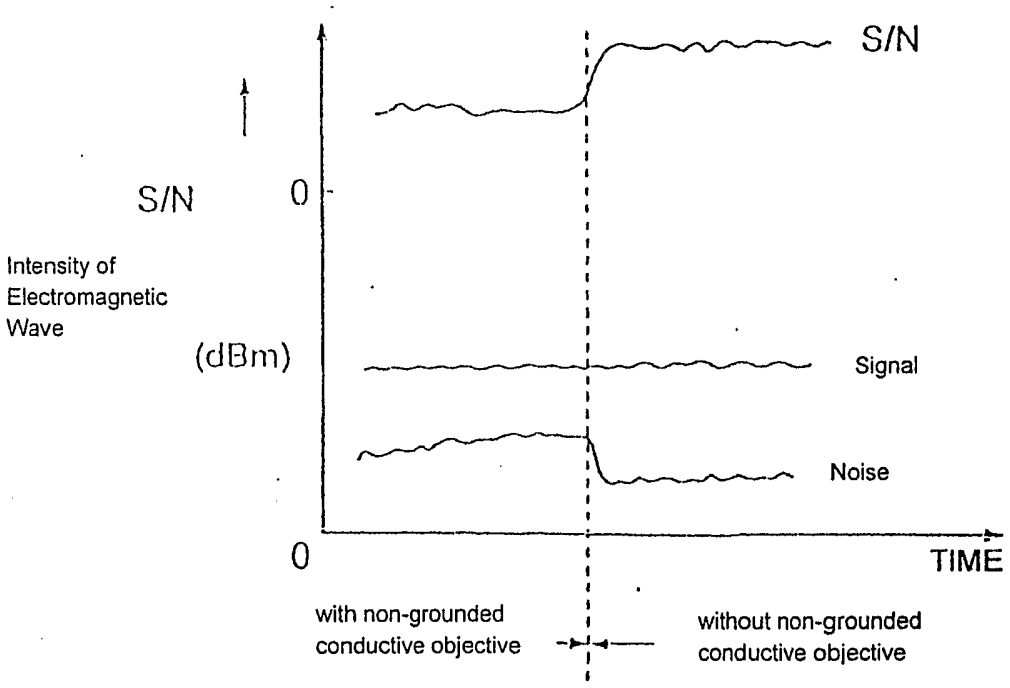

S/N
S/N
0
Intensity of
Electromagnetic
Wave
(dBm)
Signal
Noise
0
TIME
with non-grounded
conductive objective
without non-grounded
conductive objective

FIG. 14

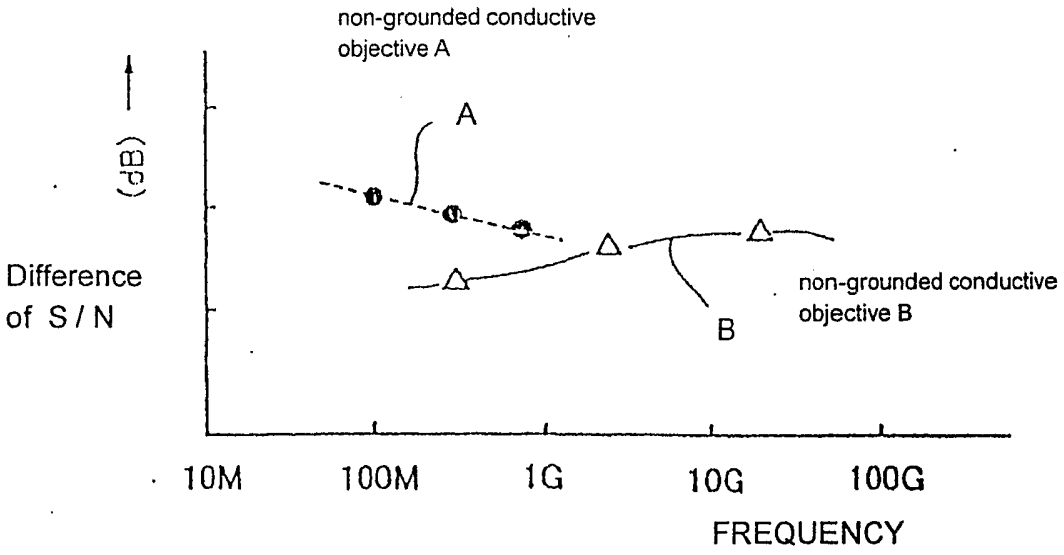

non-grounded conductive objective A
A
(dB)
Difference of S / N
B
non-grounded conductive objective B
10M
100M
1G
10G
100G
FREQUENCY

FIG. 15

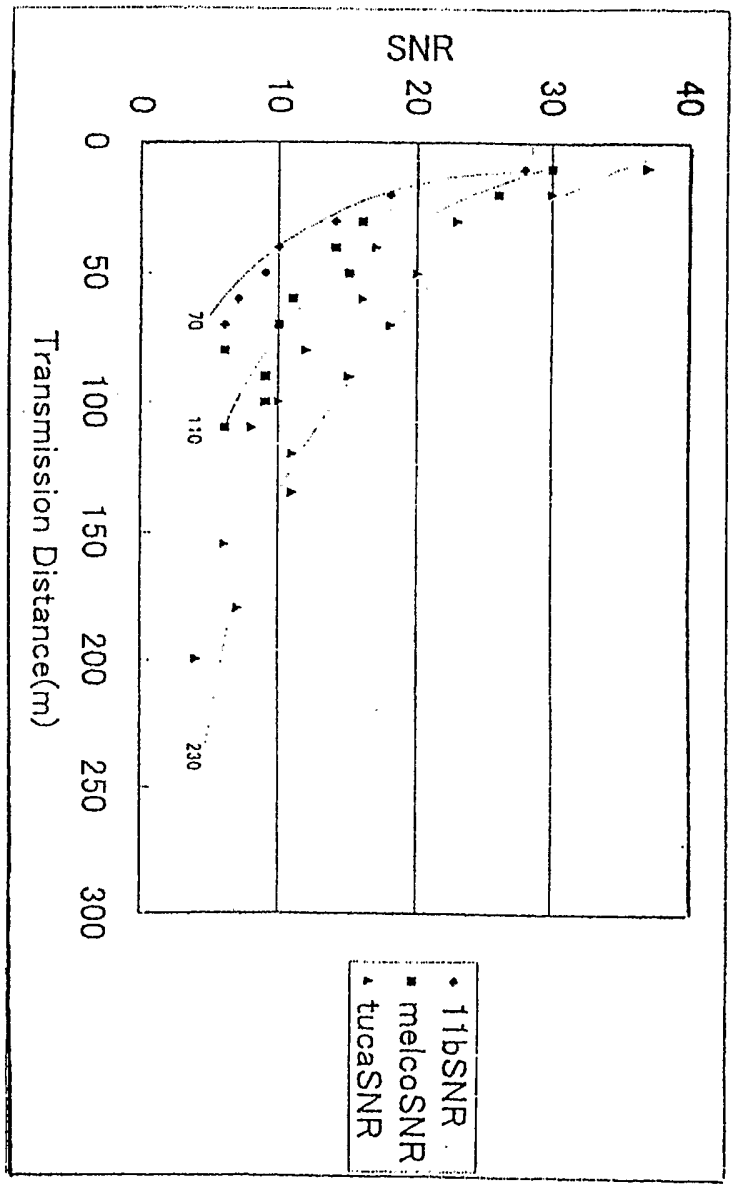

SNR
0
10
20
30
40
0
50
100
150
200
250
300
Transmission Distance(m)
70
110
230
11bSNR
melcoSNR
tucaSNR

FIG. 16

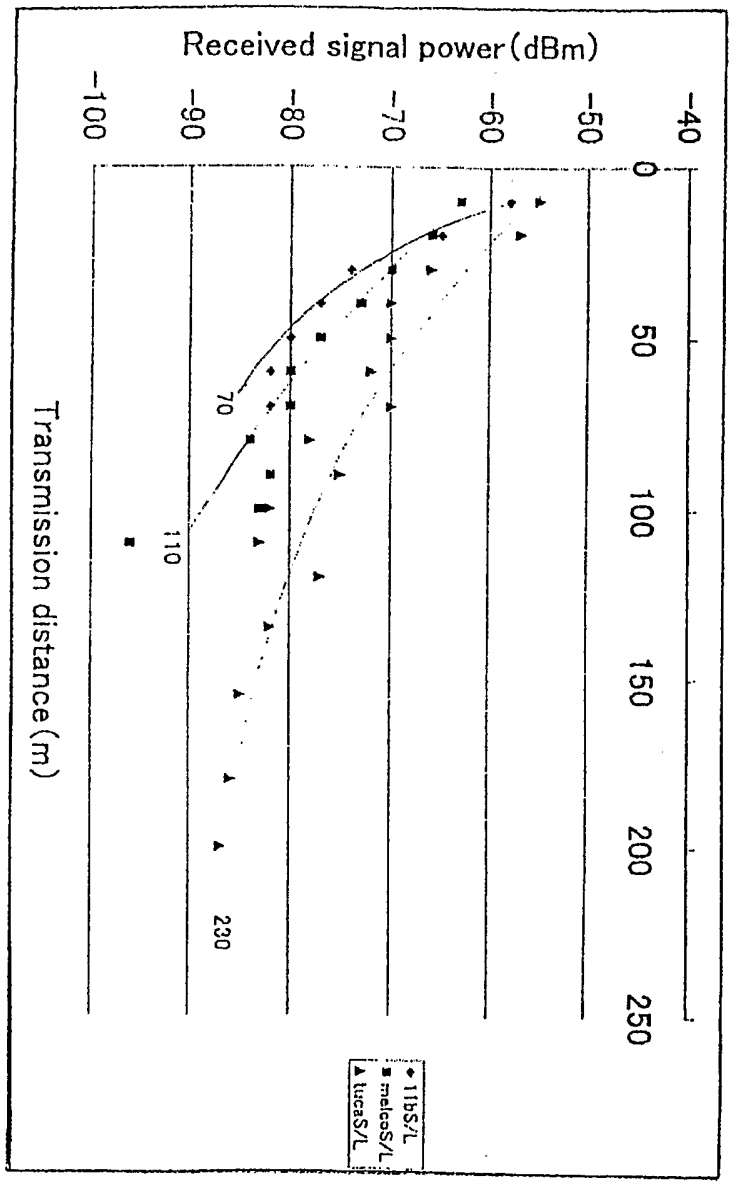

Received signal power(dBm)
-40
-50
-60
-70
-80
-90
-100
0
50
100
150
200
250
Transmission distance(m)
70
110
230
11bS/L
meleoS/L
tucaS/L

FIG. 17

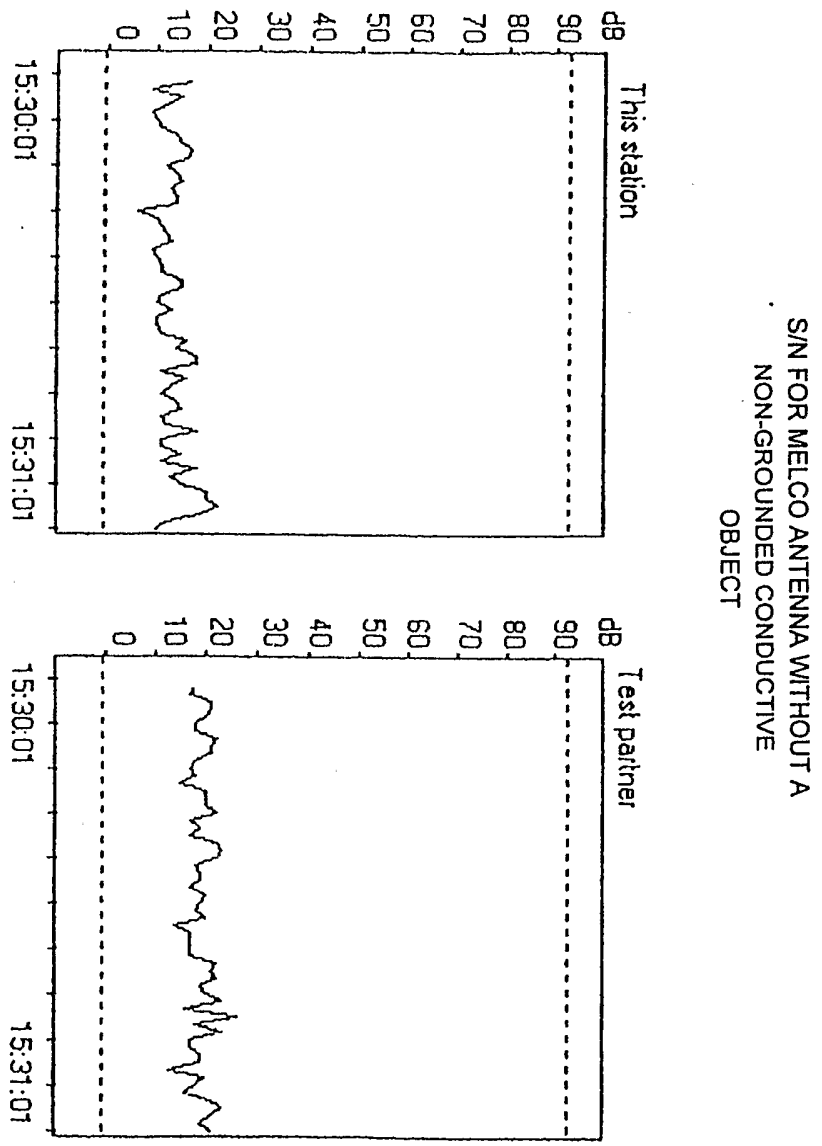

S/N FOR MELCO ANTENNA WITHOUT A
NON-GROUNDED CONDUCTIVE
OBJECT
This station
dB
90
80
70
60
50
40
30
20
10
0
15:30:01
15:31:01
Test partner
dB
90
80
70
60
50
40
30
20
10
0
15:30:01
15:31:01

FIG. 18

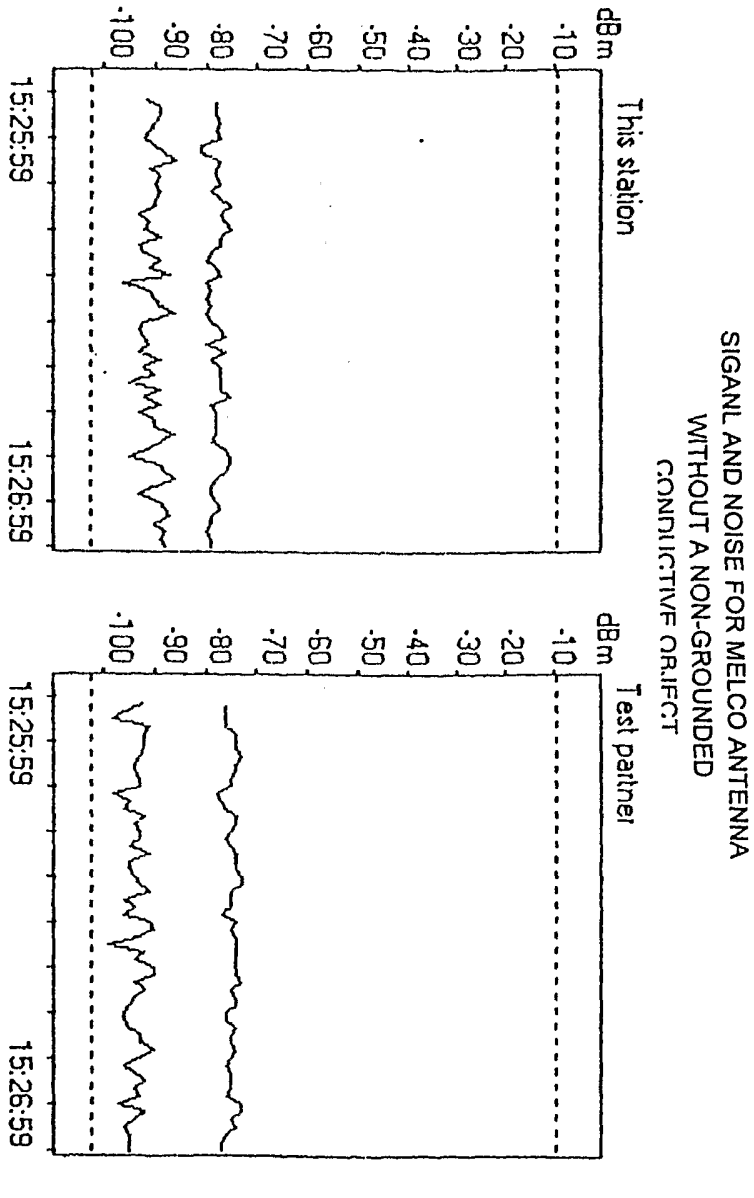

SIGANL AND NOISE FOR MELCO ANTENNA
WITHOUT A NON-GROUNDED
CONDUCTIVE OBJECT
This station
Test partner
dBm
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
15:25:59
15:26:59

FIG. 19

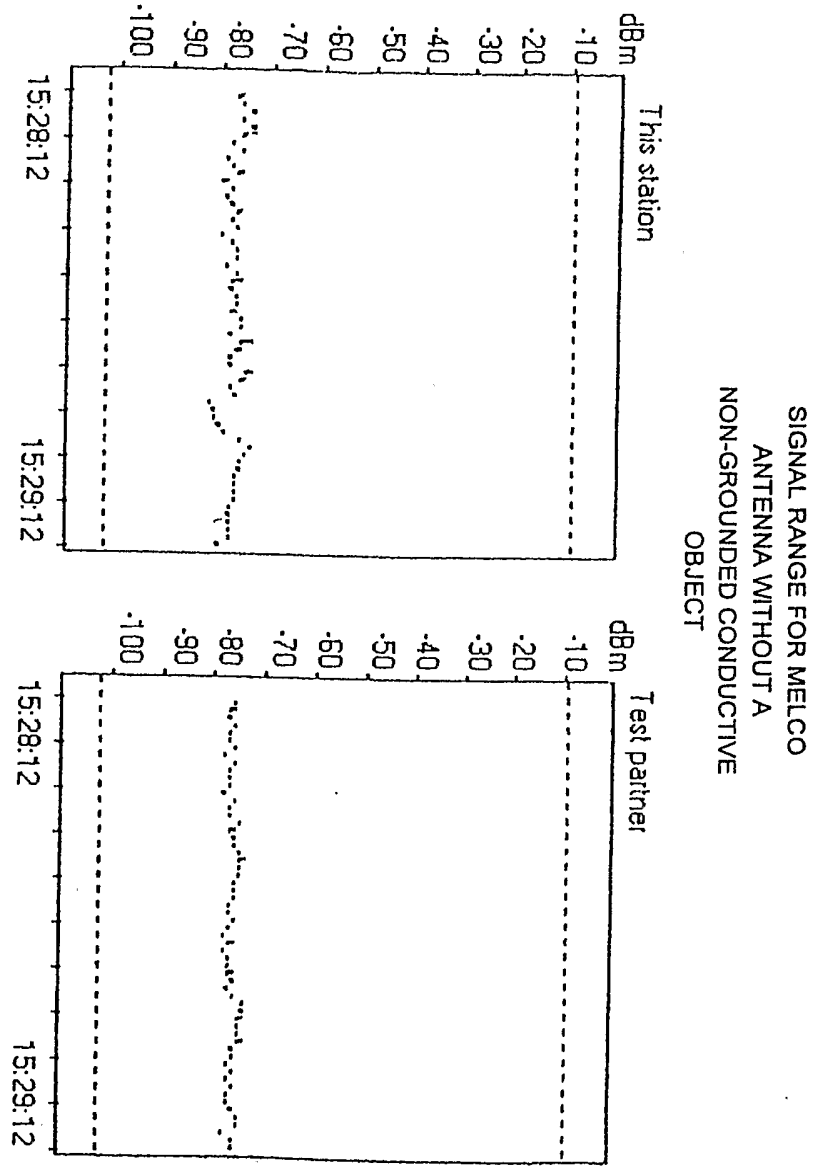

SIGNAL RANGE FOR MELCO
ANTENNA WITHOUT A
NON-GROUNDED CONDUCTIVE
OBJECT
This station
Test partner
dBm
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
15:28:12
15:29:12

FIG. 20

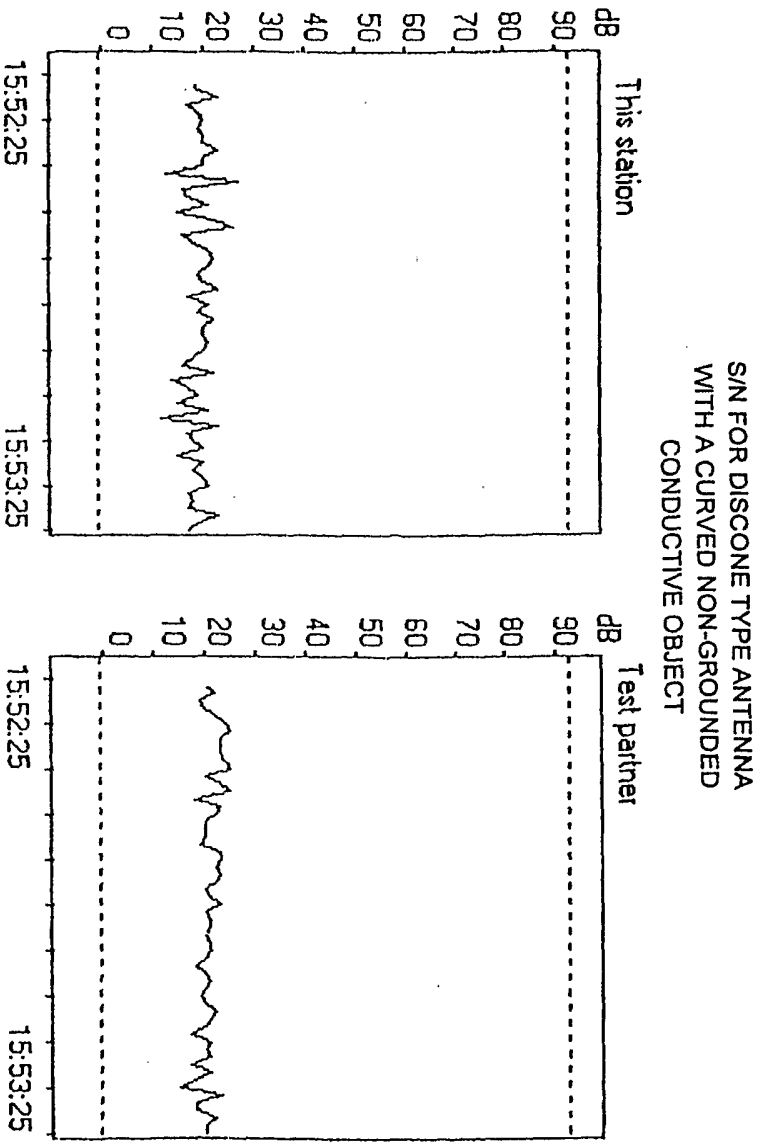

S/N FOR DISCONE TYPE ANTENNA
WITH A CURVED NON-GROUNDED
CONDUCTIVE OBJECT
This station
Test partner
dB
90
80
70
60
50
40
30
20
10
0
15:52:25
15:53:25

FIG. 21

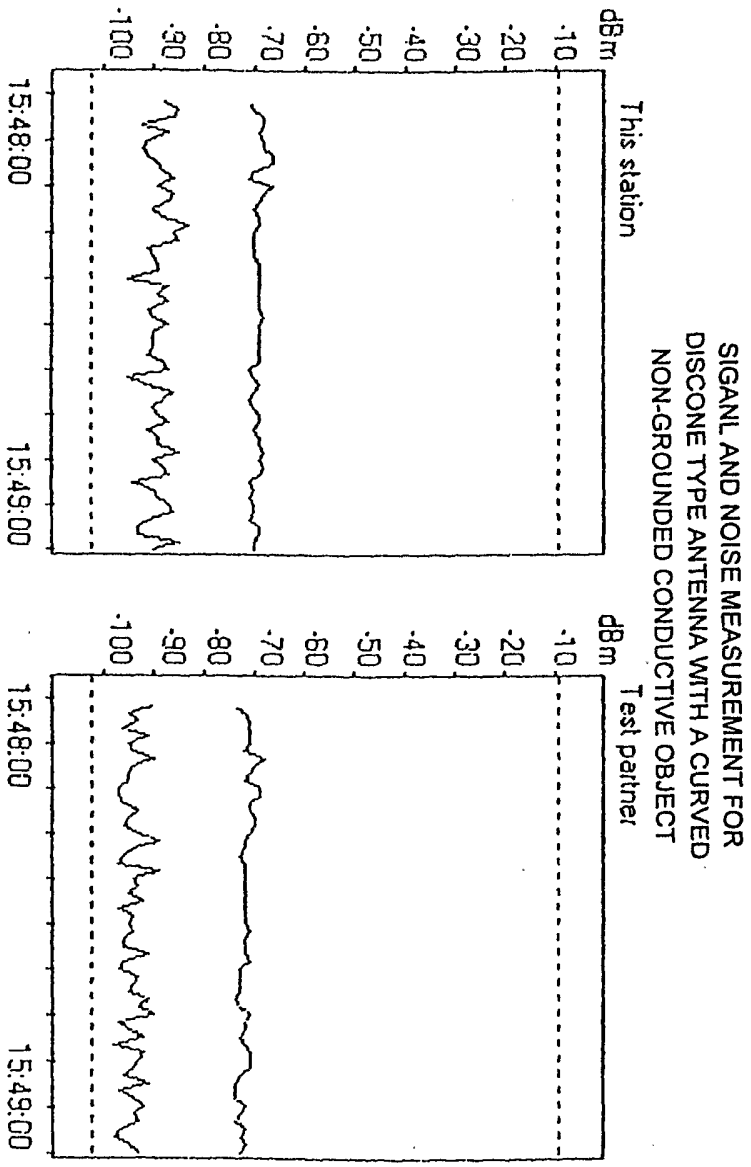

SIGANL AND NOISE MEASUREMENT FOR
DISCONE TYPE ANTENNA WITH A CURVED
NON-GROUNDED CONDUCTIVE OBJECT
This station
Test partner
dBm
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
15:48:00
15:49:00

FIG. 22

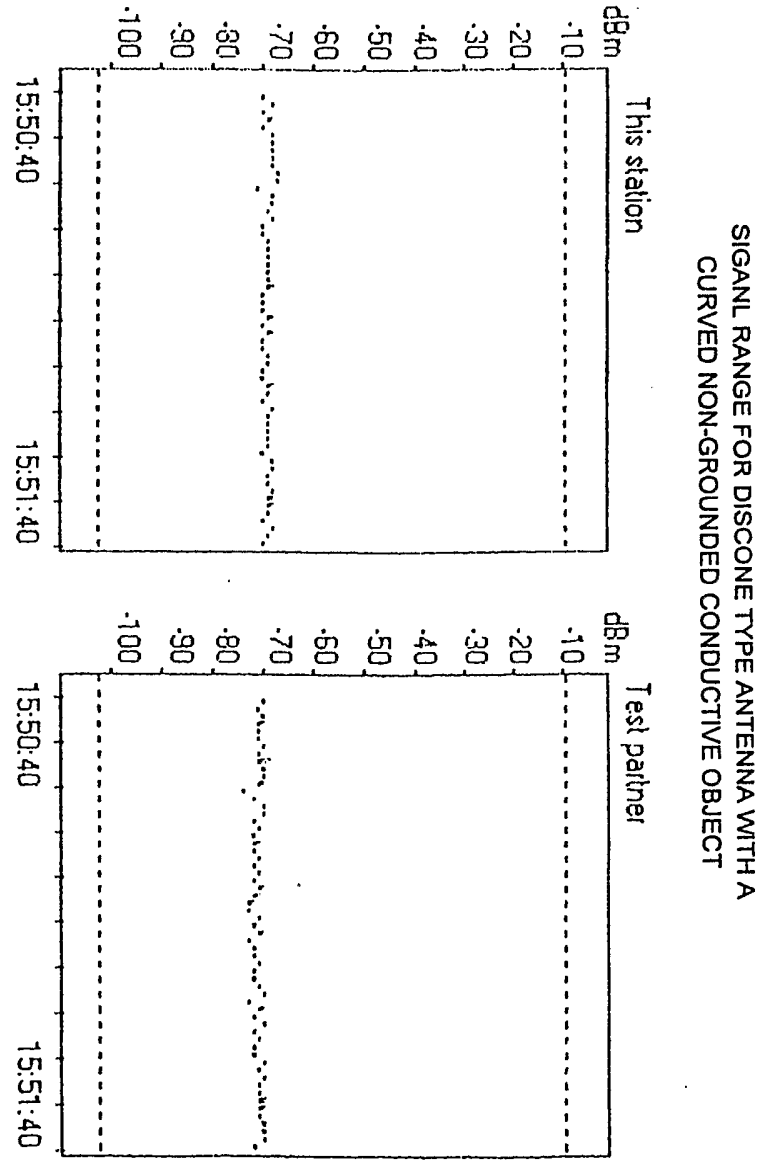

SIGANL RANGE FOR DISCONE TYPE ANTENNA WITH A CURVED NON-GROUNDED CONDUCTIVE OBJECT
This station
Test partner
dBm
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
15:50:40
15:51:40

FIG. 23

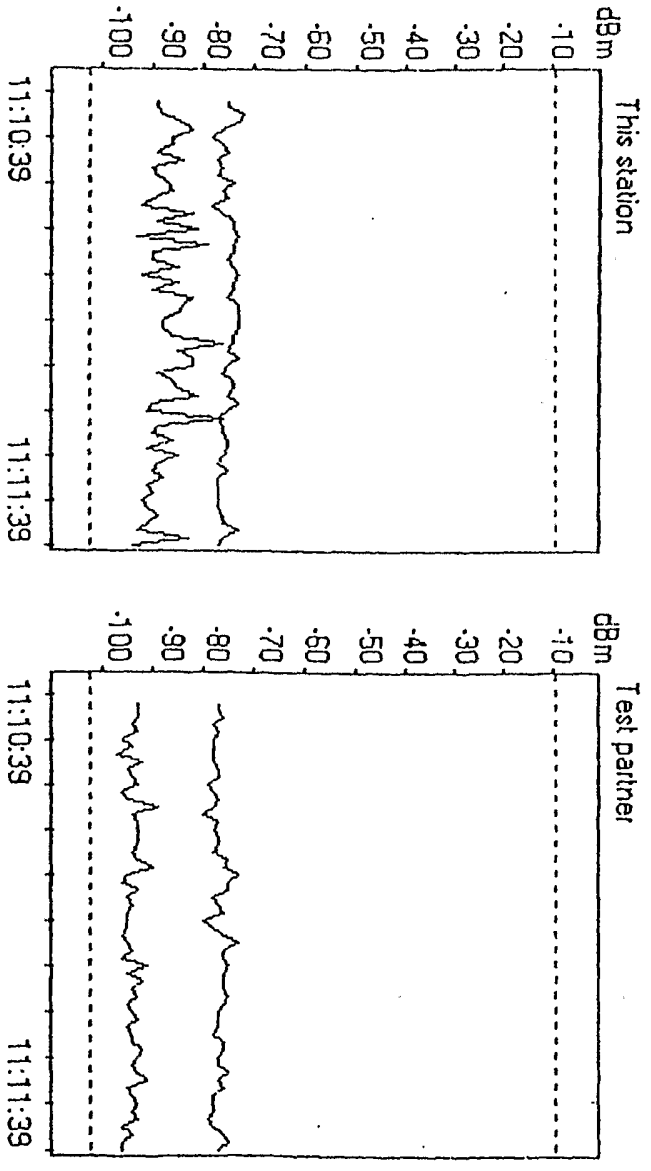

SIGNAL AND NOISE READINGS FOR THE PC CARD
WITH NO EXTERNAL ANTENNA
This station
Test partner
dBm
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
11:10:39
11:11:39

FIG. 24

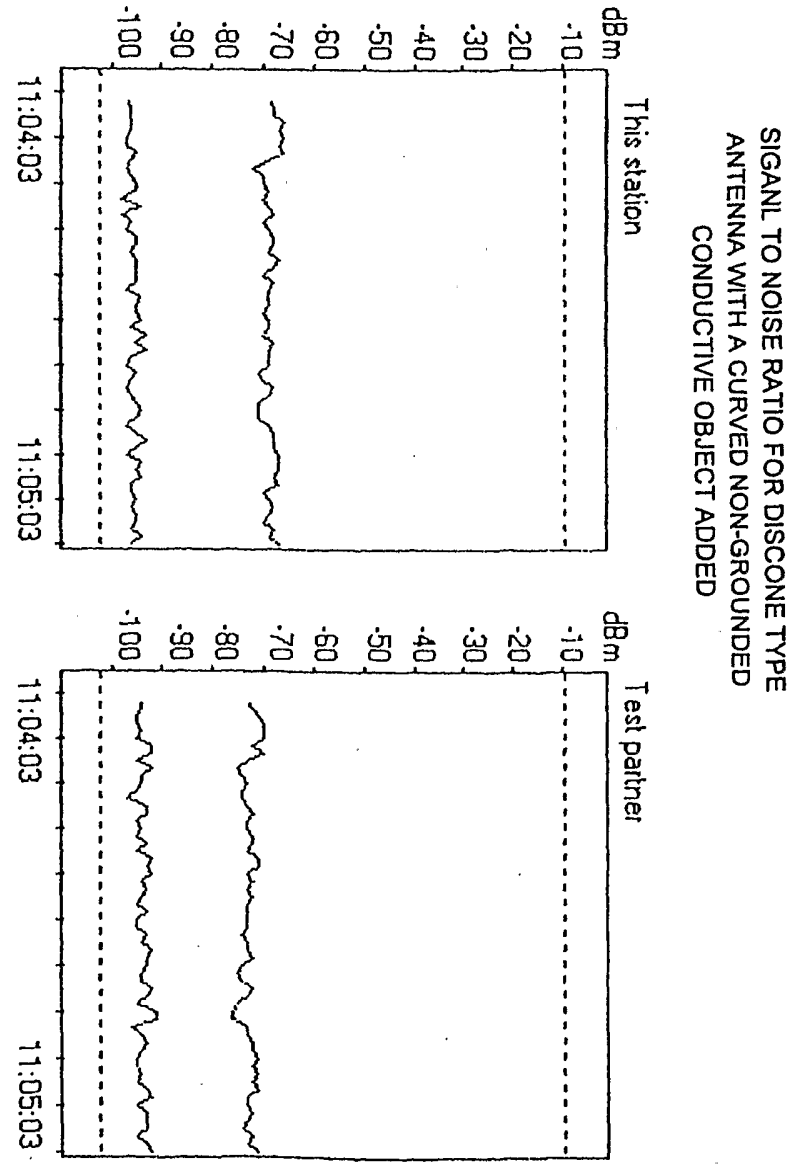

SIGANL TO NOISE RATIO FOR DISCONE TYPE
ANTENNA WITH A CURVED NON-GROUNDED
CONDUCTIVE OBJECT ADDED
This station
Test partner
dBm
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
11:04:03
11:05:03

FIG. 25

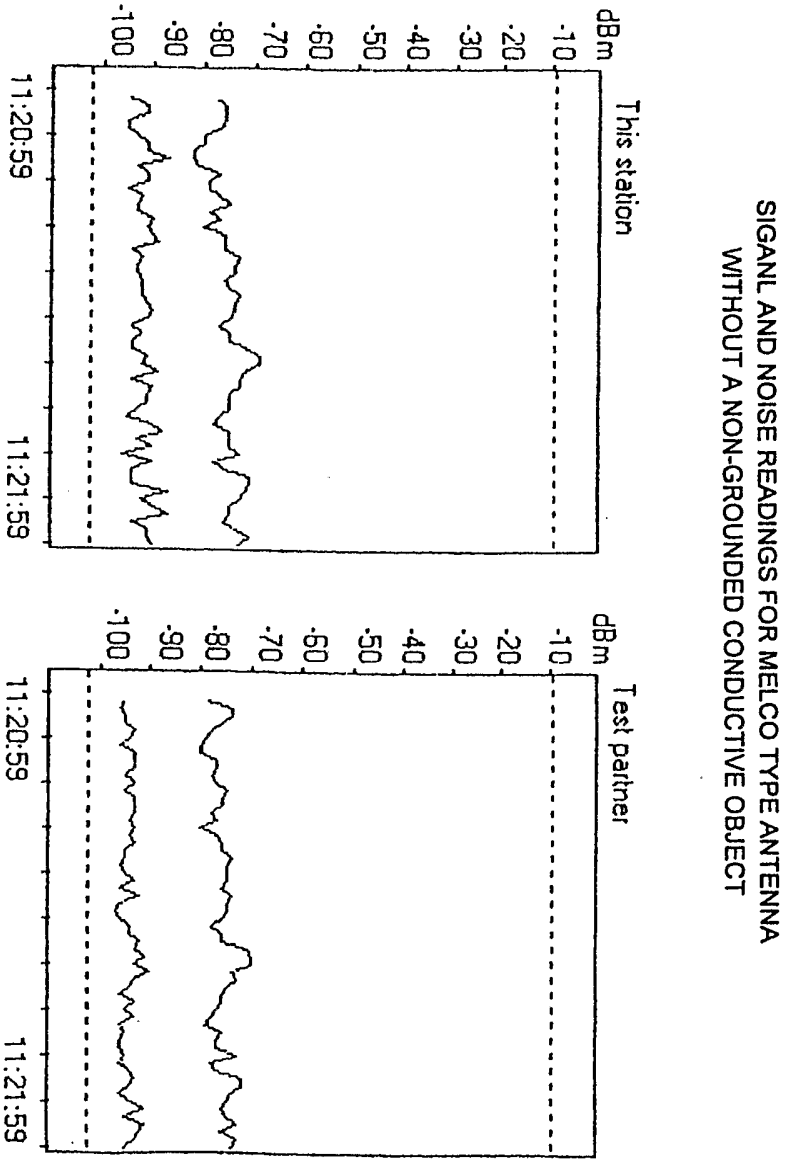

SIGANL AND NOISE READINGS FOR MELCO TYPE ANTENNA
WITHOUT A NON-GROUNDED CONDUCTIVE OBJECT
This station
Test partner
dBm
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
11:20:59
11:21:59

FIG. 26

INTERNATIONAL SEARCH REPORT

Int onal Application No
PCT/IB2004/001675

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01Q9/28 H01Q19/10

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)
IPC 7 H01Q

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

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

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CHANDRA MOULY M C ET AL: "ANALYTICAL EVALUATION OF RADIATION PATTERNS OF A TACAN ANTENNA" PROCEEDINGS OF THE NATIONAL AEROSPACE AND ELECTRONICS CONFERENCE. (NAECON). DAYTON, MAY 22 - 26, 1989, NEW YORK, IEEE, US, vol. VOL. 1 CONF. 41, 22 May 1989 (1989-05-22), pages 187-192, XP000076359 section Analysis	1-28
X	WO 97/44909 A (RICHARTZ WILLY) 27 November 1997 (1997-11-27) abstract; figure 1	1,21,27, 28

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 July 2004	10/08/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Van Dooren, G

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB2004/001675

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 926 599 A (TELEFUNKEN PATENT) 22 May 1963 (1963-05-22) page 2, lines 33-92; figure 1	1-3, 21-23
A	US 5 373 304 A (NOLAN JAMES F ET AL) 13 December 1994 (1994-12-13) abstract	1,21
A	EP 0 055 591 A (BUNNY CYRIL VICTOR) 7 July 1982 (1982-07-07) abstract; figure 1	1,21
A	GB 1 532 010 A (THOMSON CSF) 15 November 1978 (1978-11-15) figure 4	1,21
A	DE 14 41 103 A (SIEMENS AG) 10 October 1968 (1968-10-10) figures 1,2	1,21
A	WO 01/54224 A (LIBERMAN MARTY ; MACGILLIVRAY MARILYN (CA)) 26 July 2001 (2001-07-26) figures 1,7	1,21

INTERNATIONAL SEARCH REPORT

formation on patent family members

Inte onal Application No
PCT/IB2004/001675

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		AU 5683696 A	09-12-1997
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