Industria y Comercio

SUPERINTENDENCIA

Delegatura de Propiedad Industrial
División de Nuevas Creaciones

11-3771

SOLICITUD

PATENTE DE INVENCIÓN

21. **EXPEDIENTE No.** _____

54. **TÍTULO** ANTENA

51. **CLASIFICACIÓN INTERNACIONAL** _____

71. **SOLICITANTE** FRACARRO RADIOINDUSTRIE S.P.A.

DOMICILIO ITALIA

74. **APODERADO** JUAN CARLOS URIBE RESTREPO

22. **BOGOTÁ, D.C.,** ENERO 14 DE 2011

(FORMA P-10)

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO

No. 11-003771- -00000-0000

Fecha: 2011-01-14 16:31:59 Dep. 2020 DIR.NUEVASCR
Tra. 11 PATENTEIYII Eve: 378 FASENACIONALI
Act. 411 PRESENTACION Folios: 131

No. 11-003771- -00000-0000

Fecha: 2011-01-14 16:31:59 Dep. 2020 DIR.NUEVASCR
Tra. 2 PATENTES Eve: 1 RADEPOSITO
Act. 411 PRESENTACION Folios: 131

Industria y Comercio
SUPERINTENDENCIA

FORMULARIO ÚNICO DE SOLICITUD DE PATENTES
PCT
ENTRADA EN FASE NACIONAL

1 SOLICITUD DE:

[X] Patente de Invención [ ] Patente de Modelo de Utilidad

[X] Capítulo I [ ] Capítulo II

2 SOLICITANTE

Nombre: FRACASSO RADICI INDUSTRIE S.R.L.
Dirección: VIA CAZZAGO 6, 31059 S. GIUSEPPE DI CASSOLA (VI)
Nacionalidad o Domicilio: ITALIA
Lugar de Constitución: ITALIA
Teléfono: Fax:
E- Mail:

IDENTIFICACION

[ ] C.C. [ ] NIT
[ ] C.E. [ ] Otro
Cúal
Número

3 REPRESENTANTE O APODERADO

Nombre: JUAN CARLOS URIBE RESTREPO
Dirección: CALLE 93B No. 12-48, Piso 4o. BOGOTA, D.C., COLOMBIA
Teléfono: 6019660 Fax: 6114209
E- mail: tum@tumnet.com

IDENTIFICACIÓN

[X] C.C. [ ] NIT
[ ] C.E. [ ] Otro
Cúal
Número 79.159.313 TP 54.493

En caso de haber presentado poder general para asuntos que se adelanten ante la Delegatura de Propiedad Industrial, sírvase indicar el numero de radicación (del poder).

4 INVENTOR (ES)

(72)

Nombre: (i) WALTER BARBIRATO, (ii) LUIGINO RIGHETTO
Dirección: (i) VIA S. CHIARA 21, 36022 S. GIUSEPPE DI CASSOLA (VI), ITALIA (ii) VIA FRATELLI CERVI 8, 31055 QUINTO DI TREVISO (TV)
Nacionalidad o Domicilio: ITALIA / ITALIA

5 PCT (86)

Solicitud Internacional No. PCT/IB2009/005885 Fecha 09.06.2009
Publicación internacional No. WO 2009/153640 A1 Fecha 23.12.2009

6 Titulo (54) ANTENA

7 Clasificación Internacional (51) H01Q 19/30 (2006.01)

8 Prioridad

[X] SI [ ] NO

(33)País de Origen	(32) Fecha	(31) Número de Solicitud
ITALIA	17.06.2008	TO2008A000473

9 Comprobante del pago No. Fecha

Instrucciones para el diligenciamiento del presente formulario, ver reverso de esta página

10 Anexos

- [X] Comprobante de pago de la tasa de presentación de la solicitud.
- [ ] Documento que acredita la existencia y representación legal de la persona jurídica peticionaria, en cuanto no estén inscritas en alguna Cámara de Comercio Colombiana.
- [ ] Poderes, si fuere el caso.
- [ ] Documento de cesión del inventor al solicitante o a su causante.
- [X] Traducción de la solicitud internacional al castellano (Resumen, descripción, reivindicaciones, dibujos)
- [ ] Copia del examen preliminar internacional efectuado por la Autoridad Internacional de Examen preliminar (IPEA)
- [ ] Traducción de examen preliminar internacional efectuado por la IPEA
- [ ] De ser el caso, copia del contrato de acceso.
- [ ] De ser el caso, documento que acredite la licencia o autorización de uso de conocimientos tradicionales de las comunidades indígenas.
- [ ] De ser el caso, certificado de depósito del material biológico
- [X] Arte final 12x12.
- [ ] De ser el caso, información sobre otras solicitudes de patente o títulos obtenidos en el extranjero por el mismo titular o su causante, relacionadas parcial o totalmente con la invención de esta solicitud.
- [ ] De ser el caso, modificaciones efectuadas a la solicitud internacional.
- [X] Otros VER ANEXO No. 1

11 FIGURA CARACTERISTICA:

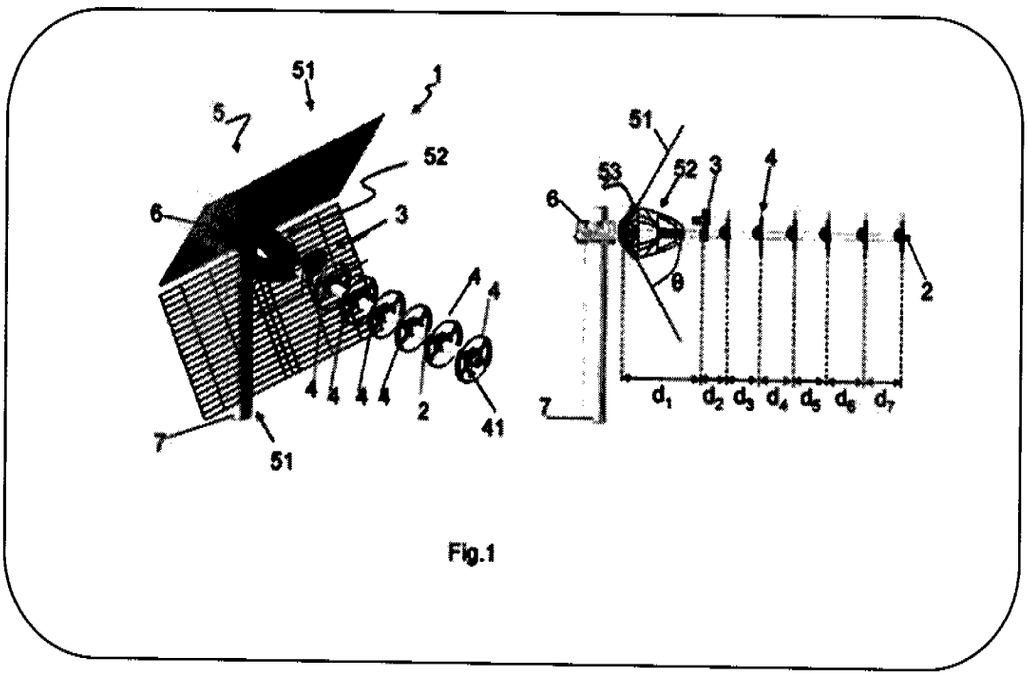


Fig.1

12 Solicito la concesión de la patente

NOMBRE: JUAN CARLOS URIBE RESTREPO

FIRMA

C.C. 79.159.319 T.P. 54196

Instrucciones para el diligenciamiento del presente formulario, ver reverso de esta página

ANEXO No. 1

1. PUBLICACIÓN INTERNACIONAL (WO2009/153640 A1)

2. REPORTE DE BÚSQUEDA INTERNACIONAL (PCT/ISA/210)

3. OPINIÓN ESCRITA DE LA AUTORIDAD DE BÚSQUEDA INTERNACIONAL (PCT/ISA/237)

4. ANTERIORIDADES CITADAS POR EL REPORTE DE BÚSQUEDA INTERNACIONAL CORRESPONDIENTES A :

   - PCT/US 2005/012528 CON PUBLICACIÓN INTERNACIONAL WO2005/1223331 A1
   - DE 44 43 055 A1

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
NIT : 800.176.089-2
- / -

Industria y Comercio
SUPERINTENDENCIA

RECIBO DE CAJA

No. 11 - 003944

Bogotá D.C., 14 de 2011 - 16:10:34

RECIBIDO DE : TRIANA URIBE & MICHELSEN LTDA NI 830.001.432

*** Soporte del Pago ***

TIPO PAGO	BANCO	CUENTA	No. PAGO	FECHA PAGO	VR.PAGO
CONSIGNACION	BANCO DE BOGOTA	062754387	353168524	14/01/2011	6.592.000.00

*** Conceptos Pagados ***

CANT.	RENTISTICO	CONCEPTO	Vr.UNDITARIO	Vr.CONCEPTO
1	50005-01-01 SOLICITUDES	1 TRAMITES DE SOL. DE PATENTE DE INVENCION	571.000.00	571.000.00
				$571.000.00

SON: **QUINIENTOS SETENTA Y UN MIL PESOS MONEDA CORRIENTE***

Responsable: _____

Recibo de Caja Aplicado al Expediente No. _____

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
No. 11-003771- -00000-0000
Fecha: 2011-01-14 16:31:59 Dep. 2020 DIR.NUEVASCR
Tra. 2 PATENTES Eve: 1 RECDEPOSITO
Act. 411 PRESENTACION Folios: 131

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
No. 11-003771- -00000-0000
Fecha: 2011-01-14 16:31:59 Dep. 2020 DIR.NUEVASCR
Tra. 11 PATENTEIYII Eve: 378 FASENACIONALI
Act. 411 PRESENTACION Folios: 131

5

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
NIT : 800.176.089-2
- / -

Industria y Comercio
SUPERINTENDENCIA

RECIBO DE CAJA

No. 11 - 003945

Bogotá D.C., 14 de 2011 - 16:10:34

RECIBIDO DE : TRIANA URIBE & MICHELSEN LTDA NI 830.001.432

*** Soporte del Pago ***

TIPO PAGO	BANCO	CUENTA	No. PAGO	FECHA PAGO	VR.PAGO
CONSIGNACION	BANCO DE BOGOTA	062754387	353168524	14/01/2011	6.592.000.00

*** Conceptos Pagados ***

CANT.	RENTISTICO	CONCEPTO	Vr.UNDITARIO	Vr.CONCEPTO
5	50005-01-01 SOLICITUDES	1607 REIVINDICACION UNITARIA ADICIONAL A LAS 10 INICIALES	27.000.00	135.000.00
				$135.000.00

SON: **CIENTO TREINTA Y CINCO MIL PESOS MONEDA CORRIENTE*

Responsable: _____

Recibo de Caja Aplicado al Expediente No. _____

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
No. 11-003771- -00000-0000
Fecha: 2011-01-14 16:31:59 Dep. 2020 DIR.NUEVASCR
Tra. 2 PATENTES Eve: 1 REGDEPOSITO
Act 411 PRESENTACION Folios: 131

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
No. 11-003771- -00000-0000
Fecha: 2011-01-14 16:31:59 Dep. 2020 DIR.NUEVASCR
Tra. 11 PATENTEIYII Eve: 378 FASENACIONALI
Act. 411 PRESENTACION Folios: 131

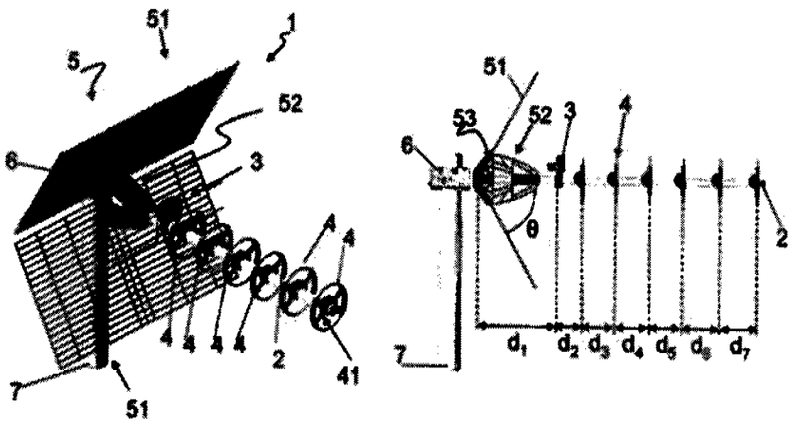


Fig.1

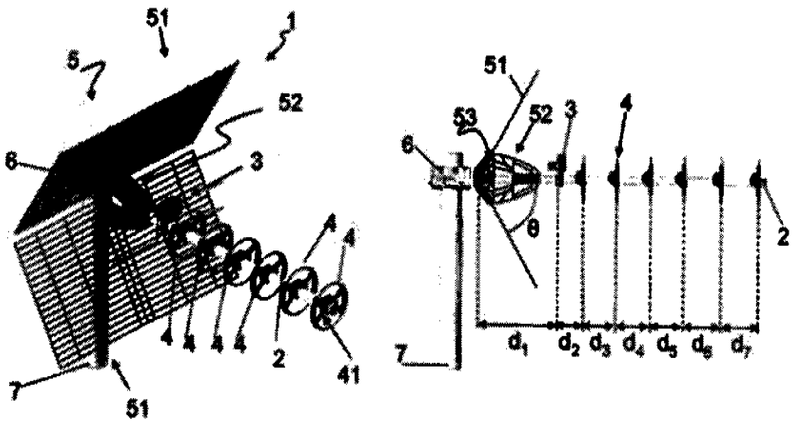


Fig.1

ANTENA

Descripción de la Invención

La presente invención se refiere a una antena de acuerdo con el preámbulo de la reivindicación 1. En la actualidad, son conocidos varios tipos de antenas, las cuales pueden ser clasificadas de acuerdo con un número de características tales como la capacidad de recibir líneas de polarizaciones circulares. En general, una antena comprende tres elementos básicos: un radiador que genera el campo electromagnético (es decir, la señal de radio) transmitida por la antena, un reflector y uno o más elementos parásitos o directores que modifican este campo con el propósito de hacer más direccional u orientada la antena. Las antenas de Yagi-Uda permiten la recepción y transmisión de campos electromagnéticos polarizados en forma lineal; estas antenas son equipadas con un radiador adaptado para generar este campo (por ejemplo, un dipolo $\lambda/2$ o un dipolo plegado) y con directores de forma lineal (en forma típica, varillas de metal) adaptados para recibir una polarización lineal, es decir, un campo eléctrico polarizado en forma lineal. Las antenas de este tipo son conocidas a partir de la solicitud de patente GB 2406971, la cual describe antenas cuyos directores son varillas de metal situadas en el soporte extensible de antena, o elementos de forma-X con varillas de metal insertadas en un alojamiento dieléctrico y que salen de los mismos en un patrón entrecruzado. En su lugar, las antenas de circuito Yagi pueden recibir una onda de radio que tiene una polarización elíptica o circular, y son caracterizadas por un radiador anular y directores que tienen

una sección transversal circular. El número de directores, la energía suministrada al radiador y la longitud de la antena son iguales, este segundo tipo de antena es usualmente más direccional y proporciona un ancho de banda más ancho que las antenas de Yagi-Uda.

Sin embargo, las antenas de circuito Yagi experimentan el inconveniente de que no es posible discriminar entre las señales de radio de polarización horizontal y polarización vertical.

El objetivo de la presente invención es proporcionar una antena que sea alternativa a la técnica anterior.

En particular, el objetivo principal de la presente invención es mejorar la directividad y la ganancia de las antenas conocidas para la recepción de señales polarizadas en forma lineal.

Estos objetivos son conseguidos a través de una antena que incorpora las características señaladas en las reivindicaciones adjuntas, las cuales se pretende como una parte integral de la presente descripción.

La presente invención está basada en la idea de utilizar un radiador que pueda generar y recibir un campo electromagnético polarizado en forma lineal (es decir, una señal de radio) y de utilizar directores adaptados para recibir un campo electromagnético que tenga una polarización elíptica o circular.

Los directores tienen un cuerpo que es conductivo dentro de la frecuencia de operación de la antena; y tienen por objetivo la recepción de la polarización circular, el cuerpo conductivo es de manera que la proyección del mismo sobre un plano ortogonal a la dirección de la ganancia máxima

de la antena encierra una porción limitada del plano.

Por ejemplo, la proyección podría ser un anillo (que tiene una forma circular o elíptica) o de manera más general, una figura que se encierre por sí misma al menos en un punto, como una nariz.

Las pruebas realizadas por la solicitante han mostrado de hecho, que los directores de este tipo incrementan la ganancia de la antena, incluso si el radiador es utilizado para generar o recibir un campo electromagnético polarizado en forma lineal.

De manera ventajosa, el elemento de director de la antena podría comprender un elemento helicoidal con un eje de rotación de la hélice que es paralelo o coincidente con la dirección de la ganancia máxima de la antena. Esta solución ofrece la ventaja de que el proceso de ensamble de antena es simplificado y la antena es mecánicamente más fuerte.

Los objetivos y ventajas adicionales de la presente invención serán aparentes a partir de la siguiente descripción y de las figuras adjuntas, las cuales son suministradas por medio de un ejemplo no limitante, en donde:

La **Figura 1** muestra dos vistas en perspectiva de una antena de acuerdo con una primera modalidad de la presente invención;

Las **Figuras 2a** y **2b** muestran dos ejemplos de radiadores que podrían ser utilizados en la antena de la Figura 1;

Las **Figuras 3a-3d** muestran algunas formas posibles de un elemento de director de una antena de acuerdo con la presente invención;

La **Figura 4** muestra una antena de acuerdo con una

segunda modalidad de la presente invención;

Las **Figuras 5a-5i** muestran algunas formas posibles de una rejilla de reflector de una antena de acuerdo con la presente invención;

La **Figura 6** muestra una antena de acuerdo con una tercera modalidad de la presente invención;

La **Figura 7** muestra una serie de antenas que comprenden dos antenas de acuerdo con la presente invención.

La Figura 1 muestra una antena 1 de acuerdo con una primera modalidad de la presente invención.

La antena 1 es diseñada para recibir y transmitir señales de radio polarizadas en forma lineal dentro de la banda UHF.

La antena 1 comprende un elemento de soporte 2, el cual en el ejemplo de la Figura 1 es una varilla (referida en la industria como "soporte extensible"), en la cual un radiador 3, los directores 4 y un reflector 5 son montados. La antena 1 también es proporcionada con un accesorio 6 a través del cual puede ser montada sobre un poste 7.

En el ejemplo de la Figura 1, el radiador 3 mostrado en la Figura 2a es un dipolo bicónico y puede generar y recibir señales de radio polarizadas en forma lineal.

Los radiadores del tipo mostrado en la Figura 2a son por ejemplo, aquellos montados en las antenas BLU420F vendidas por Fracarro Industries S.p.A., y comprenden un conductor 31, en forma típica, una varilla o placa de metal, que es plegada de tal modo que forma una estructura de dos patillas que se asemeja a una estructura bicónica.

El radiador 3 también es colocado con un transformador colocado en el interior del alojamiento 32, el

cual permite que la impedancia del radiador 3 sea adaptada a la del cable coaxial con el cual será conectada la antena, por ejemplo, a través de un conector F designado por el número de referencia 33.

Por medio del transformador, la antena recibe una señal de tensión alternante que posteriormente es transferida al conductor 31, en donde es creada una distribución de carga variable de tiempo para así generar un campo electromagnético polarizado en forma lineal, es decir, la señal de radio que será transmitida.

Por el contrario, cuando la antena es utilizada en la recepción, el campo electromagnético recibido produce en el conductor 31 una distribución de carga variable de tiempo, es decir, una corriente que entonces es transferida al cable coaxial a través del transformador.

El radiador 3 también es equipado con un accesorio 34 para su conexión con el soporte extensible de antena 2.

La selección del radiador no es vinculante, con la condición de que el radiador sea adaptado para generar y recibir las polarizaciones lineales; por lo tanto, podrían utilizarse también otros tipos de radiadores, tal como el mostrado en la Figura 2b. La Figura 2b muestra un radiador plegado, en donde el conductor 31 es una varilla plegada de tal modo que forme un perfil de "mariposa". Los radiadores de este tipo son montados, por ejemplo, en las antenas TAU15/45 vendidas por Fracarro Industries S.p.A. Aunque la antena 1 es diseñada para recibir y transmitir señales de radio polarizadas en forma lineal, los directores 4 también pueden recibir señales de radio con campos electromagnéticos que tienen una polarización circular o elíptica (además de las

señales polarizadas en forma lineal).

Como es conocido, en el caso de los campos que tienen una polarización circular o elíptica, el campo eléctrico puede ser separado en dos componentes vectoriales desplazados ortogonales (horizontal y vertical), de modo que la dirección del campo resultante cambia con respecto al tiempo.

Por lo tanto, cada elemento de director 4 capaz de recibir campos que tienen una polarización circular o elíptica puede recibir ambos componentes del campo eléctrico resultante en cualquier instante de tiempo.

En el ejemplo de la Figura 1, la antena comprende seis directores 4, cada uno consiste de un anillo de metal circular.

Cada director 4 es asegurado en el soporte 2 por medio de un elemento de anclaje dieléctrico 41, el cual en el ejemplo de la Figura 1 mantiene el soporte 2 dentro del área definida por el perímetro del director 4.

En forma alterna, el director 4 podría ser montado de tal modo que el soporte permanezca fuera del área definida por el perímetro del director 4.

En general, los directores 4 son montados de tal modo que los centros geométricos de los mismos son alineados a lo largo de un eje que coincide con la dirección de la ganancia máxima de la antena.

De preferencia, el elemento de anclaje 41 comprende una abrazadera que permite que sea montada con facilidad sobre el soporte y que puede ser apretada, de manera subsiguiente, por ejemplo, por medio de un tornillo.

Como es conocido, la posición de los directores 4

sobre el soporte 2 está en función de los valores de pérdida de ganancia y retorno que serán obtenidos a partir de la antena 1, mientras que las dimensiones de los directores están relacionadas en gran medida con la banda de frecuencia que será recibida por la antena 1.

Para una antena que va a recibir señales de banda UHF (470-862 MHz), los directores podrían consistir, de manera ventajosa, de anillos circulares que tienen un diámetro aproximadamente de 10 cm colocados a una distancia alrededor de 10 cm entre sí, con el radiador ubicado aproximadamente a 20 cm a partir del reflector y aproximadamente a 5 cm del director más cercano.

En el ejemplo de la Figura 1, la antena es diseñada para recibir señales de banda UHF; el arreglo de los elementos a lo largo del soporte ha sido optimizado como sigue:

- el radiador 3 es localizado a una distancia d_1 de 20 cm a partir del punto en donde el reflector 5 (tipo de diedro) es montado sobre el soporte 2,

- el primer director es localizado a una distancia d_2 de 5 cm del radiador,

- el segundo director es localizado a una distancia d_3 de 11 cm del primer director,

- el tercer director es localizado a una distancia d_4 de 8 cm del segundo director,

- el cuarto director es localizado a una distancia d_5 de 9 cm del tercer director,

- el quinto director es localizado a una distancia d_6 de 9 cm del cuarto director,

- el sexto director es localizado a una distancia d_7

de 9 cm del quinto director.

Al utilizar los directores que tienen un diámetro de 10 cm, la antena optimizada de esta manera tiene una dirección máxima de ganancia que coincide con el eje longitudinal del soporte; en la banda UHF de interés, ésta tiene una ganancia entre 12 dBi (en 470 MHz) y 15 dBi (en 862 MHz) y una pérdida de retorno por debajo de -14dB a través de toda la banda.

Aunque en el ejemplo de la Figura 1 los directores consisten de anillos circulares de metal, esta forma no será considerada como limitante; de hecho, también son posibles diferentes formas, como se muestra por medio de ejemplo en las Figuras 3a-3d.

En todos los casos, con el objeto de recibir señales de polarización circular dentro de una banda de frecuencia dada, el director comprende al menos un cuerpo que es conductivo dentro de esta banda, y es configurado de tal modo que la proyección del cuerpo sobre un plano ortogonal a la dirección de la ganancia máxima del radiador encierra una porción limitada del plano.

De esta manera, el director 4 tiene una forma helicoidal, como se muestra en la Figura 3a, y de preferencia, es montado sobre el soporte de tal modo que el eje de hélice es paralelo o coincidente con la dirección de la ganancia máxima de la antena.

Por lo tanto, es obtenido un anillo cuando la hélice montada de esta manera es proyectada sobre un plano ortogonal a la dirección de la ganancia máxima, es decir, una figura que encierra una porción plana.

Si la hélice tuviera un eje inclinado no ortogonal

al eje de la ganancia máxima, la proyección de la hélice sobre el plano ortogonal a la ganancia máxima sería una curva que comprende una serie de narices conectadas entre sí, cada nariz es una figura que encierra una porción plana limitada.

Como una alternativa, el director 4 podría tener una forma poligonal, por ejemplo, hexagonal (Figura 3b) u octagonal (Figura 3c).

Asimismo, en otra modalidad, el director 4 podría tener una forma elíptica (Figura 3d).

De preferencia, las esquinas de director (si estuvieran presentes, por ejemplo, Figuras 3b y 3c) son redondeadas.

De preferencia, el director 4 consiste de un cuerpo de metal de una pieza, por ejemplo, un cilindro de lámina de metal o una varilla de metal.

En forma alterna, el director 4 podría consistir de una pluralidad de elementos de metal soldados juntos o unidos por medio de (por ejemplo, abrazaderas de metal).

El director 4 también podría incluir, de manera alternativa, una parte central aislante (por ejemplo, elaborara de plástico) que tiene una cubierta de metal (por ejemplo, de una hoja delgada de aluminio).

El cuerpo conductivo también podría comprender un capacitor, por ejemplo, un capacitor de cara plana, que es un circuito cerrado dentro de la banda de frecuencia en la cual opera la antena. De este modo, el cuerpo es conductivo en la banda de frecuencia de interés incluso si una porción del mismo comprende un material dieléctrico.

Si el director 4 es un anillo cerrado, como se muestra en las Figuras 3b-3d, entonces, se prefiere que sea

montado de tal modo que se sitúe en un plano ortogonal a la dirección de la ganancia máxima de la antena.

Además, los directores montados en el mismo soporte se prefiere que sean colocados de tal modo que los centros geométricos de los mismos sean alineados a lo largo de un eje que es paralelo a la dirección de la ganancia máxima de la antena, de esta manera, se mejora la ganancia aérea.

El reflector 5 de antena podría ser de forma de diedro (como se muestra en la Figura 1) o plano.

En el ejemplo de la Figura 1, el reflector 5 es una estructura que consiste de dos rejillas de metal 51 colocadas en los lados opuestos del soporte de modo que correspondan con las caras de un ángulo de diedro. Las rejillas son montadas sobre una estructura de soporte 52 que caracteriza las ranuras adecuadas 53 dentro de las cuales son insertadas. Cuando son montadas sobre la estructura 52, las rejillas 51 forman un ángulo θ de 60° con el plano horizontal, es decir, con la dirección de la ganancia máxima del radiador 3 de la Figura 1.

Un ejemplo de una antena que tiene un reflector plano cuadrado se muestra en la Figura 4, en donde los mismos números de referencia de la Figura 1 designan los ítems idénticos o equivalentes.

La antena de la Figura 4 tiene un radiador de dipolo plegado 3 (Figura 2b) empleado como un sustituto del radiador de dipolo bicónico de la Figura 1, y un reflector plano que consiste de una rejilla única 51 montada en posición vertical, es decir, perpendicular a la dirección de la ganancia máxima del radiador. En forma alterna, un reflector plano podría ser obtenido por medio de dos o más rejillas colocadas en los lados opuestos del soporte y que se sitúan

en un plano que es ortogonal a las mismas.

Las Figuras 5a-5f muestran algunas posibles modalidades de la rejilla 51 de un reflector (plano o de diedro) que podría ser utilizado en la antena de acuerdo con la presente invención; más detalles en:

- En la Figura 5a, la rejilla 51 tiene una forma elíptica
- En la Figura 5b, la rejilla 51 tiene una forma octagonal
- En la Figura 5c, la rejilla 51 tiene una forma hexagonal
- En la Figura 5d, la rejilla 51 tiene una forma circular
- En la Figura 5e, la rejilla 51 tiene una forma pentagonal
- En la Figura 5f, la rejilla 51 tiene una forma rectangular.

En donde el reflector es plano o de forma de diedro, éste podría ser proporcionado como una rejilla que consiste en su totalidad de elementos de metal colocados en un patrón entrecruzado (como se muestra en las Figuras 5a-5f), o también podría comprender elementos dieléctricos.

En los ejemplos de las Figuras 5g-5i, (la así llamada solución de "tubo"), la rejilla 51 está constituida de una pluralidad de varillas de metal (sólidas o huecas) 54 montadas en paralelo entre sí sobre una estructura que comprende un apoyo central metálico 55 y dos apoyos laterales 56 elaborados de material metálico o dieléctrico.

El número, dimensiones y separación de las varillas podrían ser variados con el propósito de mejorar la

direccionalidad y ganancia de la antena; en el ejemplo de la Figura 5g, la rejilla de reflector comprende siete varillas; en la Figura 5h, existen cinco varillas; en la Figura 5i existen tres varillas.

En los ejemplos de las Figuras 5g-5i, la rejilla es más densa (es decir, las varillas se encuentran más cercanas entre sí) en esta porción (la porción inferior en estas figuras) que estará más cerca al soporte en la posición instalada; esto proporciona el efecto de mejora de la relación hacia delante/hacia atrás de la antena.

Mientras en las Figuras 5g y 5h los apoyos laterales 56 consisten de placas de metal, en la Figura 5i los apoyos laterales 56 son proporcionados en la forma de un alojamiento dieléctrico en el cual son aseguradas las varillas 53.

Las ventajas de la presente invención son aparentes a partir de la descripción anterior, por lo tanto, es claro que podrían realizarse muchos cambios a la misma por aquellas personas expertas en la técnica sin apartarse del alcance de protección de la presente invención.

Por ejemplo, una antena podría comprender una pluralidad de directores que tiene diferentes formas (por ejemplo, una hélice y anillos circulares) montadas sobre uno o más elementos de soporte.

Los directores montados sobre la misma varilla, incluso cuando tienen diferentes formas, se prefiere que sean alineados de tal modo que los centros respectivos son alineados a lo largo de un eje que coincide o es paralelo con la dirección de la ganancia máxima de la antena.

Asimismo, el radiador podría ser cualquier dispositivo capaz de generar y recibir un campo

electromagnético polarizado en forma lineal, por ejemplo, podría comprender un par de conductores colocados en forma simétrica en un patrón V (esta solución es conocida como una antena de doble-V o ventilador), a fin de obtener dos dipolos de mitad de onda.

Además, el radiador 3 no podría ser montado, de manera directa, sobre el soporte extensible. Este es el caso por ejemplo, de la antena mostrada en la Figura 6, en donde un radiador único 3 es colocado entre dos soportes 2a y 2b, cada uno a su vez es colocado con los respectivos directores 4a y 4b, el número de los cuales es de 10 por soporte en el ejemplo de la Figura 6.

El radiador 3 de la Figura 6 es montado de tal modo que la dirección de la ganancia máxima es una línea recta paralela a ambos soportes 2a y 2b.

La antena de la Figura 6 comprende un reflector único 5 dimensionado, de manera adecuada, para cubrir el radiador 3 así como también ambos de los soportes 2a y 2b; el reflector 5 es del tipo de diedro, en donde las dos rejillas 51 son montadas sobre dos estructuras de soporte 52a y 52b proporcionadas en ambos soportes 2a y 2b. Para que los soportes permanezcan en posición mientras que al mismo tiempo soporten el radiador 3, la antena de la Figura 6 comprende tres piezas cruzadas dieléctricas 8, 9 y 10, que mantienen los soportes 2a y 2b paralelos entre sí.

La pieza cruzada 9 soporta el radiador 3, la pieza cruzada 10 conecta los soportes con el poste 7 a través de un accesorio 61, y la pieza cruzada 8 refuerza la estructura total de la antena evitando cualquier movimiento relativo entre los dos soportes 2a y 2b que es provocado, por ejemplo,

por el viento.

Además, es aparente que la invención descrita con anterioridad también es aplicable a una serie de antenas, lo que significa que un conjunto de antenas tiene un reflector común.

Un ejemplo de una serie de antenas se muestra en la Figura 7, en donde la serie comprende dos antenas, cada una proporcionada con su propio radiador 3a y 3b y director 4a y 4b montados en dos respectivos soportes 2a y 2b.

La serie de la Figura 7 utiliza un reflector único 5 que es común para ambas antenas.

REIVINDICACIONES

1. Una antena que recibe y transmite señales de radio dentro de una banda de frecuencia que comprende un elemento de radiador adaptado para irradiar una señal de radio polarizada en forma lineal dentro de la banda de frecuencia, un elemento de soporte y al menos un primer elemento de director montado sobre el elemento de soporte y que comprende un cuerpo que es conductivo dentro de la banda de frecuencia, caracterizada porque la proyección del cuerpo sobre un plano ortogonal a la dirección de la ganancia máxima de la antena encierra la porción limitada del plano y porque el elemento de radiador es un dipolo bicónico.

2. La antena de conformidad con la reivindicación 1, caracterizada porque el cuerpo conductivo tiene una forma helicoidal y se extiende en una dirección que es paralela a la dirección de la ganancia máxima.

3. La antena de conformidad con la reivindicación 1, caracterizada porque el cuerpo conductivo es un anillo.

4. La antena de conformidad con la reivindicación 3, caracterizada porque el anillo tiene una forma elíptica.

5. La antena de conformidad con la reivindicación 3, caracterizada porque el anillo tiene una forma circular.

6. La antena de conformidad con cualquiera de las reivindicaciones anteriores, caracterizada porque el cuerpo conductivo es elaborado de metal.

7. La antena de conformidad con cualquiera de las reivindicaciones 1-6, caracterizada porque el cuerpo comprende una parte central aislante que tiene una cubierta

de metal.

8. La antena de conformidad con cualquiera de las reivindicaciones anteriores, caracterizada porque el cuerpo comprende un capacitor que es un circuito cerrado dentro de la banda de frecuencia.

9. La antena de conformidad con cualquiera de las reivindicaciones anteriores, caracterizada porque comprende una pluralidad de elementos de director, en donde los centros geométricos de los cuerpos conductivos de los elementos de director son alineados a lo largo de la dirección de la ganancia máxima de la antena.

10. La antena de conformidad con la reivindicación 9, caracterizada porque un segundo elemento de director tiene una forma que es diferente de la forma del primer elemento de director.

11. La antena de conformidad con la reivindicación 9, caracterizada porque al menos un elemento de director comprende seis elementos de director, y en donde la antena además comprende al menos una rejilla de metal montada sobre el elemento de soporte, y en donde:

- el radiador es localizado a una distancia de 20 cm a partir del punto en donde la rejilla es montada sobre el elemento de soporte,

- el primer director es localizado a una distancia de 5 cm del radiador,

- el segundo director es localizado a una distancia de 11 cm del primer director,

- el tercer director es localizado a una distancia de 8 cm del segundo director,

- el cuarto director es localizado a una distancia

de 9 cm del tercer director,

- el quinto director es localizado a una distancia de 9 cm del cuarto director,

- el sexto director es localizado a una distancia de 9 cm del quinto director.

12. La antena de conformidad con la reivindicación 11, caracterizada porque al menos un elemento de director tiene un cuerpo conductivo proporcionado en la forma de un anillo circular que tiene un diámetro de 10 cm.

13. La antena de conformidad con cualquiera de las reivindicaciones anteriores, caracterizada porque comprende al menos un segundo elemento de soporte y por lo menos un segundo elemento de director montado sobre el segundo elemento de soporte, en donde el elemento de radiador es colocado entre los dos elementos de soporte de la antena.

14. La antena de conformidad con cualquiera de las reivindicaciones anteriores, caracterizada porque comprende al menos un segundo elemento de soporte, un segundo elemento de radiador adaptado para irradiar una señal de radio polarizada en forma lineal dentro de la banda de frecuencia, y al menos un segundo elemento de director, en donde el segundo elemento de radiador y el segundo elemento de director son montados sobre el segundo elemento de soporte.

15. La antena de conformidad con cualquiera de las reivindicaciones anteriores, caracterizada porque al menos un elemento de director es adaptado para recibir el campo eléctrico de una onda electromagnética que tiene una polarización circular o elíptica en cualquier instante de tiempo.

RESUMEN DE LA INVENCIÓN

La invención se refiere a una antena (1) para la recepción y transmisión de señales de radio dentro de una cierta banda de frecuencia. La antena (1) comprende un elemento de radiador (3), el cual puede irradiar una señal de radio polarizada en forma lineal dentro de la banda de operación de la antena. La rejilla también comprende un elemento de soporte (2) y al menos uno de un primer elemento de director (4) montado sobre el elemento de soporte. El elemento de director comprende un cuerpo que es conductivo dentro de la banda de operación de la antena. La forma del cuerpo es de manera que la proyección del mismo sobre un plano ortogonal a la dirección de la ganancia máxima de la antena encierra la porción limitada de plano.

FIGURA No. 1

1/8

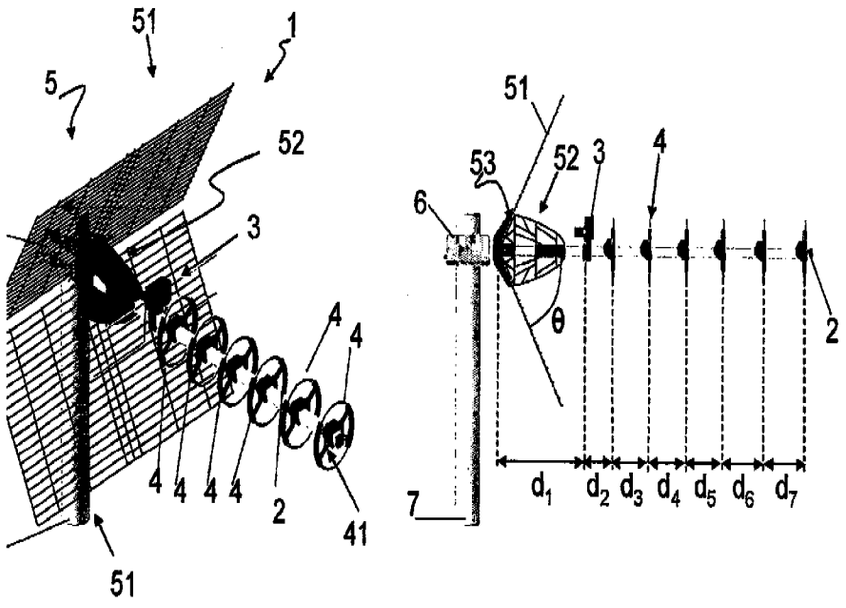


Fig.1

FIGURA No. 2

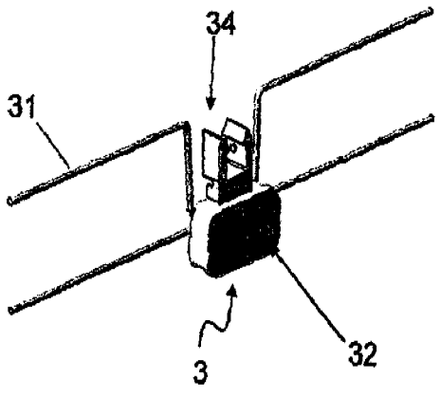


Fig. 2a

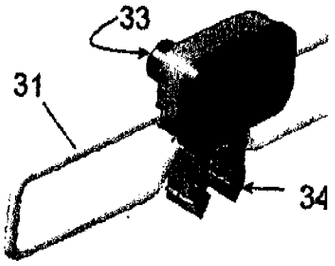


Fig. 2b

FIGURA No. 3

3/8

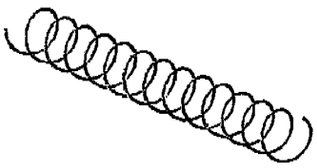


Fig. 3a

Fig. 3b

Fig. 3c

Fig. 3d

FIGURA No. 4

4/8

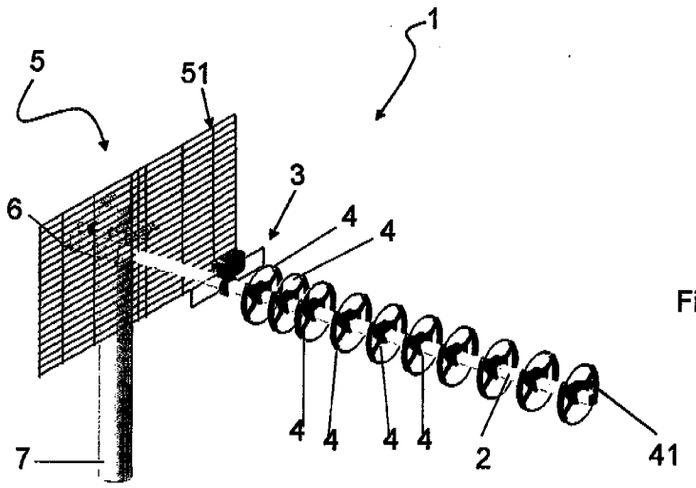


Fig.4

FIGURA No. 5

5/8

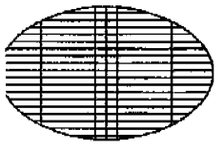


Fig.5a

Fig.5b

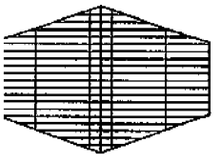


Fig.5c

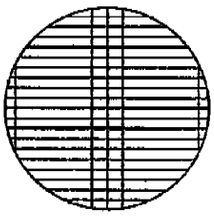


Fig.5d

Fig.5e

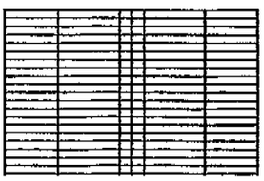


Fig.5f

FIGURA No. 6

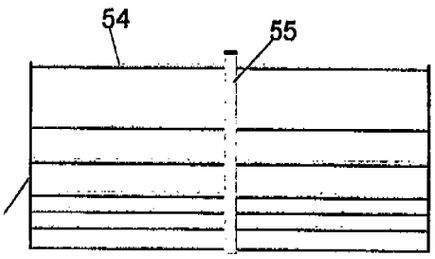


Fig.5g

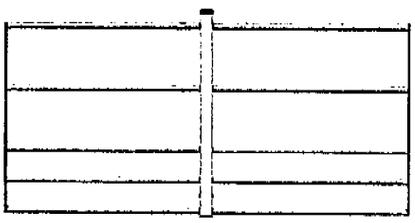


Fig.5h

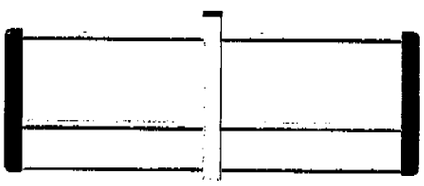


Fig.5i

FIGURA No. 7

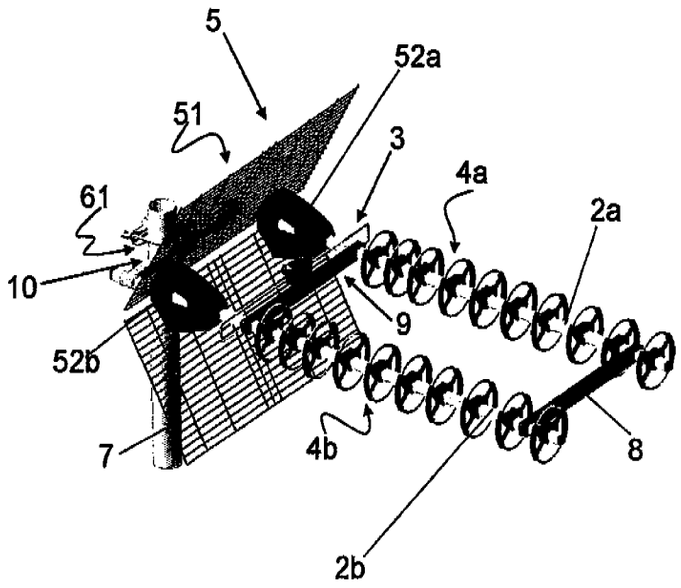


Fig. 6

FIGURA No. 8

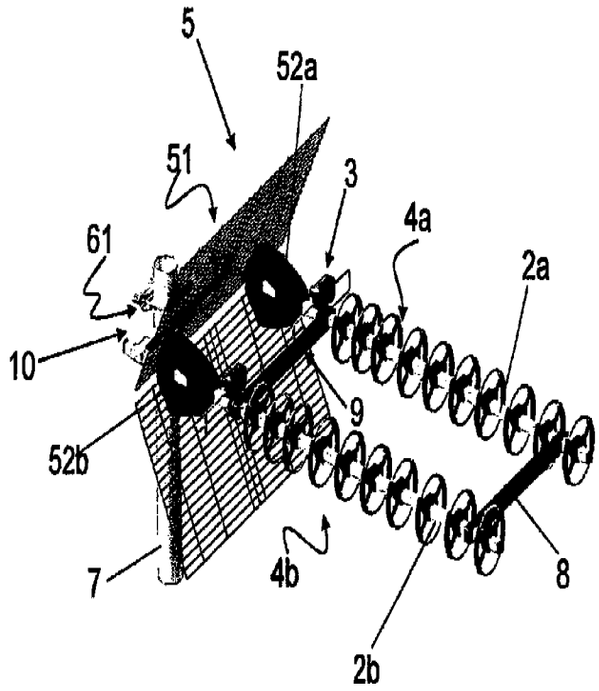


Fig. 7

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
23 December 2009 (23.12.2009)

PCT

(10) International Publication Number
WO 2009/153640 A1

(51) International Patent Classification:
H01Q 19/30 (2006.01)

(21) International Application Number:
PCT/IB2009/005885

(22) International Filing Date:
9 June 2009 (09.06.2009)

(25) Filing Language: Italian

(26) Publication Language: English

(30) Priority Data:
TO2008A000473 17 June 2008 (17.06.2008) IT

(71) Applicant *(for all designated States except US)*: **FRACARRO RADIOINDUSTRIE S.P.A.** [IT/IT]; Via Cazzaro, 3, 31033 Castelfranco Veneto (IT).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **BARBIRATO, Walter** [IT/IT]. **RIGHETTO, Luigino** [IT/IT].

(74) Agent: **CAMOLESE, Marco**; c/o Metroconsult S.R.L., Via Sestriere 100, 10060 None (IT).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) Title: AERIAL

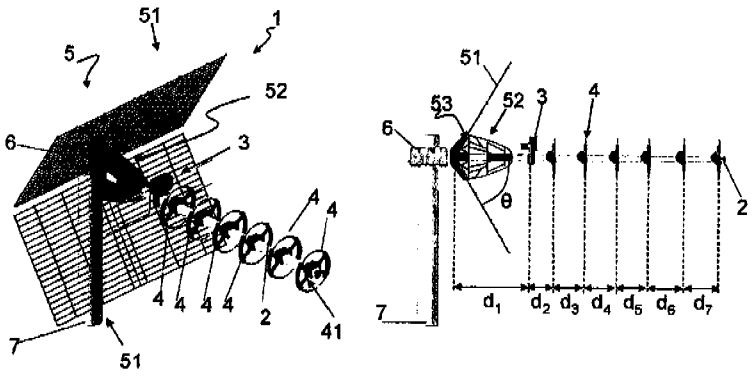


Fig.1

(57) Abstract: The invention relates to an aerial (1) for receiving and transmitting radio signals within a certain frequency band. The aerial (1) comprises a radiator element (3) which can radiate a linearly polarized radio signal within the operating band of the aerial. The latter also comprises a support element (2) and at least one first director element (4) mounted on said support element. The director element comprises a body which is conductive within the operating band of the aerial. The shape of said body is such that the projection thereof onto a plane orthogonal to the direction of maximum gain of the aerial encloses a limited plane portion.

WO 2009/153640 A1

AERIAL

DESCRIPTION

The present invention relates to an aerial according to the preamble of claim 1.

Nowadays several types of aerials are known, which can be classified according to a number of features such as the capability of receiving linear of circular polarizations.

In general, an aerial comprises three basic elements: a radiator which generates the electromagnetic field (i.e. the radio signal) transmitted by the aerial, a reflector, and one or more directors which modify such field in order to make the aerial more directive.

Yagi-Uda aerials allow for the reception and transmission of linearly polarized electromagnetic fields; these aerials are equipped with a radiator adapted to generate such a field (e.g. a $\lambda/2$ dipole or a bent dipole) and with linearly shaped directors (typically metal rods) adapted to receive a linear polarization, i.e. a linearly polarized electric field.

Aerials of this kind are known from patent application GB 2406971, which describes aerials whose directors are metal rods laid on the aerial boom, or X-shaped elements with metal rods inserted in a dielectric housing and coming out thereof in a criss-cross pattern.

Instead, Yagi loop aerials can receive a radio wave having elliptic or circular polarization and are characterized by annular radiator and directors having a circular cross-section.

The number of directors, the power supplied to the radiator, and the length of the aerial being equal, this second type of aerial is usually more directive and provides a wider bandwidth than Yagi-Uda aerials.

However, Yagi loop aerials suffer from the drawback that it is not possible to discriminate between horizontal-polarization and vertical-polarization radio signals.

It is the object of the present invention to provide an aerial which is alternative to the prior art.

In particular, the main object of the present invention is to improve the directivity and gain of known aerials for receiving linearly polarized signals.

These objects are achieved through an aerial incorporating the features set out in the appended claims, which are intended as an integral part of the present description.

The present invention is based on the idea of using a radiator which can generate and receive a linearly polarized electromagnetic field (i.e. radio signal) and of using directors

adapted to receive an electromagnetic field having elliptic or circular polarization.

The directors have a body which is conductive within the operating frequency of the aerial; aiming at receiving circular polarization, said conductive body is such that the projection thereof onto a plane orthogonal to the direction of maximum gain of the aerial encloses a limited portion of said plane.

For example, said projection may be a ring (having a circular or elliptic shape) or more in general a figure which closes back to itself at least in one point, like a noose.

Tests carried out by the Applicant have shown, in fact, that directors of this type increase the gain of the aerial even if the radiator is used for generating or receiving a linearly polarized electromagnetic field.

Advantageously, the director element of the aerial may comprise a helicoidal element with an axis of rotation of the helix that is parallel to or coinciding with the direction of maximum gain of the aerial. This solution offers the advantage that the aerial assembly process is simplified and the aerial is mechanically stronger .

Further objects and advantages of the present invention will become apparent from the following description and from the annexed drawings, which are supplied by way of non-limiting example, wherein:

Fig. 1 shows two perspective views of an aerial according to a first embodiment of the present invention;

Figs. 2a and 2b show two examples of radiators which may be used in the aerial of Fig. 1;

Figs. 3a-3d show some possible shapes of a director element of an aerial according to the present invention;

Fig. 4 shows an aerial according to a second embodiment of the present invention;

Figs. 5a-5i show some possible shapes of a reflector grid of an aerial according to the present invention;

Fig. 6 shows an aerial according to a third embodiment of the present invention;

Fig. 7 shows an array of aerials comprising two aerials according to the present invention;

Fig. 1 shows an aerial 1 according to a first embodiment of the present invention.

Aerial 1 is designed to receive and transmit linearly polarized radio signals within the UHF band.

Aerial 1 comprises a support element 2, which in the example of Fig. 1 is a rod (referred to

as "boom" in the industry), on which a radiator 3, directors 4 and a reflector 5 are mounted. Aerial 1 is also provided with a fitting 6 through which it can be mounted onto a pole 7.

In the example of Fig. 1, radiator 3, shown in Fig. 2a, is a biconic dipole and can generate and receive linearly polarized radio signals.

Radiators of the type shown in Fig. 2a are, for example, those mounted on the BLU420F aerials sold by Fracarro Radioindustrie S.p.A, and comprise a conductor 31, typically a metal rod or plate, which is bent in a manner such as to form a two-whisker structure resembling a biconic structure.

Radiator 3 is also fitted with a balun placed inside housing 32, which allows the impedance of radiator 3 to be adapted to that of the coaxial cable to which the aerial will be connected, e.g. through a connector F designated by reference numeral 33.

By means of the balun, the aerial receives an alternating voltage signal which is then transferred to conductor 31, where a time-variable charge distribution is created so as to generate a linearly polarized electromagnetic field, i.e. the radio signal to be transmitted.

Conversely, when the aerial is used in reception the received electromagnetic field produces in conductor 31 a time-variable charge distribution, i.e. a current that is then transferred to the coaxial cable through the balun.

Radiator 3 is also equipped with a fitting 34 for its connection to aerial boom 2.

The selection of the radiator is not binding, so long as the radiator is adapted to generate and receive linear polarizations; therefore, other types of radiators may be used as well, such as the one shown in Fig. 2b. Fig. 2b shows a bent radiator wherein conductor 31 is a rod bent in such a way as to form a "butterfly" profile. Radiators of this kind are, for example, mounted on the TAU15/45 aerials sold by Fracarro Radioindustrie S.p.A.

Although aerial 1 is designed to receive and transmit linearly polarized radio signals, directors 4 can also receive radio signals with electromagnetic fields having circular or elliptic polarization (in addition to linearly polarized signals).

As known, in the case of fields having circular or elliptic polarization the electric field can be broken up into two offset orthogonal (horizontal and vertical) vectorial components, so that the direction of the resulting field changes over time.

Each director element 4 capable of receiving fields having circular or elliptic polarization can therefore receive both components of the resulting electric field at any time instant.

In the example of Fig. 1, the aerial comprises six directors 4, each consisting of a circular metal ring.

Each director 4 is secured to boom 2 by means of a dielectric anchoring element 41, which in the example of Fig. 1 keeps boom 2 within the area defined by the perimeter of director 4.

Alternatively, director 4 may be mounted in a manner such that the boom remains outside the area defined by the perimeter of director 4.

In general, directors 4 are mounted in a manner such that the geometrical centres thereof are aligned along an axis matching the direction of maximum gain of the aerial.

Anchoring element 41 preferably comprises a clamp which allows it to be mounted easily onto the boom and which can subsequently be tightened, e.g. by means of a screw.

As known, the position of directors 4 on boom 2 depends on the gain and return loss values which are to be obtained from aerial 1, whereas the dimensions of the directors are strongly related to the frequency band to be received by aerial 1.

For an aerial which is to receive UHF band signals (470MHz-862MHz), the directors may advantageously consist of circular rings having a diameter of approximately 10 cm arranged at a distance of about 10 cm from one another, with the radiator located at about 20 cm from the reflector and about 5 cm from the nearest director.

In the example of Fig. 1, the aerial is designed to receive UHF band signals; the arrangement of the elements along the boom has been optimized as follows:

- radiator 3 is located at a distance d_1 of 20 cm from the point where reflector 5 (dihedral type) is mounted on boom 2,
- the first director is located at a distance d_2 of 5 cm from the radiator,
- the second director is located at a distance d_3 of 11 cm from the first director,
- the third director is located at a distance d_4 of 8 cm from the second director,
- the fourth director is located at a distance d_5 of 9 cm from the third director,
- the fifth director is located at a distance d_6 of 9 cm from the fourth director,
- the sixth director is located at a distance d_7 of 9 cm from the fifth director.

By using directors having a diameter of 10 cm, the aerial thus optimized has a maximum gain direction that matches the longitudinal axis of the boom; in the UHF band of interest it has a gain between 12 dBi (at 470 MHz) and 15 dBi (at 862 MHz) and a return loss below

-14dB over the whole band.

Although in the example of Fig. 1 the directors consist of circular metal rings, this shape is not to be considered as limiting; in fact, different shapes are possible as well, as shown by way of example in Figs. 3a-3d.

In all cases, in order to receive circular polarization signals within a given frequency band, the director comprises at least one body which is conductive within that band, and is shaped in a manner such that the projection of said body onto a plane orthogonal to the direction of maximum gain of the radiator encloses a limited portion of said plane.

Director 4 may thus have a helicoidal shape, as shown in Fig. 3a, and be preferably mounted on the boom in a manner such that the helix axis is parallel to or coinciding with the direction of maximum gain of the aerial.

A ring is therefore obtained when the helix thus mounted is projected onto a plane orthogonal to the direction of maximum gain, i.e. a figure that encloses a plane portion.

Should the helix have an inclined axis not orthogonal to the axis of maximum gain, the projection of the helix onto the plane orthogonal to the one of maximum gain would be a curve comprising a series of nooses connected to one another, each noose being a figure that encloses a limited plane portion.

As an alternative, director 4 may have a polygonal shape, e.g. hexagonal (Fig. 3b) or octagonal (Fig. 3c).

Also, in another embodiment director 4 may have an elliptic shape (Fig. 3d).

Preferably the director corners (if present, e.g. Figs. 3b and 3c) are rounded off.

Director 4 preferably consists of a one-piece metal body, e.g. a sheet-metal cylinder or a metal rod.

Alternatively, director 4 may consist of a plurality of metal elements welded together or joined by means of (for example, metal clamps).

Director 4 may also alternatively include an insulating core (e.g. made of plastic) having a metal covering (e.g. an aluminium foil).

The conductive body may also comprise a capacitor, e.g. a flat-faced capacitor, which is a closed circuit within the frequency band in which the aerial operates. In this manner, the body is conductive in the frequency band of interest even if a portion thereof comprises a dielectric material.

If director 4 is a closed ring, as shown in Figs. 3b-3d, then it is preferably mounted in a manner such as to lie in a plane orthogonal to the direction of maximum gain of the aerial. Furthermore, the directors mounted on the same boom are preferably arranged in a manner such that the geometrical centres thereof are aligned along an axis which is parallel to the direction of maximum gain of the aerial, thus enhancing the aerial gain.

Aerial reflector 5 may be either dihedral (as shown in Fig. 1) or flat.

In the example of Fig. 1, reflector 5 is a structure consisting of two metal grids 51 arranged on opposite sides of the boom so as to correspond to the faces of a dihedral angle. The grids are mounted on a support structure 52 featuring suitable slots 53 into which they are inserted. When mounted on structure 52, grids 51 form an angle θ of 60° with the horizontal plane, i.e. with the direction of maximum gain of radiator 3 of Fig. 1.

An example of an aerial having a square flat reflector is shown in Fig. 4, wherein the same reference numerals of Fig. 1 designate identical or equivalent items.

The aerial of Fig. 4 has a bent dipole radiator 3 (Fig. 2b) employed as a substitute for the biconic dipole radiator of Fig. 1, and a flat reflector consisting of a single grid 51 mounted vertically, i.e. perpendicularly to the direction of maximum gain of the radiator.

Alternatively, a flat reflector may be obtained by means of two or more grids arranged on opposite sides of the boom and lying in one plane which is orthogonal thereto.

Figs. 5a-5f show some possible embodiments of a grid 51 of a (flat or dihedral) reflector that may be used in the aerial according to the present invention; more in detail:

- In Fig. 5a, grid 51 has an elliptic shape
- In Fig. 5b, grid 51 has an octagonal shape
- In Fig. 5c, grid 51 has a hexagonal shape
- In Fig. 5d, grid 51 has a circular shape
- In Fig. 5e, grid 51 has a pentagonal shape
- In Fig. 5f, grid 51 has a rectangular shape

Whether flat or dihedral, the reflector may be provided as a grid entirely consisting of metal elements arranged in a criss-cross pattern (as shown in Figs. 5a-5f), or it may also comprise dielectric elements.

In the examples of Figs. 5g-5i (the so-called "tube" solution), grid 51 is made up of a plurality of (solid or hollow) metal rods 54 mounted parallel to one another on a structure

comprising a metallic central upright 55 and two side uprights 56 made of metallic or dielectric material.

The number, dimensions and spacing of the rods may be varied in order to improve the directionality and gain of the aerial; in the example of Fig. 5g the reflector grid comprises seven rods; in Fig. 5h there are five rods; in Fig. 5i there are three rods.

In the examples of Figs. 5g-5i, the grid is denser (i.e. the rods are closer together) in that portion (the lower portion in these drawings) which will be closer to the boom in the installed position; this provides the effect of improving the forward/backward ratio of the aerial.

While in Figs. 5g and 5h side uprights 56 consist of metal plates, in Fig. 5i side uprights 56 are provided in the form of a dielectric housing in which rods 53 are secured.

The advantages of the present invention are apparent from the above description, it is therefore clear that many changes may be made thereto by those skilled in the art without departing from the protection scope of the present invention.

For example, an aerial may comprise a plurality of directors having different shapes (e.g. a helix and circular rings) mounted on one or more support elements.

The directors mounted on the same rod, even when having different shapes, are preferably aligned in a manner such that the respective centres are aligned along an axis which coincides with or is parallel to the direction of maximum gain of the aerial.

Also, the radiator may be any device capable of generating and receiving a linearly polarized electromagnetic field, for example, it may comprise a pair of conductors arranged symmetrically in a V pattern (this solution is known as double-V or fan aerial), so as to obtain two half-wave dipoles.

Moreover, radiator 3 may not be mounted directly on the boom. This is the case, for example, of the aerial shown in Fig. 6, wherein a single radiator 3 is placed between two booms 2a and 2b, each fitted with respective directors 4a and 4b, the number of which is ten per boom in the example of Fig. 6.

Radiator 3 of Fig. 6 is mounted in a manner such that the direction of maximum gain is a straight line parallel to both booms 2a and 2b.

The aerial of Fig. 6 comprises a single reflector 5 sized appropriately to cover radiator 3 as well as both booms 2a and 2b; reflector 5 is of the dihedral type, wherein the two grids 51

are mounted on two support structures 52a and 52b provided on both booms 2a and 2b.

For the booms to stay in position while at the same time supporting radiator 3, the aerial of Fig. 6 comprises three dielectric crosspieces 8, 9 and 10 which keep booms 2a and 2b parallel to each other.

Crosspiece 9 supports radiator 3, crosspiece 10 connects the booms to pole 7 through a fitting 61, and crosspiece 8 stiffens the overall structure of the aerial by preventing any relative movement between the two booms 2a and 2b, e.g. caused by the wind.

It is furthermore apparent that the above-described invention is also applicable to an array of aerials, meaning by that a set of aerials having a common reflector.

An example of an array of aerials is shown in Fig. 7, wherein the array comprises two aerials, each provided with its own radiator 3a and 3b and director 4a and 4b mounted on two respective booms 2a and 2b.

The array of Fig. 7 uses a single reflector 5 which is common to both aerials.

CLAIMS

1. Aerial (1) for receiving and transmitting radio signals within a frequency band, comprising a radiator element (3) adapted to radiate a linearly polarized radio signal within said frequency band, a support element (2), and at least one first director element (4) mounted on said support element (2) and comprising a body which is conductive within said frequency band, characterized in that the projection of said body onto a plane orthogonal to the direction of maximum gain of the aerial encloses a limited portion of said plane.

2. Aerial according to claim 1, wherein said conductive body has a helicoidal shape and extends in a direction which is parallel to said direction of maximum gain.

3. Aerial according to claim 1, wherein said conductive body is a ring.

4. Aerial according to claim 3, wherein said ring has an elliptical shape.

5. Aerial according to claim 3, wherein said ring has a circular shape.

6. Aerial according to any of the preceding claims, wherein said conductive body is made of metal.

7. Aerial according to any of claims 1 to 6, wherein said body comprises an insulating core having a metal covering.

8. Aerial according to any of the preceding claims, wherein said body comprises a capacitor which is a closed circuit within said frequency band.

9. Aerial according to any of the preceding claims, comprising a plurality of director elements, wherein the geometrical centres of the conductive bodies of said director elements are aligned along said direction of maximum gain of the aerial.

10. Aerial according to claim 9, wherein a second director element has a shape which is different from that of said first director element.

11. Aerial according to claim 9, wherein said at least one director element comprises six director elements, and wherein said aerial further comprises at least one metal grid (51) mounted on said support element, and wherein:

- said radiator (3) is located at a distance (d_1) of 20 cm from the point where said grid is mounted on said support element (2),
- the first director is located at a distance (d_2) of 5 cm from the radiator,
- the second director is located at a distance (d_3) of 11 cm from the first director,

- the third director is located at a distance (d_4) of 8 cm from the second director,
- the fourth director is located at a distance (d_5) of 9 cm from the third director,
- the fifth director is located at a distance (d_6) of 9 cm from the fourth director,
- the sixth director is located at a distance (d_7) of 9 cm from the fifth director.

12. Aerial according to claim 11, wherein said at least one director element has a conductive body provided in the form of a circular ring having a diameter of 10 cm.

13. Aerial according to any of the preceding claims, comprising at least one second support element (2b) and at least one second director element (4b) mounted on said second support element (2b), wherein the radiator element is arranged between the two support elements of the aerial.

14. Aerial according to any of the preceding claims, comprising at least one second support element (2b), one second radiator (3b) adapted to radiate a linearly polarized radio signal within said frequency band, and at least one second director element (4b), wherein said second radiator element (3b) and said second director element (4b) are mounted on said second support element (2b).

15. Aerial according to any of the preceding claims, wherein said at least one director element is adapted to receive the electric field of an electromagnetic wave having circular or elliptic polarization at any time instant.

1/8

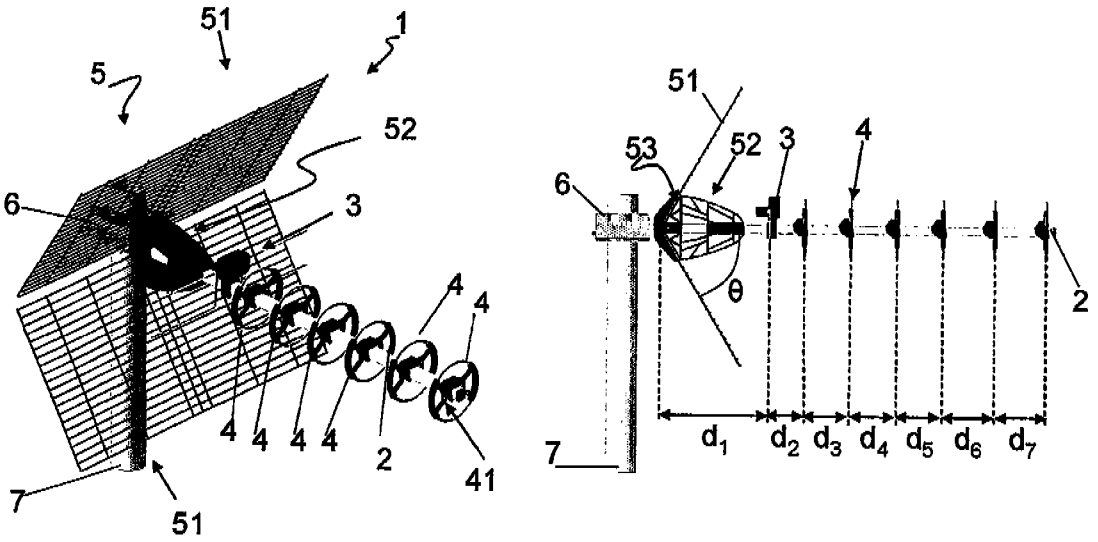


Fig.1

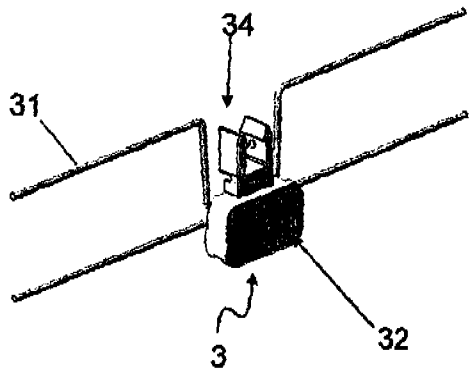


Fig. 2a

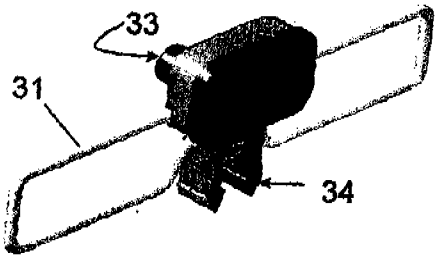


Fig. 2b

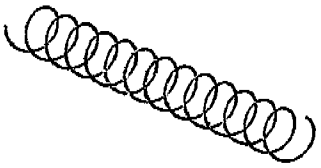


Fig. 3a

Fig. 3b

Fig. 3c

Fig. 3d

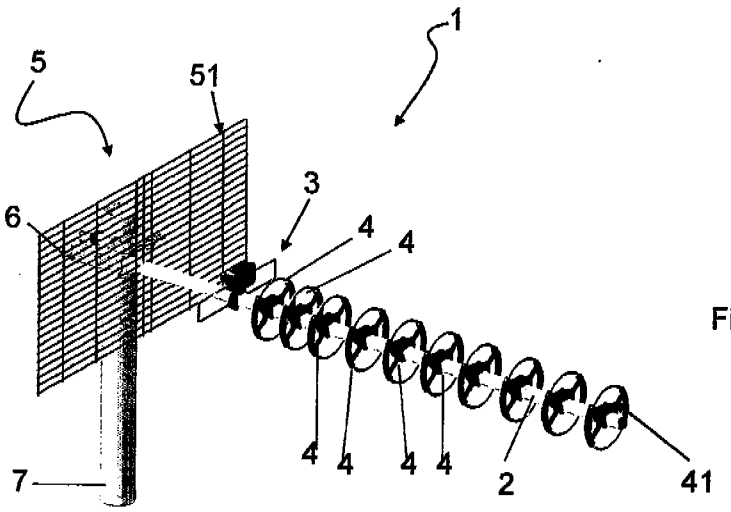


Fig.4

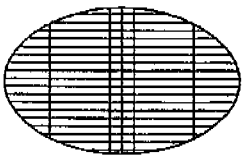


Fig.5a

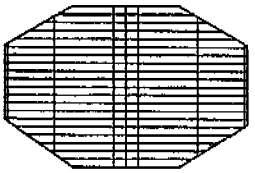


Fig.5b

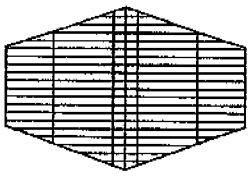


Fig.5c

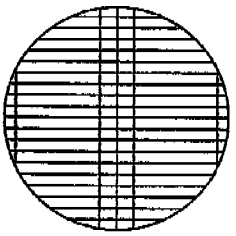


Fig.5d

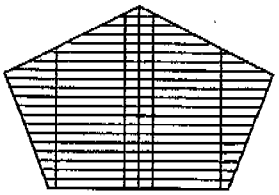


Fig.5e

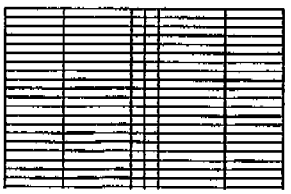


Fig.5f

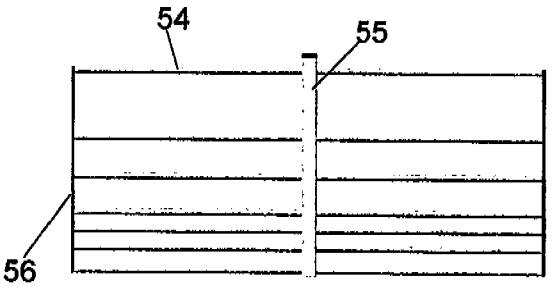


Fig.5g

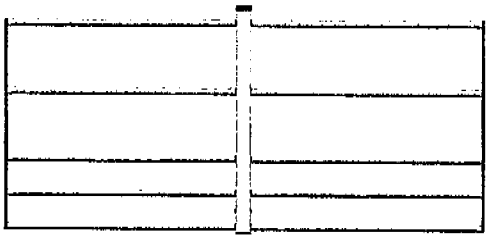


Fig.5h

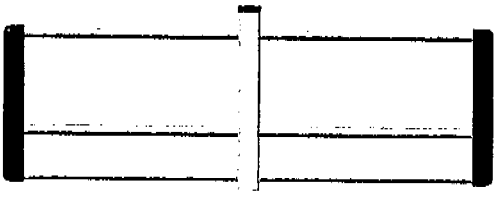


Fig.5i

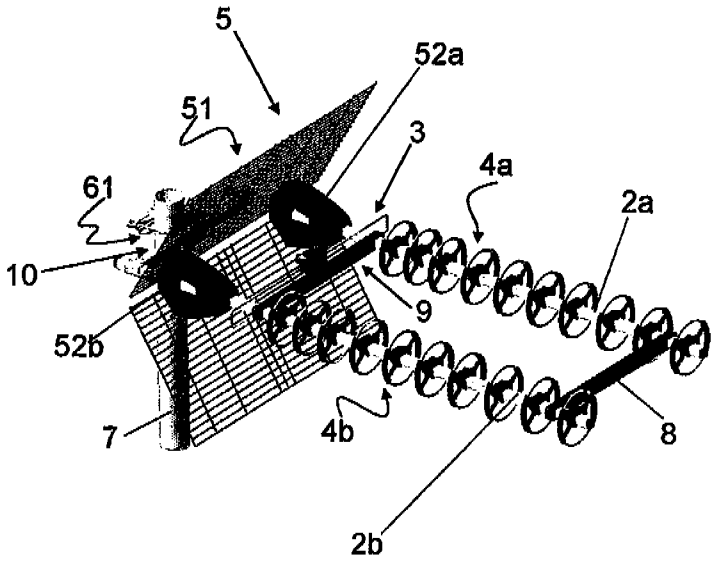


Fig. 6

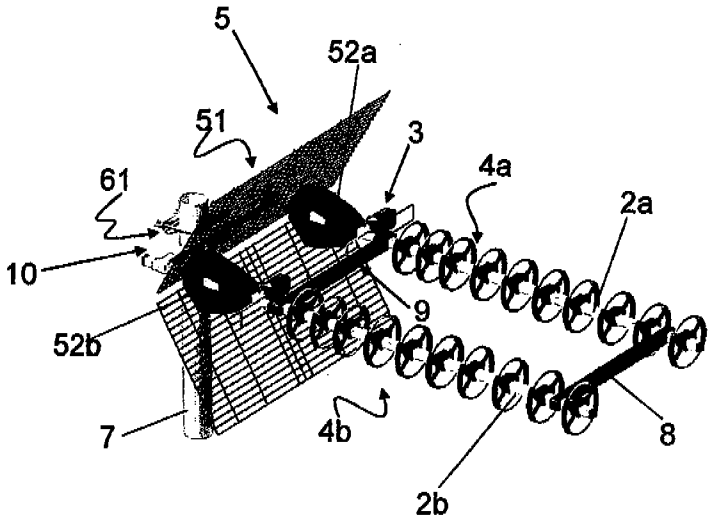


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/005885

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01Q19/30

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)
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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/279471 A1 (ZIMMERMAN MARTIN L [US]) 14 December 2006 (2006-12-14)	1,3,5-7, 9,11,12, 14
Y	figures 1-6 paragraphs [0036] - [0038] paragraphs [0045], [0046] paragraph [0059]	13
X	WO 2005/122331 A (ANDREW CORP [US]) 22 December 2005 (2005-12-22) figures 10-12 page 20, line 8 - page 22, line 24	1,3,5,9
X	DE 44 43 055 A1 (GRIESHABER VEGA KG [DE]) 20 June 1996 (1996-06-20) figures 1-3,7,8 column 5, lines 25-47 column 6, line 62 - column 7, line 39	1-3,5-7, 15

-/--

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

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 September 2009	23/09/2009

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, Fax: (+31-70) 340-3016	Unterberger, Michael

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/005885

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 66 09 325 U (KOLBE & CO HANS [DE]) 20 April 1972 (1972-04-20) figures 1-3 page 7, line 10 - page 9, line 11	1,3-5,10
Y	GB 1 268 121 A (EHRENSPECK HERMANN WALTER [US]) 22 March 1972 (1972-03-22) figure 7	13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2009/005885

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006279471 A1	14-12-2006	NONE	
WO 2005122331 A	22-12-2005	EP 1751821 A1	14-02-2007
		JP 2008507163 T	06-03-2008
		KR 20070020272 A	20-02-2007
DE 4443055 A1	20-06-1996	NONE	
DE 6609325 U	20-04-1972	NONE	
GB 1268121 A	22-03-1972	BE 739108 A	02-03-1970
		FR 2063949 A5	16-07-1971
		NL 6913809 A	12-03-1971

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/005885

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01Q19/30

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)
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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/279471 A1 (ZIMMERMAN MARTIN L [US]) 14 December 2006 (2006-12-14)	1,3,5-7, 9,11,12, 14
Y	figures 1-6 paragraphs [0036] - [0038] paragraphs [0045], [0046] paragraph [0059]	13
X	WO 2005/122331 A (ANDREW CORP [US]) 22 December 2005 (2005-12-22) figures 10-12 page 20, line 8 - page 22, line 24	1,3,5,9
X	DE 44 43 055 A1 (GRIESHABER VEGA KG [DE]) 20 June 1996 (1996-06-20) figures 1-3,7,8 column 5, lines 25-47 column 6, line 62 - column 7, line 39	1-3,5-7, 15

-/--

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

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 September 2009	23/09/2009

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, Fax: (+31-70) 340-3016	Unterberger, Michael

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/005885

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 66 09 325 U (KOLBE & CO HANS [DE]) 20 April 1972 (1972-04-20) figures 1-3 page 7, line 10 - page 9, line 11	1,3-5,10
Y	GB 1 268 121 A (EHRENSPECK HERMANN WALTER [US]) 22 March 1972 (1972-03-22) figure 7	13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2009/005885

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 2006279471	A1	14-12-2006	NONE		
WO 2005122331	A	22-12-2005	EP	1751821 A1	14-02-2007
			JP	2008507163 T	06-03-2008
			KR	20070020272 A	20-02-2007
DE 4443055	A1	20-06-1996	NONE		
DE 6609325	U	20-04-1972	NONE		
GB 1268121	A	22-03-1972	BE	739108 A	02-03-1970
			FR	2063949 A5	16-07-1971
			NL	6913809 A	12-03-1971

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

see form PCT/ISA/220

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/IB2009/005885	09.06.2009	17.06.2008

International Patent Classification (IPC) or both national classification and IPC
INV. H01Q19/30

Applicant
FRACARRO RADIOINDUSTRIE S.P.A.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notifed the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA:	Date of completion of this opinion	Authorized Officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Fax: +49 89 2399 - 4465	see form PCT/ISA/210	Unterberger, Michael Telephone No. +49 89 2399-7131

Form PCT/ISA/237 (Cover Sheet) (April 2005)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/IB2009/005885

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

      ☐ a sequence listing

      ☐ table(s) related to the sequence listing

   b. format of material:

      ☐ on paper

      ☐ in electronic form

   c. time of filing/furnishing:

      ☐ contained in the international application as filed.

      ☐ filed together with the international application in electronic form.

      ☐ furnished subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/IB2009/005885

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	8,11-13
	No:	Claims	1-7,9,10,14,15
Inventive step (IS)	Yes:	Claims	8
	No:	Claims	11-13
Industrial applicability (IA)	Yes:	Claims	1-15
	No:	Claims	

2. Citations and explanations

see separate sheet

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (SEPARATE SHEET)

International application No.
PCT/IB2009/005885

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following documents:

   D1: US 2006/279471 A1 (ZIMMERMAN MARTIN L [US]) 14 December 2006 (2006-12-14)
   D2: WO 2005/122331 A (ANDREW CORP [US]) 22 December 2005 (2005-12-22)
   D3: DE 44 43 055 A1 (GRIESHABER VEGA KG [DE]) 20 June 1996 (1996-06-20)
   D4: DE 66 09 325 U (KOLBE & CO HANS [DE]) 20 April 1972 (1972-04-20)
   D5: GB-A-1 268 121 (EHRENSPECK HERMANN WALTER [US]) 22 March 1972 (1972-03-22)

2. The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1-7, 9, 10, 14 and 15 is not new in the sense of Article 33(2) PCT.

2.1 Independent claim 1
The document D1 discloses, see Figures 1-6; paragraphs [0036]-[0038], [0045], [0046] and [0059], an aerial comprising:
a radiator element adapted to radiate a linear polarized radio signal;
a support element (25);
ring-shaped conductive directors mounted on the support.

Therefore, all technical features of claim 1 are disclosed in D1. Therefore, the subject-matter of claim 1 is not new.

The same objections equally apply in view of documents D2 (Figures 10-14; page 20, line 8 to page 22, line 23), D3 (Figures 1-4; column 5, lines 25-47; column 6, line 62 to column 7, line 19) or D4 (Figures 1-3; page 7, line 10 to page 8, line 35)

2.2 A helicoidal shape (claim 2) is disclosed in D3 (Figure 7), a ring shape (claim 3 and 5) in Documents D1 and D2 (see Figures), and a elliptical shape (claim 4) in Document D4 (page 8, lines 29 and 30).

Metal as material (claim 6) is disclosed in D4 (page 7, line 36), an insulating core

(claim 7) having a metal covering is disclosed in D1 (paragraph [0046]).

The arrangement of plural directors, as claimed in claim 9, is disclosed in each of the documents D1-D4.

Directors having different shapes (claim 10) are disclosed in D4, see the passages cited above.

A second radiator and director, as claimed in claim 14, are disclosed in D1, see Figure 6.

A reception of a electromagnetic wave having circular polarization, as claimed in claim 15, is disclosed in D3, see column 7, lines 7-19.

3. The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 11-13 does not involve an inventive step in the sense of Article 33(3) PCT.

3.1 The arrangement and distances, as claimed in claims 11 and 12, are constructional details which come within the scope of the customary practice followed by persons skilled in the art.

3.2 Dependent claim 13 claims a radiator being arranged between two support elements, each support element carrying at least one director.

However, these features have already been employed for the same purpose in a similar antenna, see document D5, Figure 7. It would be obvious to the person skilled in the art, namely when the same result is to be achieved, to apply these features with corresponding effect to an antenna according to document D1, thereby arriving at an antenna according to claim 13.

Possible steps after receipt of the international search report (ISR) and written opinion of the International Searching Authority (WO-ISA)

General information	For all international applications filed on or after 01/01/2004 the competent ISA will establish an ISR. It is accompanied by the WO-ISA. Unlike the former written opinion of the IPEA (Rule 66.2 PCT), the WO-ISA is not meant to be responded to, but to be taken into consideration for further procedural steps. This document explains about the possibilities.
Amending claims under Art. 19 PCT	Within 2 months after the date of mailing of the ISR and the WO-ISA the applicant may file amended claims under Art. 19 PCT directly with the International Bureau of WIPO. The PCT reform of 2004 did not change this procedure. For further information please see Rule 46 PCT as well as form PCT/ISA/220 and the corresponding Notes to form PCT/ISA/220.
Filing a demand for international preliminary examination	In principle, the WO-ISA will be considered as the written opinion of the IPEA. This should, in many cases, make it unnecessary to file a demand for international preliminary examination. If the applicant nevertheless wishes to file a demand this must be done before expiry of 3 months after the date of mailing of the ISR/WO-ISA or 22 months after priority date, whichever expires later (Rule 54bis PCT). Amendments under Art. 34 PCT can be filed with the IPEA as before, normally at the same time as filing the demand (Rule 66.1 (b) PCT). If a demand for international preliminary examination is filed and no comments/amendments have been received the WO-ISA will be transformed by the IPEA into an IPRP (International Preliminary Report on Patentability) which would merely reflect the content of the WO-ISA. The demand can still be withdrawn (Art. 37 PCT).
Filing informal comments	After receipt of the ISR/WO-ISA the applicant may file informal comments on the WO-ISA directly with the International Bureau of WIPO. These will be communicated to the designated Offices together with the IPRP (International Preliminary Report on Patentability) at 30 months from the priority date. Please also refer to the next box.
End of the international phase	At the end of the international phase the International Bureau of WIPO will transform the WO-ISA or, if a demand was filed, the written opinion of the IPEA into the IPRP, which will then be transmitted together with possible informal comments to the designated Offices. The IPRP replaces the former IPER (international preliminary examination report).
Relevant PCT Rules and more information	Rule 43 PCT, Rule 43bis PCT, Rule 44 PCT, Rule 44bis PCT, PCT Newsletter 12/2003, OJ 11/2003, OJ 12/2003

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

To:
METROCONSULT S.R.L.
Attn. Camolese, Marco
Via Sestriere 100
I-10060 None (TO)
ITALIE

021372

Applicant's or agent's file reference FR012/PCT	Date of mailing *(day/month/year)* 23/09/2009
International application No. PCT/IB2009/005885	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
Applicant FRACARRO RADIOINDUSTRIE S.P.A.	International filing date *(day/month/year)* 09/06/2009

1. [x] The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the International Search Report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Fascimile No.: (41-22) 338.82.70

   For more detailed instructions, see the notes on the accompanying sheet.

2. [ ] The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. [ ] **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   [ ] the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

   [ ] no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

   The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

   In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

   See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the International Searching Authority 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	Authorized officer Jacqueline Pitard

(See notes on accompanying sheet)

NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the *PCT Applicant's Guide*, a publication of WIPO.

In these Notes, "Article", "Rule", and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions, respectively.

INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report and the written opinion of the International Searching Authority, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims,description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only (see *PCT Applicant's Guide*, Volume I/A, Annexes B1 and B2).

The attention of the applicant is drawn to the fact that amendments to the claims under Article 19 are not allowed where the International Searching Authority has declared, under Article 17(2), that no international search report would be established (see *PCT Applicant's Guide*, Volume I/A, paragraph 296).

What parts of the international application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

When? Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

How? Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

What documents must/may accompany the amendments?

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

NOTES TO FORM PCT/ISA/220 (continued)

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped),whether

(i) the claim is unchanged;

(ii) the claim is cancelled;

(iii) the claim is new;

(iv) the claim replaces one or more claims as filed;

(v) the claim is the result of the division of a claim as filed.

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."

2. [Where originally there were 15 claims and after amendment of all claims there are 11]:
"Claims 1 to 15 replaced by amended claims 1 to 11."

3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."

4. [Where various kinds of amendments are made]:
"Claims 1–10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

"Statement under article 19(1)" (Rule 46.4)

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

It must be in the language in which the international application is to be published.

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

Consequence if a demand for international preliminary examination has already been filed

If, at the time of filing any amendments and any accompanying statement, under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the time of filing the amendments (and any statement) with the International Bureau, also file with the International Preliminary Examining Authority a copy of such amendments (and of any statement) and, where required, a translation of such amendments for the procedure before that Authority (see Rules 55.3(a) and 62.2, first sentence). For further information, see the Notes to the demand form (PCT/IPEA/401).

If a demand for international preliminary examination is made, the written opinion of the International Searching Authority will, except in certain cases where the International Preliminary Examining Authority did not act as International Searching Authority and where it has notified the International Bureau under Rule 66.1*bis*(b), be considered to be a written opinion of the International Preliminary Examining Authority. If a demand is made, the applicant may submit to the International Preliminary Examining Authority a reply to the written opinion together, where appropriate, with amendments before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later (Rule 43*bis*.1(c)).

Consequence with regard to translation of the international application for entry into the national phase

The applicant's attention is drawn to the fact that, upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see the *PCT Applicant's Guide*, Volume II.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
FR012/PCT		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/IB2009/005885	09/06/2009	17/06/2008
Applicant		
FRACARRO RADIOINDUSTRIE S.P.A.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 4 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      [X] the international application in the language in which it was filed
      [ ] a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. [ ] This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. [ ] With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. [ ] **Certain claims were found unsearchable** (See Box No. II)

3. [ ] **Unity of invention is lacking** (see Box No III)

4. With regard to the **title**,
   [X] the text is approved as submitted by the applicant
   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,
   [X] the text is approved as submitted by the applicant
   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority

6. With regard to the **drawings**,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 1
      [X] as suggested by the applicant
      [ ] as selected by this Authority, because the applicant failed to suggest a figure
      [ ] as selected by this Authority, because this figure better characterizes the invention
   b. [ ] none of the figures is to be published with the abstract

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/005885

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01Q19/30

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)
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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/279471 A1 (ZIMMERMAN MARTIN L [US]) 14 December 2006 (2006-12-14)	1,3,5-7, 9,11,12, 14
Y	figures 1-6 paragraphs [0036] - [0038] paragraphs [0045], [0046] paragraph [0059]	13
X	WO 2005/122331 A (ANDREW CORP [US]) 22 December 2005 (2005-12-22) figures 10-12 page 20, line 8 - page 22, line 24	1,3,5,9
X	DE 44 43 055 A1 (GRIESHABER VEGA KG [DE]) 20 June 1996 (1996-06-20) figures 1-3,7,8 column 5, lines 25-47 column 6, line 62 - column 7, line 39	1-3,5-7, 15

-/--

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

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 September 2009	23/09/2009

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, Fax: (+31-70) 340-3016	Unterberger, Michael

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/005885

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 66 09 325 U (KOLBE & CO HANS [DE]) 20 April 1972 (1972-04-20) figures 1-3 page 7, line 10 - page 9, line 11	1,3-5,10
Y	GB 1 268 121 A (EHRENSPECK HERMANN WALTER [US]) 22 March 1972 (1972-03-22) figure 7	13

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2009/005885

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006279471 A1	14-12-2006	NONE	
WO 2005122331 A	22-12-2005	EP 1751821 A1	14-02-2007
		JP 2008507163 T	06-03-2008
		KR 20070020272 A	20-02-2007
DE 4443055 A1	20-06-1996	NONE	
DE 6609325 U	20-04-1972	NONE	
GB 1268121 A	22-03-1972	BE 739108 A	02-03-1970
		FR 2063949 A5	16-07-1971
		NL 6913809 A	12-03-1971

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
22 December 2005 (22.12.2005)

PCT

(10) International Publication Number
WO 2005/122331 A1

(51) International Patent Classification[7]: H01Q 9/16, 19/30, 19/00

(21) International Application Number: PCT/US2005/012528

(22) International Filing Date: 13 April 2005 (13.04.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/577,138 4 June 2004 (04.06.2004) US
10/737,214 16 December 2004 (16.12.2004) US

(71) Applicant *(for all designated States except US)*: ANDREW CORPORATION [US/US]; 10500 W. 153rd Street, Orland Park, IL 60462 (US).

(72) Inventors: LE, Kevin; 1002 Winnsboro Court, Arlington, TX 76015 (US). MEYER, Louis, J.; 204 Dobbs Road, Shady Shores, TX 76208 (US). BISIULES, Pete; 1427 Blanchan Avenue, LaGrange Park, IL 60526 (US).

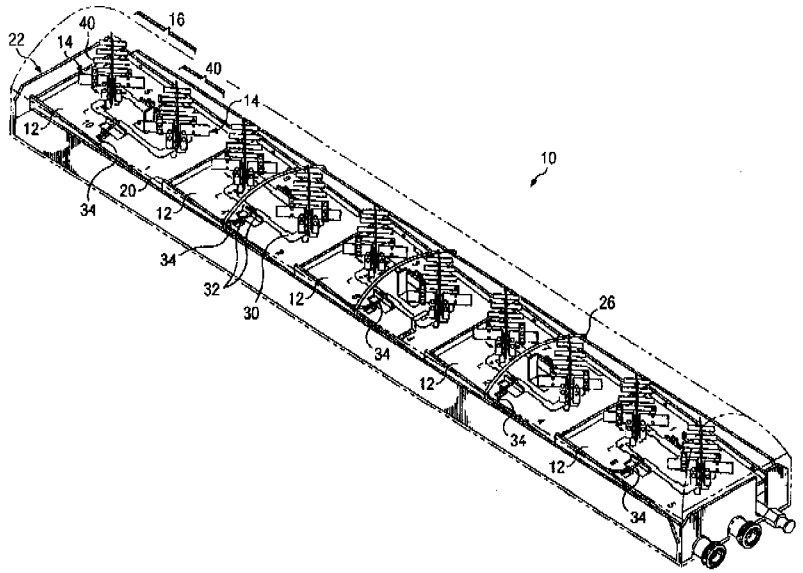
(74) Agent: KLINGER, Robert, C.; Jackson Walker L.L.P., 2435 N. Central Expressway, Suite 600, Richardson, TX 75080 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: DIRECTED DIPOLE ANTENNA



(57) Abstract: A dual polarized variable beam tilt antenna having a superior Sector Power Ratio (SPR). The antenna may have slant 45 dipole radiating elements including directors, and may be disposed on a plurality of tilted element trays to orient an antenna boresight downtilt. The directors may be disposed above or about the respective dipole radiating elements. The antenna has a beam front-to-side ratio exceeding 20 dB, a horizontal beam front-to-back ratio exceeding 40 dB, a high-roll off, and is operable over an expanded frequency range.

WO 2005/122331 A1

WO 2005/122331 A1

Published:

— *with international search report*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

DIRECTED DIPOLE ANTENNA

CLAIM OF PRIORITY

This application claims priority of U.S. Provisional Application Serial No. 60/577,138 entitled "Antenna" filed June 4, 2004, and is a Continuation-in-Part (CIP) of U.S. Patent Application Serial No. 10/737,214 filed December 16, 2004, entitled "Wideband Dual Polarized Base Station Antenna Offering Optimized Horizontal Beam Radiation Patterns And Variable Vertical Beam Tilt", which application claims priority of U.S. Provisional Patent Application Serial No. 60/484,688 entitled "Balun Antenna With Beam Director" filed July 3, 2003, and is also a Continuation-in-Part of U.S. Patent Application Serial No. 10/703,331 filed November 7, 2003, entitled "Antenna Element, Feed Probe, Dielectric Spacer, Antenna and Method of Communicating with a Plurality of Devices", which application claims priority of U.S. Provisional Patent Application Serial No. 60/482,689 entitled "Antenna Element, Multiband Antenna, and Method of Communicating with a Plurality of Devices" filed June 26, 2003.

FIELD OF THE INVENTION

The present invention is related to the field of antennas, and more particularly to antennas having dipole radiating elements utilized in wireless communication systems.

BACKGROUND OF THE INVENTION

Wireless mobile communication networks continue to be deployed and improved upon given the increased traffic demands on the networks, the expanded coverage areas for service and the new systems being deployed. Cellular type communication systems derive their name in that a plurality of antenna systems, each serving a sector or area commonly referred to as a cell, are implemented to effect coverage for a larger service area. The collective cells make up the total service area for a particular wireless communication network.

Serving each cell is an antenna array and associated switches connecting the cell into the overall communication network. Typically, the antenna array is divided into sectors, where each antenna serves a respective sector. For instance, three antennas of an antenna system may serve three sectors, each having a range of coverage of about 120°. These antennas are typically vertically polarized and have some degree of downtilt such that the radiation

pattern of the antenna is directed slightly downwardly towards the mobile handsets used by the customers. This desired downtilt is often a function of terrain and other geographical features. However, the optimum value of downtilt is not always predictable prior to actual installation and testing. Thus, there is always the need for custom setting of each antenna downtilt upon installation of the actual antenna. Typically, high capacity cellular type systems can require re-optimization during a 24 hour period. In addition, customers want antennas with the highest gain for a given size and with very little intermodulation (IM). Thus, the customer can dictate which antenna is best for a given network implementation.

It is a further objective of the invention to provide a dual polarized antenna having improved directivity and providing improved sector isolation to realize an improved Sector Power Ratio (SPR).

It is an objective of the present invention to provide a dual polarized antenna array having optimized horizontal plane radiation patterns. One objective is to provide a radiation pattern having at least a 20 dB horizontal beam front-to-side ratio, at least a 40 dB horizontal beam front-to-back ratio, and improved roll-off.

It is another objective of the invention to provide an antenna array with optimized cross polarization performance with a minimum of 10 dB co-pol to cross-pol ratio in a 120 degree horizontal sector.

It is another objective of the invention to provide an antenna array with a horizontal pattern beamwidth of 50° to 75°.

It is another objective of the invention to provide an antenna array with minimized intermodulation.

It is an objective of the invention to provide a dual polarized antenna array capable of operating over an expanded frequency range.

It is a further objective of the invention to provide a dual polarized antenna array capable of producing adjustable vertical plane radiation patterns.

It is another objective of the invention to provide an antenna with enhanced port to port isolation of at least 30 dB.

It is further object of the invention to provide an inexpensive antenna.

These and other objectives of the invention are provided by an improved antenna array for transmitting and receiving electromagnetic waves with +45°and -45° linear polarizations.

5

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a dual polarized antenna according to a first preferred embodiment of the present invention;

Figure 2 is a perspective view of a multi-level groundplane structure with a broadband slant 45 cross dipole radiating element removed therefrom, and a tray cutaway to illustrate a tilting of the groundplanes and an RF absorber in a RF choke;

Figure 3 is a perspective view of N cross-shaped directors supported above the dipole radiating element;

Figure 4 is a backside view of one element tray illustrating a microstrip phase shifter design employed to feed each pair of the cross dipole radiating elements;

Figure 5 is a backside view of the dual polarized antenna illustrating the cable feed network, each microstrip phase shifter feeding one of the other dual polarized antennas;

Figure 6 is a perspective view of the dual polarized antenna including an RF absorber functioning to dissipate RF radiation from the phase shifter microstriplines, and preventing the RF current cross coupling;

Figure 7 is a graph depicting the high roll-off radiation pattern achieved by the present invention, as compared to a typical cross dipole antenna radiation pattern;

Figure 8A and 8B are graphs depicting the beam patterns in a three sector site utilizing standard panel antennas;

Figure 9A and 9B are graphs depicting the beam patterns in a three sector site utilizing antennas according to the present invention;

Figure 10 is a perspective view of another embodiment of the invention including dual-band radiating elements;

Figure 11 is a perspective view of the embodiment shown in Figure 10 having director rings disposed over one of the radiating elements;

Figure 12 is a perspective view of an embodiment of the invention having director rings disposed over each of the radiating elements;

Figure 13 is a view of various suitable configurations of directors;

Figure 14 is a close-up view of a dual-band antenna; and

Figure 15 depicts an array of dual-band and single-band dipole radiating elements.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to Figure 1, there is generally shown at 10 a wideband dual polarized base station antenna having an optimized horizontal radiation pattern and also having a variable vertical beam tilt. Antenna 10 is seen to include a plurality of element trays 12 having disposed thereon broadband slant 45 cross dipole (x-dipole) radiating elements 14 arranged in dipole pairs 16. Each of the element trays 12 is tilted and arranged in a "fallen domino" arrangement and supported by a pair of tray supports 20. The integrated element trays 12 and tray supports 20 are secured upon and within an external tray 22 such that there is a gap laterally defined between the tray supports 20 and the sidewalls of tray 22, as shown in Figure 1 and Figure 2. Each tray element 12 has an upper surface defining a groundplane for the respective dipole pair 16, and has a respective air dielectric micro stripline 30 spaced thereabove and feeding each of the dipole radiating elements 14 of dipole pairs 16, as shown. A plurality of electrically conductive arched straps 26 are secured between the sidewalls of tray 22 to provide both rigidity of the antenna 10, and also to improve isolation between dipole radiating elements 14.

As shown, a pair of cable supports 32 extend above each tray element 12. Supports 32 support a respective low IM RF connection cables 34 from a cable 76 to the air dielectric micro stripline 30 and to microstrip feed network defined on a printed circuit board 50 adhered therebelow, as will be discussed in more detail shortly with reference to Figure 4.

Referring now to Figure 2, there is shown a perspective view of the element trays 12 with the sidewall of one tray support 20 and tray 22 partially cut away to reveal the tilted tray elements 12 configured in the "fallen domino" arrangement. Each tray element 12 is arranged in a this "fallen domino" arrangement so as to orient the respective dipole radiating element 14 pattern boresight at a predetermined downtilt, which may, for example, be the midpoint of the array adjustable tilt range. The desired maximum beam squint level of antenna 10 in this example is consistent with about 4° downtilt off of mechanical boresight, instead of about 8° off of mechanical boresight as would be the case without the tilt of the element trays 12. According to the present invention, maximum horizontal beam squint levels have been reduced to about 5° over conventional approaches, which is very acceptable considering the antenna's wide operating bandwidth and tilt range.

Still referring to Figure 2, there is illustrated that the tray supports 20 are separated from the respective adjacent sidewalls of tray 22 by an elongated gap defining an RF choke 36 therebetween. This choke 36 created by physical geometry advantageously reduces the RF current that flows on the backside of the external tray 22. The reduction of induced currents on the backside of the external tray 22 directly reduces radiation in the rear direction. The critical design criteria of this RF choke 36 involved in maximizing the radiation front-to-back ratio includes the height of the folded up sidewalls 38 of external tray 22, the height of the tray supports 20, and the RF choke 36 between the tray supports 20 and the sidewall lips 38 of tray 22. The RF choke 36 is preferably lambda /4 of the radiating element 14 center frequency, and the RF choke 36 has a narrow bandwidth which is frequency dependent because of internal reflection cancellation in the air dielectric, the choke bandwidth being about 22 percent of the center frequency.

According to a further embodiment of the present invention, an RF absorber 39 may be added into the RF choke 36 to make the RF choke less frequency dependent, and thus create a more broadband RF choke. The RF absorber 39 preferably contains a high percentage of carbon that slows and dissipates any RF

reflection wave from effecting the main beam radiation produced by the cross dipole antenna 12. The slant 45 cross dipole antenna 14, as shown, produces a cross polarized main beam radiation at a +/-45 degree orientation, each beam having a horizontal component and a vertical component. The cross polarization is good when these components are uniform and equal in magnitude in 360 degrees. For the panel antenna 10 shown in Figure 1 with the linearly arranged cross dipoles 14, the horizontal component of each beam orientation rolls off faster than the vertical component. This means that the vertical beamwidth is broader than the horizontal beamwidth for each beam orientation, and the vertical components travel along the edge of the respective trays 12 more than the horizontal components. Because the thin metal trays 12 have limited surface area, the surface currents thereon are less likely to reflect the horizontal components back to the main beam radiation. In contrast, along the edges of the respective trays 12 the stair cased baffles 35 have to contain many of the vertical component vector currents. Advantageously, by adding the RF absorber 39 into the RF choke 36, the vertical components of each beam orientation are minimized from reflecting back into the main beam radiation of the cross dipole 14. As such, cross dipoles 14 are not provided with a reflector behind them.

Preferably, the element trays 12 are fabricated from brass alloy and are treated with a tin plating finish for solderability. The primary function of the element trays is to support the radiating element 14 in a specific orientation, as shown. This orientation provides more optimally balanced vertical and horizontal beam patterns for both ports of the antenna 10. This orientation also provides improved isolation between each port. Additionally, the element trays 12 provide an RF grounding point at the coaxial cable/airstrip interface.

The tray supports are preferably fabricated from aluminum alloy. The primary function of the tray supports is to support the five element trays 12 in a specific orientation that minimizes horizontal pattern beam squint.

The external tray 22 is preferably fabricated from a thicker stock of aluminum alloy than element trays 12, and is preferably treated with an alodine coating to prevent corrosion due to external environment conditions. A primary functions of the external tray 22 is to support the internal array components. A secondary function is to focus the radiated RF power toward the forward sector of the antenna 10 by minimizing radiation toward the back, thereby maximizing the radiation pattern front-to-back ratio, as already discussed.

Referring now to Figure 3 there is depicted one radiator element 14 having N laterally extending parasitic broadband cross dipole directors 40 disposed above the radiating element 14 and fed by the airstrip feed network 30, as shown. N is 1,2,3,4....., where N is shown to equal 4 in this embodiment. The upper laterally extending members of parasitic broadband cross dipole director 40 are preferably uniformly spaced from one another, with the upper members preferably having a shorter length, as shown for bandwidth broadening. The lower members of director 40 are more closely spaced from the radiating element 14, so as to properly couple the RF energy to the director in a manner that provides pattern enhancement while maintaining an efficient impedance match such that substantially no gain is realized by the director 40, unlike a Yagi-Uda antenna having a reflector and spaced elements each creating gain. Advantageously, rather than realized gain, an improved pattern rolloff is achieved beyond the 3dB beamwidth of the radiation pattern while maintaining a similar 3dB beamwidth. Preferably, the upper elements of directors 40 are spaced about .033 lambda (center frequency) from one another, with the lower director elements spaced from the radiating element 14 about .025 lambda by parasitic 42 (lambda being the wavelength of the center frequency of the radiating element 14 design).

Referring now to Figure 4 there is shown one low loss printed circuit board (PCB) 50 having disposed thereon a microstrip capacitive phase shifter system generally shown at 52. The low loss PCB 50 is secured to the backside of the respective element tray 12. Microstrip capacitive phase shifter system 52 is coupled to and feeds the opposing respective pair of radiating elements 14 via the respective cables 34.

As shown in Figure 4, each microstrip phase shifter system 52 comprises a phase shifter wiper arm 56 having secured thereunder a dielectric member 54 which is arcuately adjustable about a pivot point 58 by a respective shifter rod 60. Shifter rod 60 is longitudinally adjustable by a remote handle (not shown) so as to selectively position the phase shifter wiper arm 56 and the respective dielectric 54 across a pair of arcuate feedline portions 62 and 64 to adjust the phase velocity conducting therethrough. Shifter rod 60 is secured to, but spaced above, PCB 50 by a pair of non-conductive standoffs 66. The low loss coaxial cables 34 are employed as the main transmission media providing electrical connection between the phase shifter system 52 and the radiating elements 14. Gain performance is optimized by closely controlling the phase and amplitude distribution across the radiating elements 14 of antenna 10. The very stable phase shifter design shown in Figure 4

achieves this control.

Referring now to Figure 5, there is shown the backside of the antenna 10 illustrating the cable feed network, each microstrip phase shifter system 52 feeding one of the other polarized antennas 14. Input 72 is referred as port I and is the input for the -45 polarized Slant, and input 74 is the port II input for the +45 polarized Slant. Cables 76 are the feed lines coupled to one respective phase shifter system 52, as shown in Figure 4. The outputs of phase shifter system 52, depicted as outputs 1-5, indicate the dipole pair 16 that is fed by the respective output of the phase shifter 52 system.

Referring now to Figure 6, there is shown antenna 10 further including an RF absorber 78 positioned under each of the element trays 12, behind antenna 10, that functions to dissipate any rearward RF radiation from the phase shifter microstrip lines, and preventing RF current from coupling between phase shifters systems 52.

Referring now to Figure 7, there is generally shown at 68 the high roll-off and front-to-back ratio radiation pattern achieved by antenna 10 according to the present invention, as compared to a standard 65° panel antenna having a dipole radiation pattern shown at 69. This high roll-off radiation pattern 68 is a

significant improvement over the typical dipole radiation pattern 69. The horizontal beam width still holds at approximately 65 degree at the 3 dB point.

Further, the design of the radiating elements 14 with directors 40 provides dramatic improvements in the antenna's horizontal beam radiation pattern, "where the Front-to-Side levels are shown to be 23dB in Figure 7. Conventional, cross dipole radiating elements produce a horizontal beam radiation pattern with about a 17 dB front-to-side ratio, as shown in Figure 7. According to the present invention, the broadband parasitic directors 40 integrated above the radiating elements 14 advantageously improve the antenna front-to-side ratio by up to 10 dB, and is shown as 6dB delta in the example of Figure 7. This improved front-to-side ratio effect is referred to as a "high roll-off" design. In this embodiment, radiating elements 14 and cross dipole directors 40 advantageously maintain an approximately 65 degree horizontal beamwidth at the antenna's 3 dB point, unlike any conventional Yagi-Uda antenna having more directors to get more gain and thus reducing the horizontal beamwidth.

Still referring to Figure 7, there is shown the excellent front-to-back ratio of antenna 10. As shown, panel antenna 10 has a substantially reduced

backside lobe, thus achieving a front-to-back ratio of about 40 dB. Moreover, antenna 10 has a next sector antenna/antenna isolation of about 40 dB, as compared to 26 dB for the standard 65° panel antenna. As can also be appreciated in Figure 7, with the significant reduction of a rear lobe, a 120° sector interference free zone is provided behind the radiation lobe, referred to in the present invention as the "cone of silence".

Referring now to Figure 8A and 8B, there is shown several advantages of the present invention when employed in a three sector site. Figure 8A depicts standard 65° flat panel antennas used in a three sector site, and Figure 8B depicts standard 90° panel antennas used in a three sector site. The significant overlap of these antenna radiation patterns creates imperfect sectorization that presents opportunities for increased softer hand-offs, interfering signals, dropped calls, and reduced capacity.

Referring now to Figure 9A and 9B, there is shown technical advantages of the present invention utilizing a 65° panel antenna and a 90° panel antenna, respectively according to the present invention, employed in a three sector site. With respect to Figure 9A, there is depicted significantly reduced overlap of the antenna radiation lobes, thus realizing a much smaller hand-off area. This leads to dramatic

call quality improvement, and further, a 5-10% site capacity enhancement.

Referring back to Figure 7, the undesired lobe extending beyond the 120° sector of radiation creates overlap with adjacent antenna radiation patterns, as shown in Figure 8A-8B and Figure 9A-9B. The undesired power delivered in the lobe outside of the 120° forward sector edges, as compared to that desired power delivered inside this 120° sector, defines what is referred to as the Sector Power Ratio (SPR). Advantageously, the present invention achieves a SPR being less than 2%, where the SPR is defined by the following equation:

$$SPR(\%) = \frac{\sum_{60}^{300} P\,\text{Undesired}}{\sum_{300}^{60} P\,\text{Desired}} x100$$

This SPR is a significant improvement over standard panel antennas, and is one measure of depicting the technical advantages of the present invention. The directors 40 are impedance matched at 90 ohms, although limitation to this impedance is not inferred, to the micro stripline 30. The radiating elements 14 and the cross dipole directors 40 have mutual instantaneous electromagnetic coupling which generate with source impedance at 90 ohm and source voltage of a matching network. Many other system

level performance benefits are afforded by incorporation of this high roll-off antenna design, including improved soft handoff capabilities, reduced co-site channel interference and increased base station system capacity due to increased sector-to-sector rejection.

Referring now to Figure 10, there is shown another preferred embodiment of the invention seen to comprise a band, dualpol antenna 80 including one slant 45 crossed dipole radiating element 14 and a slant 45 microstrip Annular Ring (MAR) radiator 94 encircling said dipole, as will be described shortly in reference to Figure 11. In this embodiment, antenna 80 includes N annular (ring-like) directors 82 disposed above the radiating element 14, where N = 1,2,3,4…. The N directors 82 are configured as vertically spaced parallel polygon-shaped members, shown as concentric rings, although limitation to this geometry of directors 82 is not to be inferred. Other geometric configurations of the directors may be utilized as shown in Figure 13.

The ring directors 82 react with the corresponding dipole radiating element 14 to enhance the front-to-side ratio of antenna 10 with improved rolloff. The ring directors 82 are preferably uniformly spaced above the corresponding x-dipole radiating element 14, with the ascending ring

directors 82 having a continually smaller circumference. The ring directors 82 maintain a relatively close spacing with one another being separated by electrically non-conductive spacers, not shown, preferably being spaced less than 0.15 lambda (lambda being the wavelength of the center frequency of the antenna design). Additionally, the grouping of ring directors 82 maintain a relatively close spacing between the bottommost director 82 and the top of the corresponding dipole radiating element 14, preferably less than 0.15 lambda. There are a variety of methods to build the set of planar directors 82, such as molded forms and electrically insulating clips.

The set of stacked ring directors 82 may also consist of rings of equal circumference while maintaining similar performance of improved roll-off leading to an improved SPR with the previously stated system benefits while maintaining a similar 3dB beamwidth.

Referring now to Figure 11, there is shown at 90 a dual-band antenna including a set of director rings 92 disposed above a stacked Microstrip Annular Ring (MAR) radiator 94. In this view, there are four feedprobes 96 (2 balanced feed pairs) arranged in pairs feeding dual orthogonal polarizations of the MAR radiator 94. The directors 92 in this embodiment of the invention are thin rings stacked above the

respective MAR radiator 94, as shown. Advantageously, this dual-band antenna 90 also has improved element pattern roll-off beyond the 3dB beamwidth thus increasing the SPR while maintaining an equivalent 3dB beamwidth.

Referring now to Figure 12, there is shown a dual-band antenna 100 having ring directors 82 and 92. The ring directors 92 above the MAR radiator 94 also interact with the x-dipole radiating element 14 and provide some additional beamshaping for the x-dipole radiating element, including improved roll-off of the main beam outside of the 3dB beamwidth as well as improved front-to-back radiation leading to an improved SPR and the system benefits previously mentioned while maintaining a similar 3dB beamwidth.

Both the MAR radiator element 94 and the x-dipole radiating element 14 have respective ring directors thereabove. The ring directors 82 for the x-dipole radiating element 14 are also concentric to the ring directors 92 for the MAR radiator 94. The same benefits as discussed earlier for the directors are applicable here as well per frequency band (i.e. improved roll-off beyond the 3dB beamwidth and front-to-back ratio leading to improved SPR.

Referring now to Figure 13, there is shown other suitable geometrical configurations of directors 82

and 92, and limitation to a circular ring-like director is not to be inferred. A circle is considered to be an infinitely sided polygon where the term polygon is used in the appending claims.

Referring now to Figure 14, there is shown a close-up view of dual band antenna 80 having cross shaped directors 40 extending over the radiating element 14, and the MAR radiator 94 without the associated annular director.

Referring now to Figure 15, there is shown a panel antenna 110 having an array of radiating elements 14, each having cross directors 40, alternately provided with the MAR radiators 94, each disposed over common groundplane 112. The advantages of this design include an improved H-plane pattern for the higher frequency radiating element in a dualband topology. The improved H-plane pattern provides improved roll-off beyond the 3dB beamwidth and improved front-to-back ratio. The improved roll-off additionally provides a slight decoupling of the radiators depending on the number of directors incorporated due to lower levels of side and back radiation.

Though the invention has been described with respect to a specific preferred embodiment, many variations and modifications will become apparent to those skilled in the art upon reading the present application. It is therefore the intention that the appended claims be interpreted as broadly as possible in view of the prior art to include all such variations and modifications.

WE CLAIM:

1. An antenna, comprising:

at least one slant 45 dipole radiating element adapted to generate a beam; and

at least one director disposed proximate the at least one dipole radiating element adapted to improve a Sector Power Ratio (SPR) of the beam while maintaining an equivalent 3dB beamwidth.

2. The antenna as specified in Claim 1 wherein the antenna has a Sector Power Ratio of less than 10%.

3. The antenna as specified in Claim 2 wherein the antenna has a Sector Power Ratio of less than 5%.

4. The antenna as specified in Claim 3 wherein the antenna has a Sector Power Ratio of less than 2%.

5. The antenna as specified in Claim 1 comprising at least 2 of the directors.

6. The antenna as specified in Claim 5 wherein at least 2 of the directors are parallel to one another.

7. The antenna as specified in Claim 5 wherein at least some of the directors are uniformly spaced from one another.

8. The antenna as specified in Claim 7 wherein one of the directors is spaced closer to the radiating element than an adjacent said director.

9. The antenna as specified in Claim 1 wherein the radiating element is a cross dipole radiating element.

10. The antenna as specified in Claim 9 wherein the director has at least 2 members.

11. The antenna as specified in Claim 10 wherein the members are cross-shaped members parallel to the cross dipole radiating element in the vertical direction.

12. The antenna as specified in Claim 1 wherein the at least one director comprises a polygon shaped ring.

13. The antenna as specified in Claim 12, further comprising a plurality of the polygon shaped rings disposed over the radiating element.

14. The antenna as specified in Claim 13 wherein the polygon shaped rings are concentric.

15. The antenna as specified in Claim 14 wherein the polygon shaped rings have a common diameter.

16. The antenna as specified in Claim 14 wherein the polygon shaped rings have different diameters and form a tapered director.

17. The antenna as specified in Claim 10 wherein the members have different lengths and form a tapered director.

18. The antenna as specified in Claim 1 wherein the antenna has a front-to-side ratio of at least 20 dB.

19. The antenna as specified in Claim 1 wherein the antenna has a front-to-back ratio of at least 40 dB.

20. An antenna, comprising:

a plurality of tilted groundplanes configured in a "fallen-domino" arrangement; and

a plurality of dipole radiating elements disposed above the groundplanes and configured such that the dipole radiating elements define a boresight downtilt.

21. The antenna as specified in Claim 20 wherein the antenna has a beam downtilt, further comprising a feed network coupled to the plurality of dipole radiating elements and adapted to selectively adjust the antenna beam downtilt.

22. The antenna as specified in Claim 21 wherein the boresight downtilt is defined at approximately a midpoint of an overall beam downtilt.

23. The antenna as specified in Claim 22 wherein the groundplanes are disposed a fixed distance from one another.

24. The antenna as specified in Claim 21 wherein the dipole radiating elements are grouped in pairs, wherein at least one said pair is defined on each of the groundplanes.

25. An antenna comprising a radiating element disposed over a tray having a backside and having at least one groundplane disposed above the tray, the tray having a side wall spaced from the groundplanes and defining a gap therebetween.

26. The antenna as specified in Claim 25 wherein the gap forms a RF choke configured to reduce RF current flowing in the backside of the tray.

27. The antenna as specified in Claim 26 further comprising an RF absorber disposed in the RF choke.

28. The antenna as specified in Claim 25 wherein a height of the tray sidewall is configured to increase a front-to-back ratio of the antenna.

29. The antenna as specified in Claim 25 further comprising an RF absorber disposed behind the groundplanes adapted to reduce RF current coupling between the groundplanes.

30. A dual-band antenna, comprising:

a first slant 45 dipole radiating element adapted to generate a first beam at a first frequency;

a first director disposed proximate the first radiating element adapted to improve a Sector Power Ratio of the beam while maintaining an equivalent 3dB beamwidth; and

a second radiating element disposed proximate the first radiating element and adapted to generate a second beam at a second frequency.

31. The dual-band antenna as specified in Claim 30, further comprising a second director disposed proximate the second radiating element adapted to improve the Sector Power Ratio of the second beam while maintaining an equivalent 3dB beamwidth.

32. The dual-band antenna as specified in Claim 31 wherein the first director comprises at least two members.

33. The dual-band antenna as specified in Claim 32 wherein the second director comprises at least two members.

34. The dual-band antenna as specified in Claim 33 wherein the first and second directors are disposed over the respective first and second radiating elements.

35. The dual-band antenna as specified in Claim 30 wherein the second radiating element comprises a slant 45 microstrip annular ring radiating element.

36. The dual-band antenna as specified in Claim 30 wherein the first radiating element comprises a cross-shaped radiator.

37. The dual-band antenna as specified in Claim 36 wherein the second radiating element comprises a polygon-shaped radiator.

38. The dual-band antenna as specified in Claim 30 wherein the first director comprises at least one cross-shaped member.

39. The dual-band antenna as specified in Claim 31 wherein the second director comprises at least one polygon-shaped member.

40. The dual-band antenna as specified in Claim 37 wherein the first director comprises a plurality of the cross-shaped members.

41. The dual-band antenna as specified in Claim 37 wherein the second director comprises a plurality of the polygon-shaped members.

42. The dual-band antenna as specified in Claim 30 wherein the second radiating element encompasses the first radiating element.

43. The dual-band antenna as specified in Claim 42 wherein the first radiating element comprises a cross-shaped dipole radiating element.

44. The dual-band antenna as specified in Claim 42 wherein the second radiating element comprises a polygon.

45. An antenna, comprising:

a slant 45 dipole radiating element adapted to generate a beam; and

director means for directing the beam.

46. The dual-band antenna as specified in Claim 45 wherein the director means establishes a Sector Power Ratio of the beam being less than 10%.

47. The dual-band antenna as specified in Claim 45 wherein the director means establishes a Sector Power Ratio of the beam being less than 5%.

48. The dual-band antenna as specified in Claim 45 wherein the director means establishes a Sector Power Ratio of the beam being less than 2%.

49. The dual-band antenna as specified in Claim 45 wherein the director means establishes a front-to-back ratio of the beam of at least about 40 dB.

50. The dual-band antenna as specified in Claim 45 wherein the director means establishes a front-to-side ratio of the beam of at least about 20 dB.

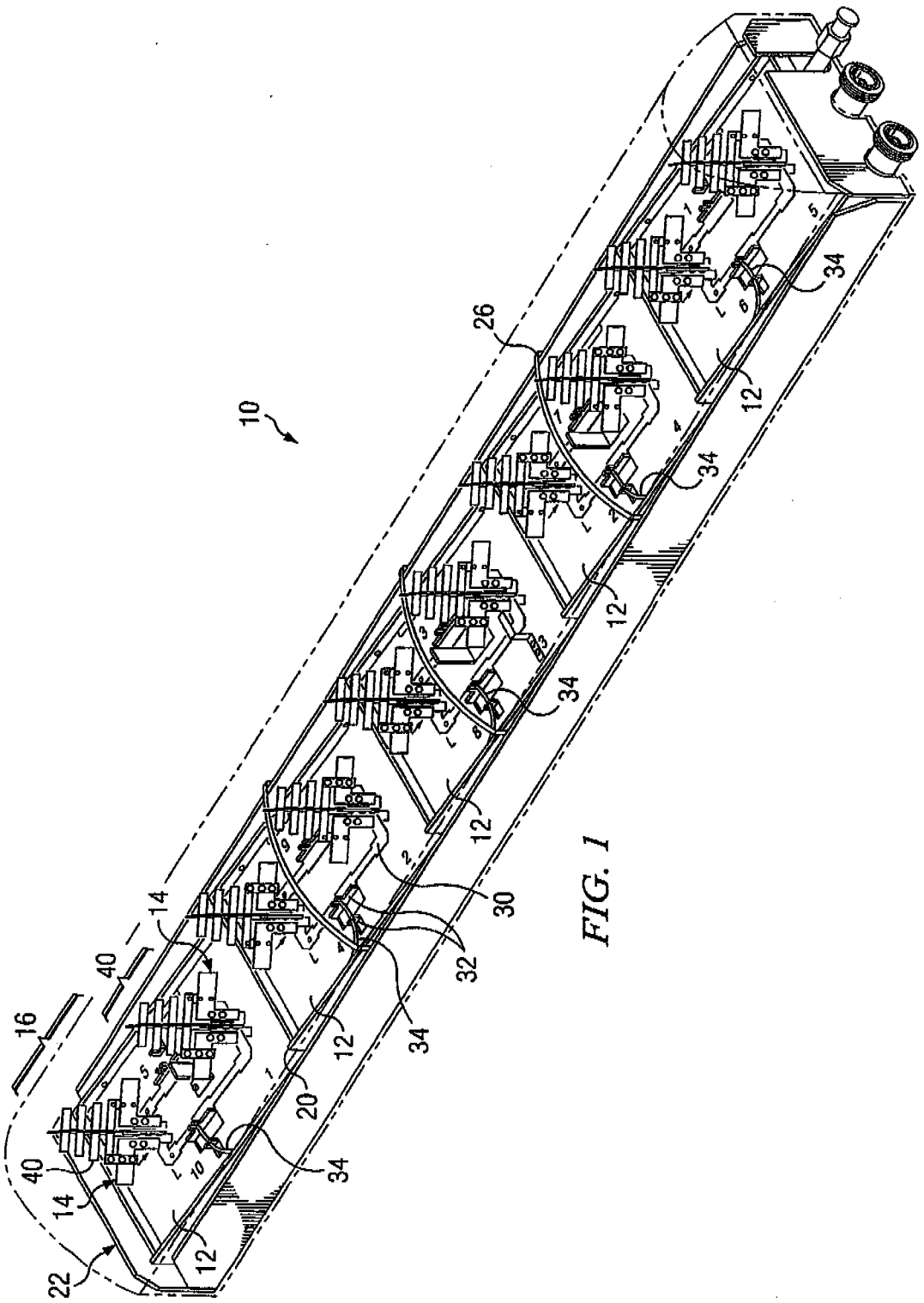


FIG. 1

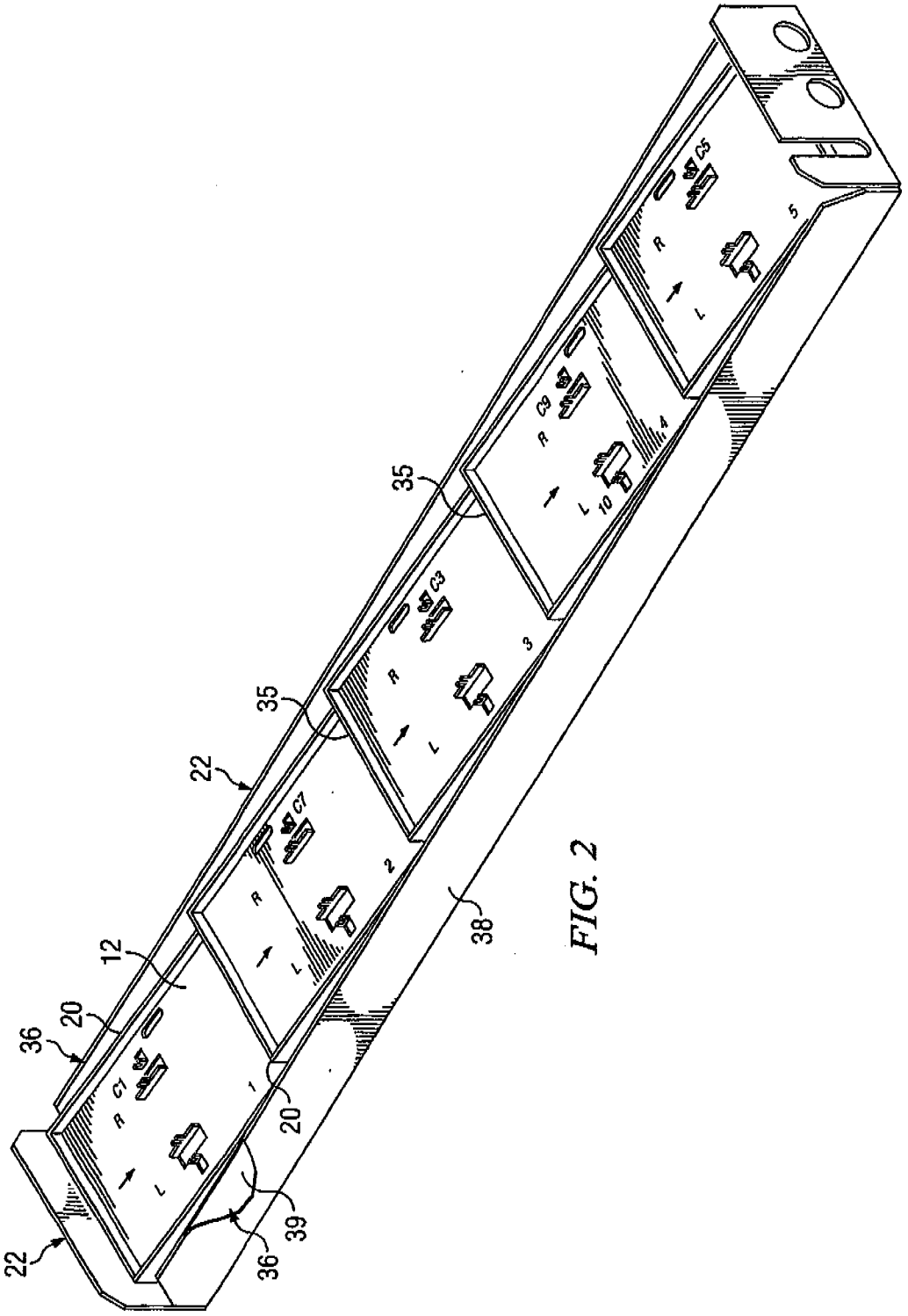


FIG. 2

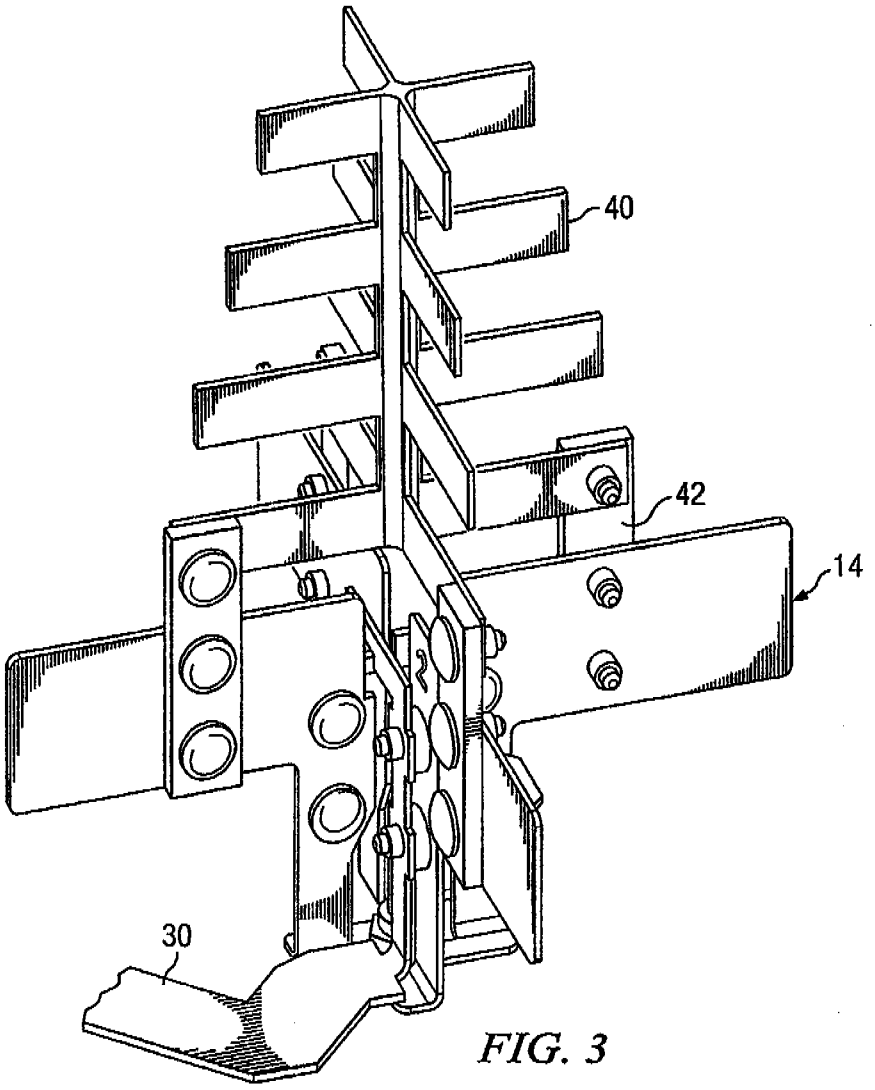


FIG. 3

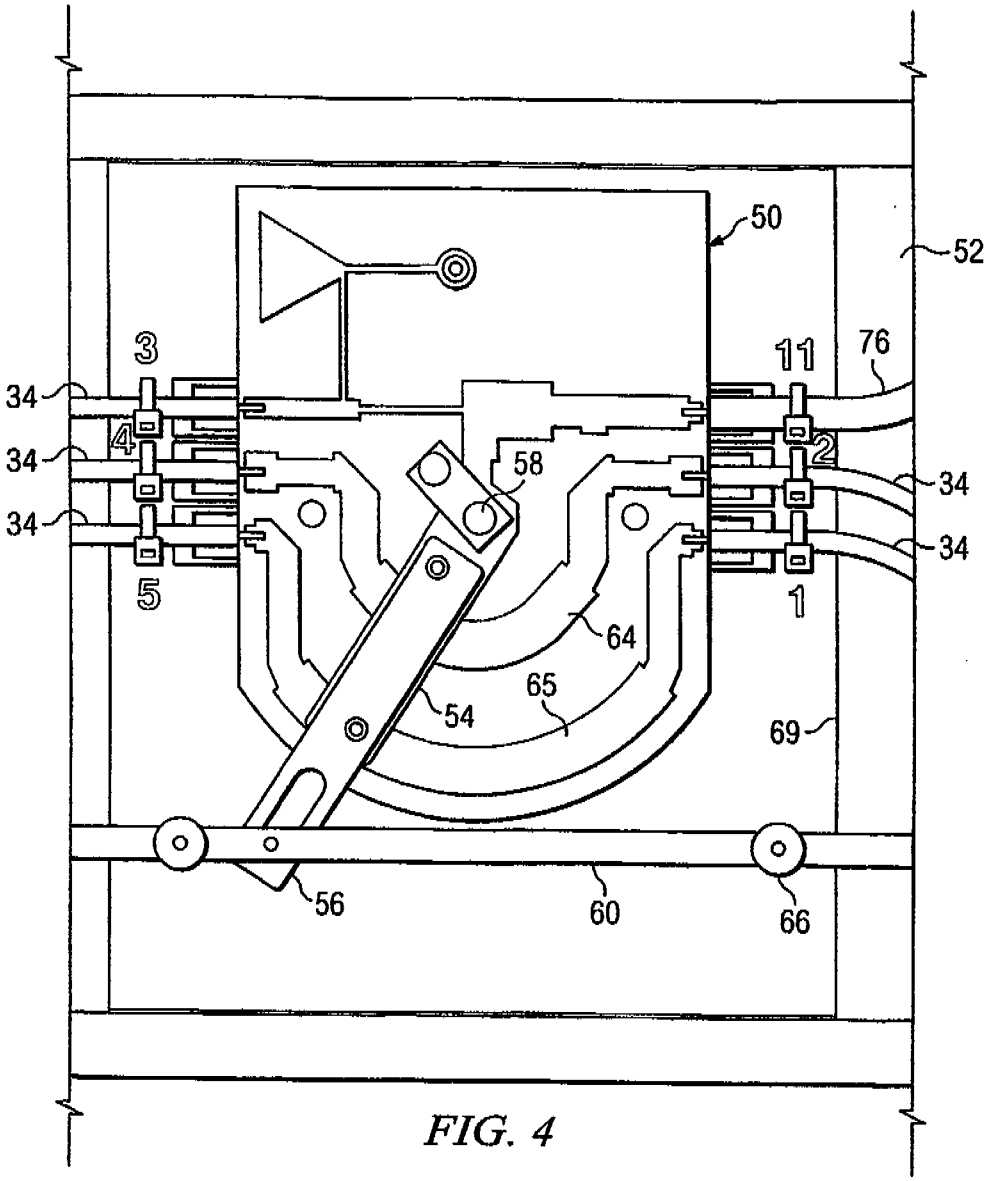


FIG. 4

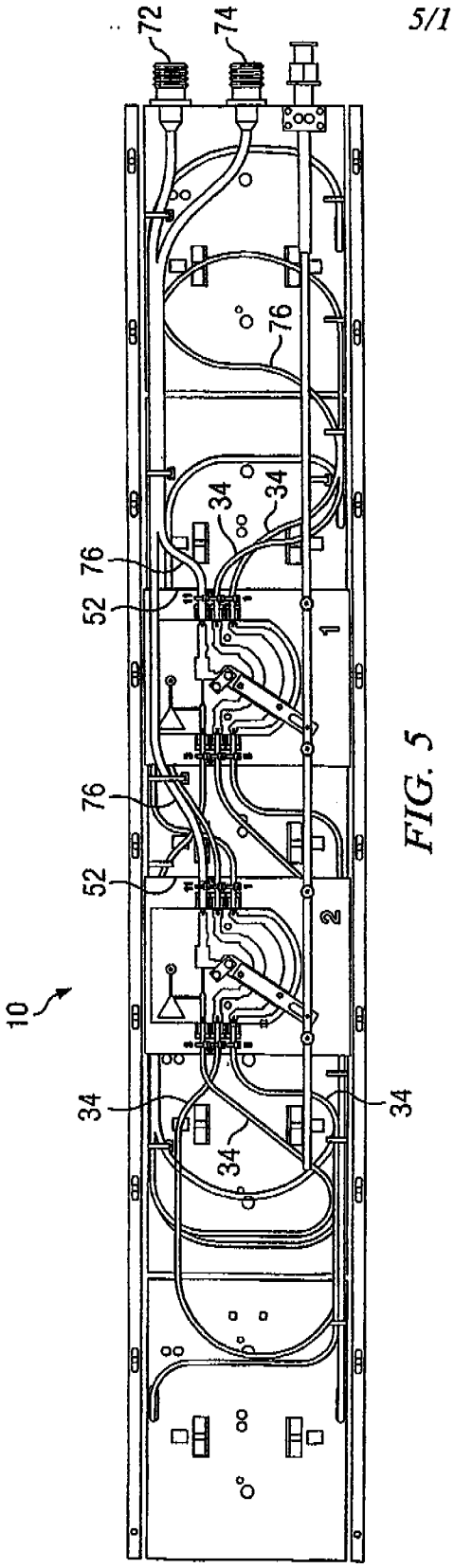


FIG. 5

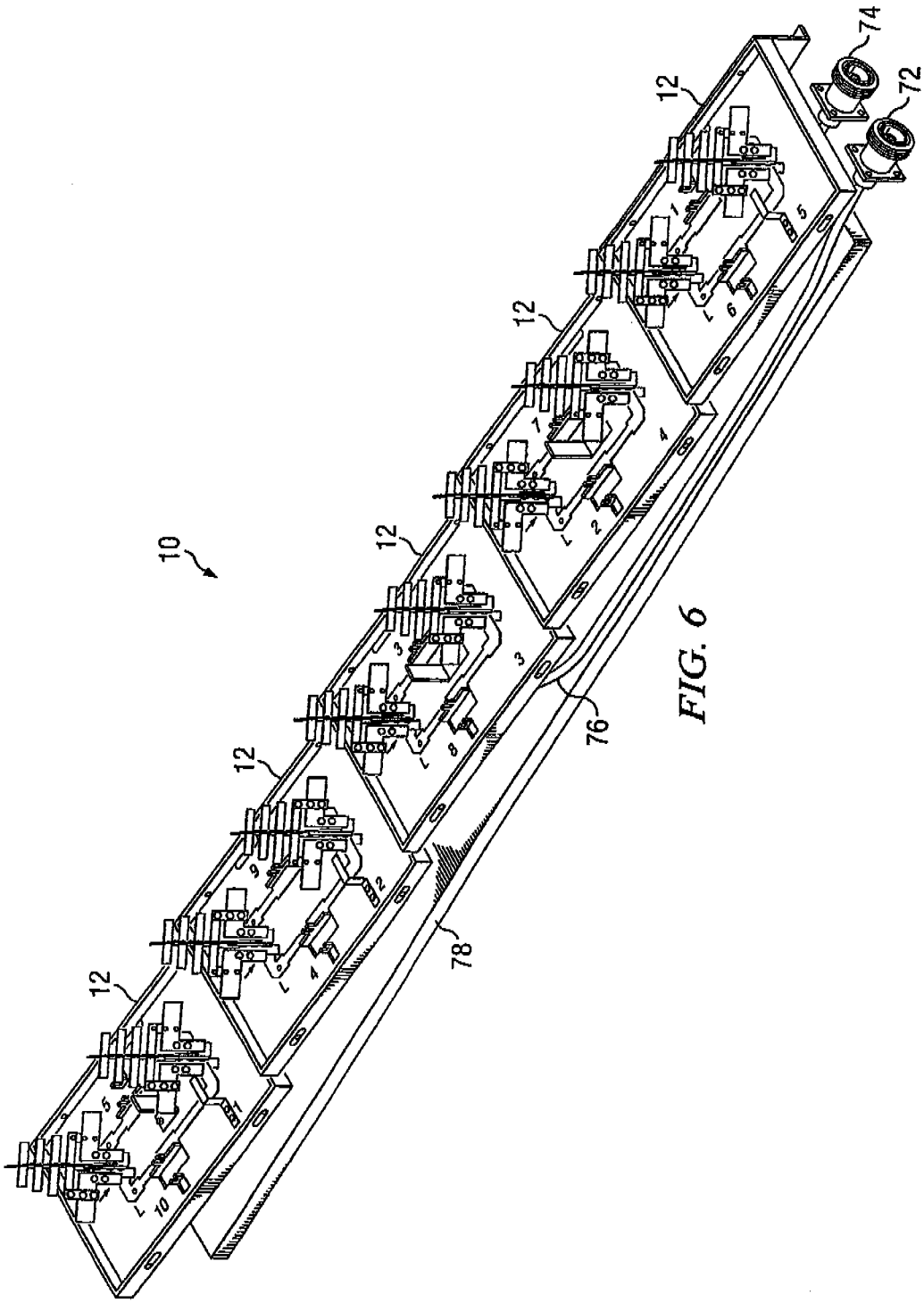


FIG. 6

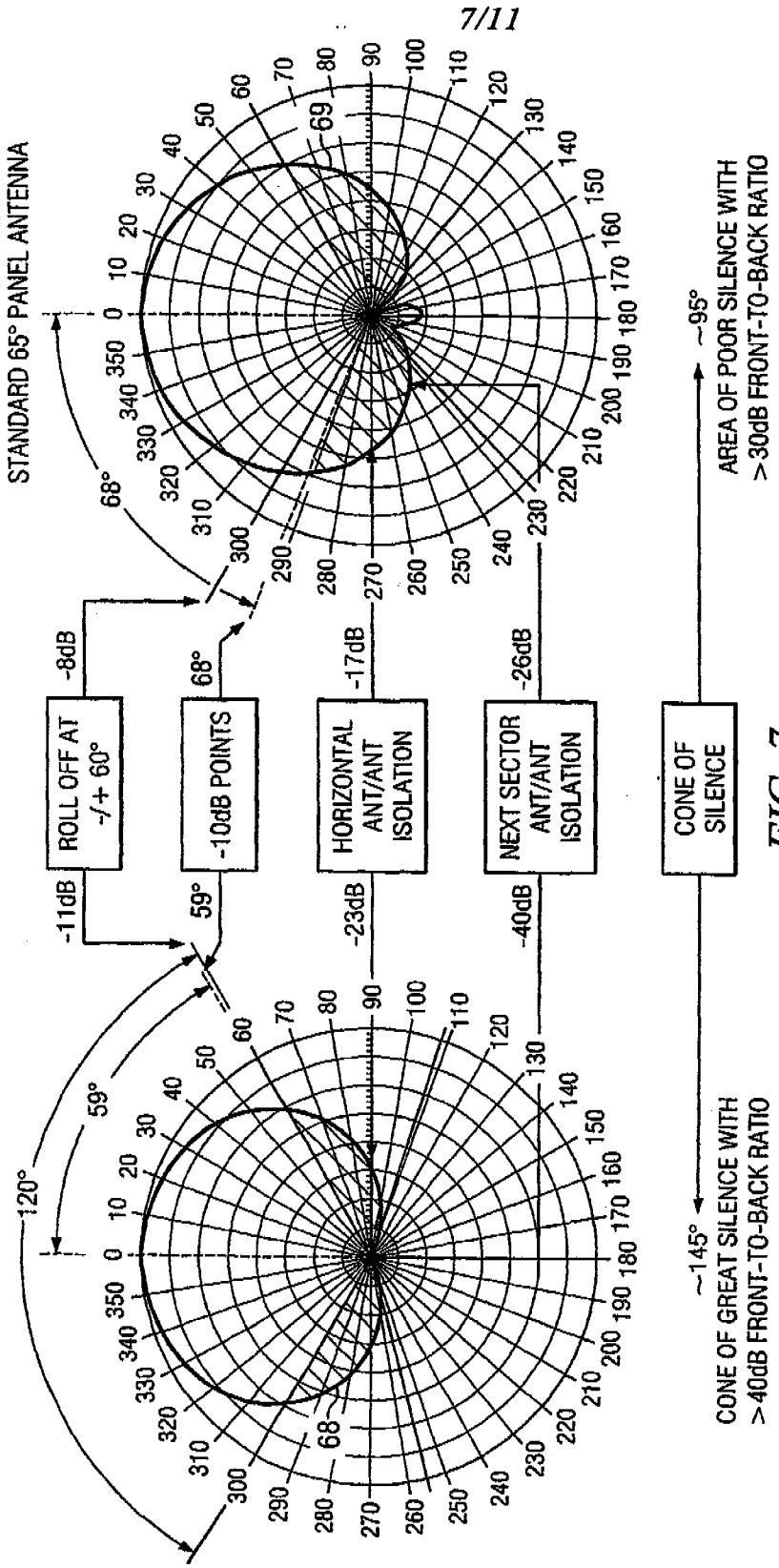

STANDARD 65° PANEL ANTENNA
68°
59°
120°
-8dB
-11dB
-23dB
-40dB
ROLL OFF AT -/+ 60°
-10dB POINTS
HORIZONTAL ANT/ANT ISOLATION
NEXT SECTOR ANT/ANT ISOLATION
CONE OF SILENCE
~95°
~145°
AREA OF POOR SILENCE WITH >30dB FRONT-TO-BACK RATIO
CONE OF GREAT SILENCE WITH >40dB FRONT-TO-BACK RATIO

FIG. 7

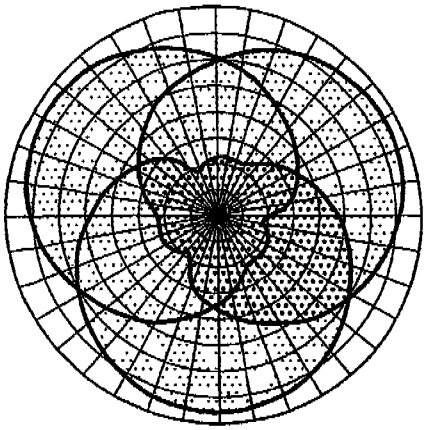


FIG. 8A

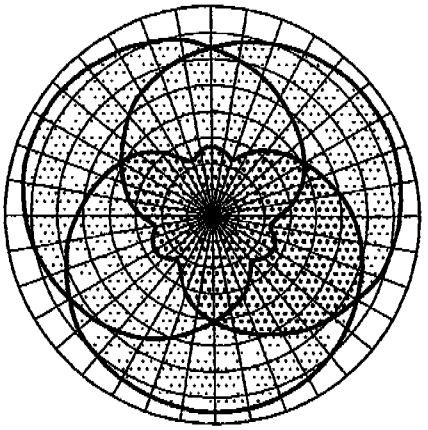


FIG. 8B

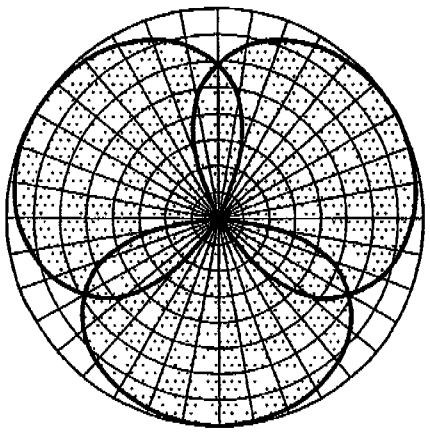


FIG. 9A

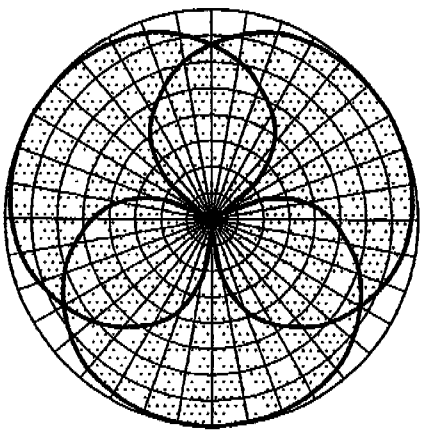


FIG. 9B

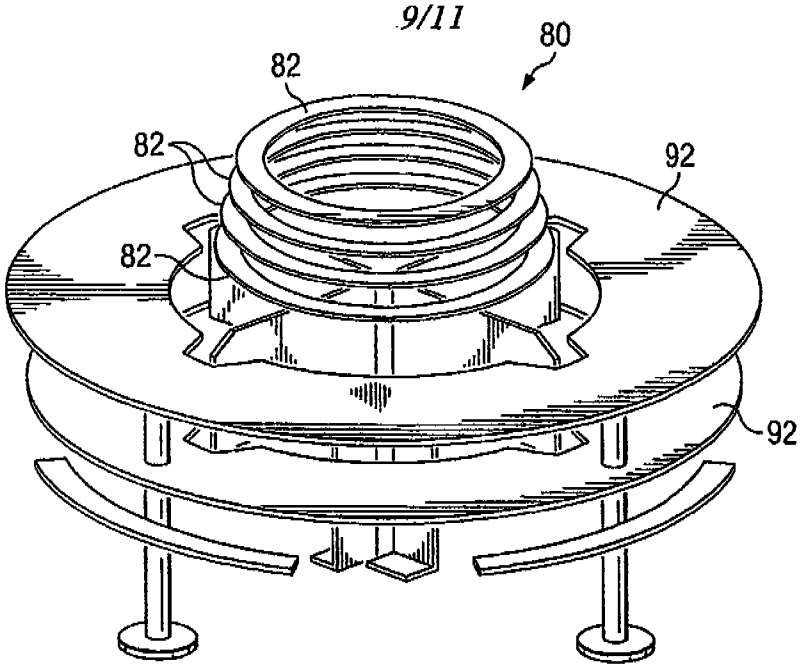


FIG. 10

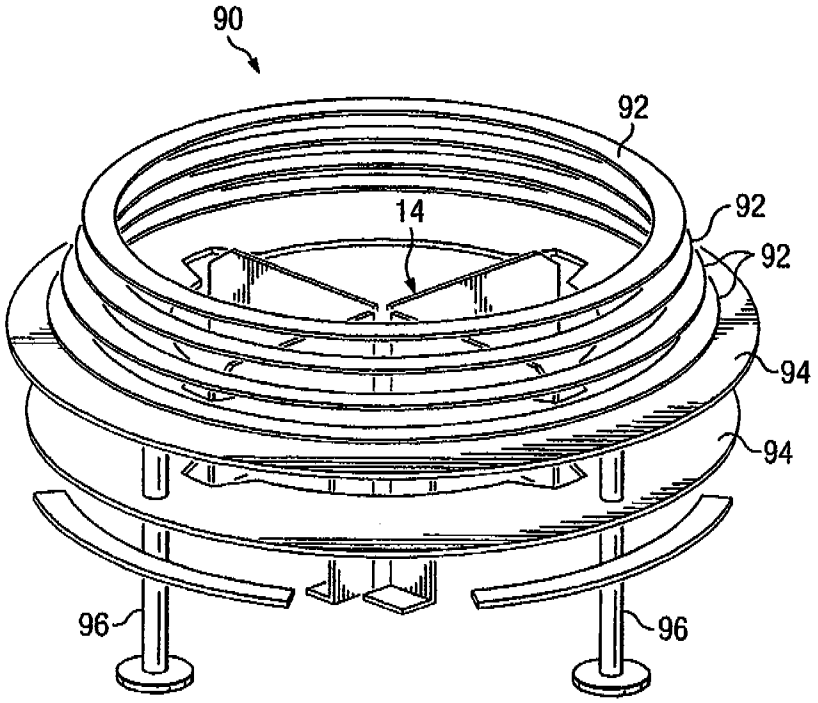


FIG. 11

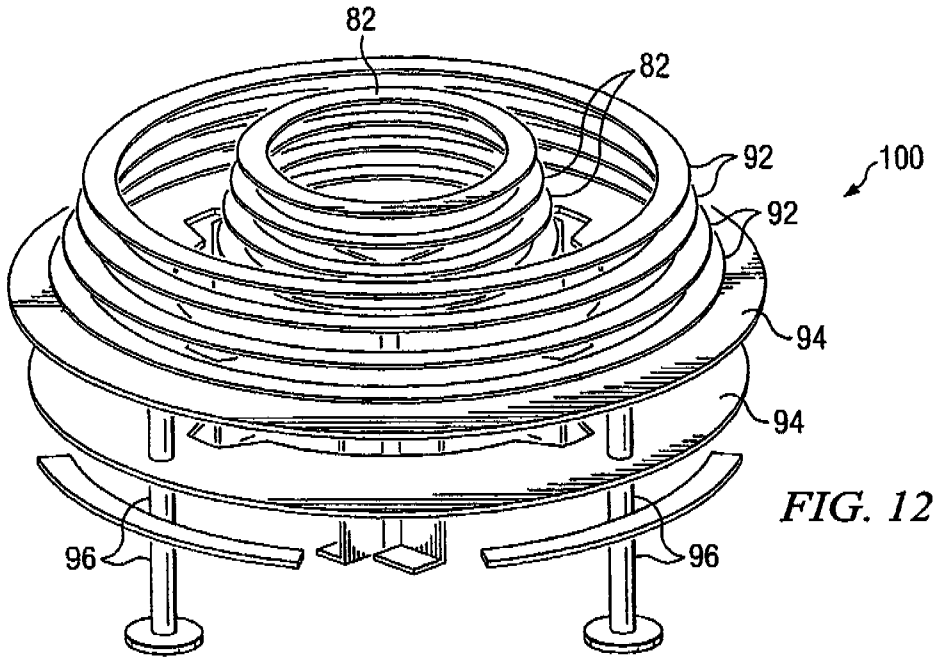


FIG. 12

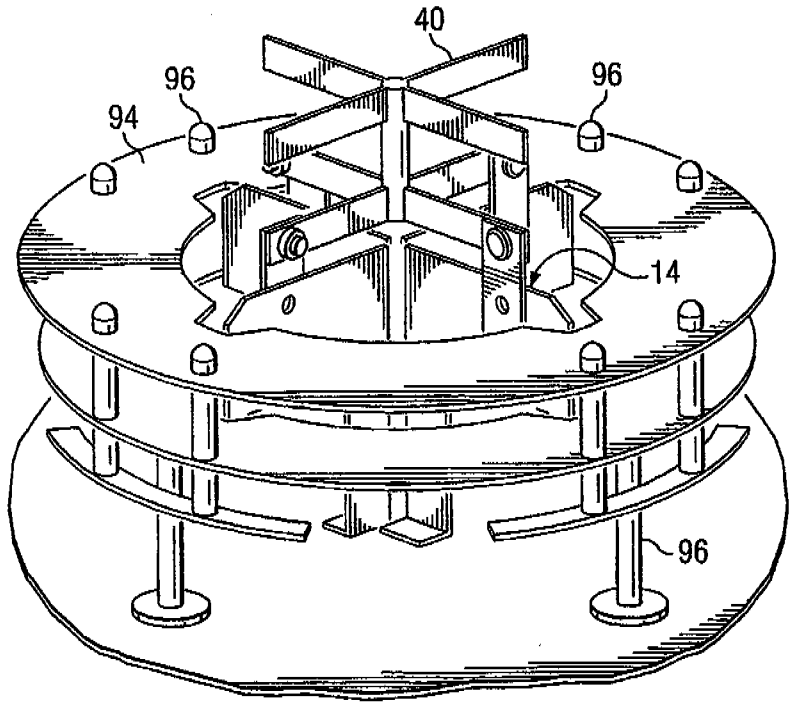


FIG. 14

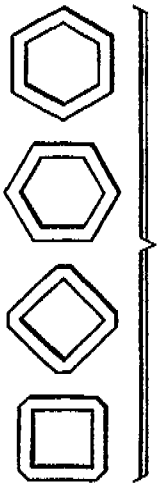


FIG. 13

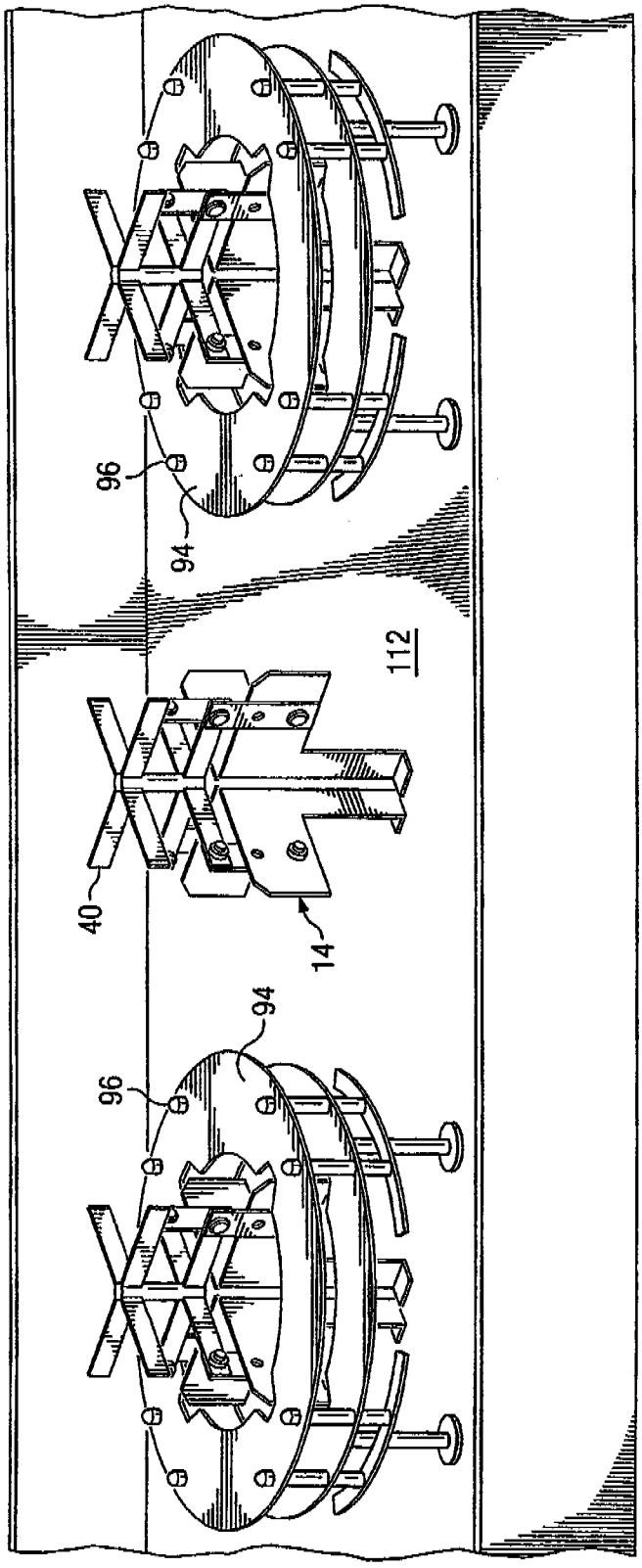


FIG. 15

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2005/012528

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01Q9/16 H01Q19/30 H01Q19/00

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 1 156 549 A (NORTEL NETWORKS LIMITED) 21 November 2001 (2001-11-21)	1-11, 17-19, 30-34, 36,38, 45-50
A	paragraphs [0030] - [0035]; figure 3	12-16, 35,37, 39-44

Y	US 4 218 686 A (BLONDER, ISAAC S) 19 August 1980 (1980-08-19)	1-11, 17-19, 30-34, 36,38, 45-50
A	column 5, lines 42-54; figure 3	12-16, 35,37, 39-44

	-/--	

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

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 August 2005	04. 11. 2005

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

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2005/012528

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 44 43 055 A1 (VEGA GRIESHABER KG, 77709 WOLFACH, DE) 20 June 1996 (1996-06-20) figures 1-3	12-16, 35,37, 39-44
A	US 6 333 720 B1 (GOETTL MAXIMILIAN ET AL) 25 December 2001 (2001-12-25) figure 4	
A	EP 1 148 582 A (LUCENT TECHNOLOGIES INC) 24 October 2001 (2001-10-24) figure 6	
A	US 5 952 983 A (DEARNLEY ET AL) 14 September 1999 (1999-09-14) abstract; figure 2	
E,L	WO 2005/062428 A (ANDREW CORPORATION; LE, KEVIN; MEYER, LOUIS, J) 7 July 2005 (2005-07-07) figure 1 (L: priority)	1,30,45
P,A	EP 1 496 569 A (ANDREW CORPORATION) 12 January 2005 (2005-01-12) abstract; figure 1	1,30,45
P,A	WO 2004/055938 A (ANDREW CORPORATION; BISIULES, PETER, JOHN; COULT, JOHN, H; DE LA CRUZ) 1 July 2004 (2004-07-01) abstract; figure 1	1,30,45
P,X	US 2004/263410 A1 (TEILLET ANTHONY ET AL) 30 December 2004 (2004-12-30) paragraphs [0028] - [0032]; figures 1-3	1,30,45

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US2005/012528

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1156549 A	21-11-2001	CA 2327837 A1	28-06-2001
		US 6211841 B1	03-04-2001
US 4218686 A	19-08-1980	CA 1105611 A1	21-07-1981
		GB 2015262 A	05-09-1979
		JP 54122954 A	22-09-1979
DE 4443055 A1	20-06-1996	NONE	
US 6333720 B1	25-12-2001	AU 755335 B2	12-12-2002
		AU 4265199 A	13-12-1999
		BR 9911595 A	13-02-2001
		CA 2331681 A1	02-12-1999
		CN 1303528 A	11-07-2001
		DE 19823749 A1	09-12-1999
		WO 9962139 A1	02-12-1999
		EP 1082782 A1	14-03-2001
		ES 2203196 T3	01-04-2004
		NZ 506976 A	28-08-2002
EP 1148582 A	24-10-2001	AU 3505701 A	11-10-2001
		BR 0101299 A	06-11-2001
		CA 2337929 A1	06-10-2001
		CN 1320982 A	07-11-2001
		JP 2001352215 A	21-12-2001
		US 6320544 B1	20-11-2001
US 5952983 A	14-09-1999	BR 9803695 A	26-12-2000
		CN 1223480 A	21-07-1999
		DE 19821223 A1	19-11-1998
		FR 2763750 A1	27-11-1998
WO 2005062428 A	07-07-2005	US 2005001778 A1	06-01-2005
EP 1496569 A	12-01-2005	AU 2004201942 A1	20-01-2005
		BR 0402509 A	31-05-2005
		CA 2456937 A1	26-12-2004
		CN 1577974 A	09-02-2005
		JP 2005020715 A	20-01-2005
		NZ 532804 A	29-07-2005
		US 2004263392 A1	30-12-2004
WO 2004055938 A	01-07-2004	AU 2003295509 A1	09-07-2004
US 2004263410 A1	30-12-2004	US 2002135527 A1	26-09-2002

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2005/012528

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-19, 30-44, 45-50

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

International Application No. PCT/ US2005/ 012528

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-19,30-44,45-50

directed to dipole directivity

---

2. claims: 20-24

directed to ground plane orientation

---

3. claims: 25-29

directed to influence of RF currents

122

(19) BUNDESREPUBLIK DEUTSCHLAND

(12) **Offenlegungsschrift**

(10) **DE 44 43 055 A 1**

(51) Int. Cl.[6]:
H 01 Q 19/30
G 01 F 23/284

DEUTSCHES PATENTAMT

(21) Aktenzeichen: P 44 43 055.8
(22) Anmeldetag: 5. 12. 94
(43) Offenlegungstag: 20. 6. 96

DE 44 43 055 A 1

(71) Anmelder:
VEGA Grieshaber KG, 77709 Wolfach, DE

(74) Vertreter:
Patentanwälte Westphal, Mussgnug & Partner, 78048 Villingen-Schwenningen

(72) Erfinder:
Fehrenbach, Josef, 77716 Haslach, DE

(56) Entgegenhaltungen:

DE 26 48 375 C2
DE 26 48 350 C2
DE 94 12 243 U1
DE 93 12 251 U1
GB 20 34 124 A
GB 14 72 968
GB 9 05 417

KOBAYASHI, S. et al.: Dielectric Tapered Rod Antennas for Millimeter-Wave Applications. In: IEEE Transactions on Antennas and Propagation, Vol. AP-30, No. 1, January 1982, S. 54-58;
WILSON, M.: Dowm East Microwave 23-cm and 13-cm Loop Yagis. In: QST, July 1990, S. 35-36;
NAKANO, H. et al.: Directive properties of pararitic helix and its application to circularly polarised antenna. In: IEEE Proceedings, Vol. 130, Pt. H., No. 6, October 1983, S. 391-396;
TRENTINI, G.v.: Wellenführende Systeme für Längsstahler. In: NTZ, 1959, H. 10, S. 501-508;
REYNOLDS, D.K.: Broadband Travelling Wave Antennas. In: IRE National Convention Record, 1957, Part 1, S. 99-107;

Prüfungsantrag gem. § 44 PatG ist gestellt

(54) Antenneneinrichtung für ein Füllstandmeß-Radargerät

(57) Die Antenneneinrichtung für ein Füllstandmeß-Radargerät weist einen HF-Strahler zum Abstrahlen von Mikrowellen entlang einer Hauptabstrahlrichtung und mindestens ein metallisches Element zum Bündeln der abgestrahlten Mikrowellen auf. Das mindestens eine metallische Element ist auf oder innerhalb eines aus nicht leitendem Material bestehenden, stabförmigen Trägerkörpers angeordnet. Der Trägerkörper samt metallischem Element ist von einer Korrosionsschutzschicht umgeben. Als metallisches Element kann insbesondere ein Wendelleiter auf den stabförmigen Trägerkörper aufgewickelt sein. Ein anderes Ausführungsbeispiel sieht vor, eine Vielzahl von kreisrunden Leiterschleifen als Direktoren auf den stabförmigen Trägerkörper zu wickeln. Vorteile: Korrosions- und druckbeständig, Ex-Zone 0 und 1 geeignet.

DE 44 43 055 A 1

Beschreibung

Die Erfindung betrifft eine Antenneneinrichtung für ein Füllstandmeß-Radargerät gemäß den Merkmalen des Oberbegriffs des Anspruchs 1.

Antenneneinrichtungen für Füllstandmeßgeräte, die mit Mikrowellen arbeiten, sind hinlänglich bekannt und werden beispielsweise zur kontinuierlichen Füllstandmessung sowohl bei Flüssigkeiten als auch bei Schüttgütern eingesetzt. Das Meßprinzip beruht darauf, kurze Mikrowellenimpulse von einem Hochfrequenzstrahler (HF-Strahler) auszusenden. In einem kombinierten Sende- und Empfangssystem werden die vom Füllgut reflektierten Impulse erfaßt und durch Laufzeitmessung dieser Impulse der Abstand zum Füllgut ermittelt.

Die Einkopplung der Mikrowellen in das Behälterinnere erfolgt über einen geeigneten HF-Strahler, wobei darauf zu achten ist, daß sich im Behälter keinerlei temperatur- sowie korrosionsempfindliche Komponenten der Antenneneinrichtung befinden.

Bei der Verwendung solcher mit Mikrowellen arbeitenden Füllstandmeßgeräte ist es notwendig, eine gute Abdichtung zwischen Behälterinnenraum und dem elektronischen Teil der Antenneneinrichtung zu gewährleisten. Dies ist insbesondere dann wichtig, wenn der Füllstand in Behältern, wie z. B. Industrietanks, bestimmt werden soll, in denen bei hohen oder niedrigen Betriebstemperaturen Unter- oder Überdrücke herrschen und der Behälter explosible und/oder hoch hochaggressive und/oder toxische Medien enthält. Die Antenneneinrichtung muß demzufolge möglichst temperatur-, druck- und korrosionsbeständig ausgebildet sein. Darüber hinaus muß die Antenneneinrichtung den Zulassungsvorschriften zum Einsatz in explosionsgefährdeten Betriebsstätten entsprechen. Die Antenneneinrichtung muß insbesondere den harmonisierten Europäischen Normen "Elektrische Betriebsmittel für explosionsgefährdete Bereiche" bzw. der ElexV Ex-Zone 0 sowie Ex-Zone 1 entsprechen. Ex-Zone 0 umfaßt hierbei Bereiche, in denen gefährliche, explosionsfähige Atmosphäre ständig oder langzeitig vorhanden ist, während die Zone 1 Bereiche umfaßt, in denen damit zu rechnen ist, daß gefährliche explosionsfähige Atmosphäre gelegentlich auftritt.

Um die Mikrowellen möglichst eng gebündelt auf die Füllgutoberfläche zu lenken, werden regelmäßig sogenannte Hochgewinnantennen bei den Füllstandmeß-Radargeräten eingesetzt. Hierbei ist die Divergenz, d. h. der Öffnungswinkel eines Antennenstrahls umgekehrt proportional zu ihrem Größen-/Wellenlängenverhältnis. Dies hat zur Folge, daß bei gegebener Wellenlänge und diversen konstruktiven Randbedingungen, Öffnungswinkel von einigen Grad bis etwa 40° gebrauchsübliche Dimensionen darstellen.

Die bei der Füllstandmessung mittels Mikrowellen am meisten verbreitete Antenneneinrichtung ist die Hornantenne. Eine üblicherweise aus Metall bestehende Trichterkonstruktion bestimmt mit ihrer Geometrie die Antennencharakteristika, wie z. B. Gewinn, Divergenz und Strahlungsdiagramm. Das Trichtermaterial wird vorzugsweise aus weitgehend chemisch resistenten Metallen hergestellt. Aus dem deutschen Gebrauchsmuster G 93 12 251.9 der Anmelderin ist ein Füllstandmeß-Radargerät bekannt, bei dem zwischen Erregerteil eines Hohlleiter-Antennensystems und dem Gehäuse des Sende- und Empfangsteils eine diffusions- und druckdichte Glasdurchführung angeordnet ist, welche eine Füllstandmessung mit Hornantennen auch in Behältern

mit brennbaren und/oder explosiblen Medien erlaubt.

Die Hornantenne ist für die meisten Anwendungen der beste Kompromiß zwischen den Anforderungen Divergenz, Druck, Temperatur, chemischer Beständigkeit und Herstellungsaufwand.

Für hochgenaue Messungen und bei Messungen für größere Distanzen und schwach reflektierenden Füllgütern werden teilweise Parabolantennen eingesetzt. Diese Parabolantennen haben im allgemeinen einen größeren Durchmesser als Hornantennen, wodurch eine schärfere Bündelung und damit eine kleinere Divergenz des Mikrowellenstrahls möglich ist. Allerdings sind solche Parabolantennen aufgrund ihrer verhältnismäßig großen Abmessungen nicht oder nur aufwendig in gebräuchlichen Rohrstutzen montierbar. Spezielle und damit aufwendige Befestigungsvorrichtungen sind notwendig.

In einigen Anwendungsfällen sind ausschließlich Kunststoffe gegenüber dem Füllgut und dessen Dämpfen chemisch beständig. Um diese Resistenz zu erreichen, können die vorstehend genannten Antenneneinrichtungen entweder beschichtet oder vor solche Antennen entsprechende Fenster, vorzugsweise aus Polytetrafluorethylen (PTFE), montiert werden.

Darüber hinaus sind mittlerweile auch dielektrische Stabantennen für das Abstrahlen von Mikrowellen bekannt, wie beispielsweise die Druckschrift "IEEE Transactions on Antennas and Propagation", Vol. AP-30, No. 1, Januar 1982, S. 54—58, zeigt. Diese dielektrischen Stabantennen bestehen im wesentlichen aus einem Hohlleiter, an dessen Ende ein sich vorzugsweise verjüngender Stab aus dielektrischem Material sitzt.

Aus dem deutschen Gebrauchsmuster 94 12 243.1 der Anmelderin ist ebenfalls eine dielektrische Stabantenne für ein Füllstandmeß-Radargerät bekannt. Eine hohe chemische Beständigkeit, Druckfestigkeit und Korrosionsbeständigkeit wird dadurch erreicht, daß die dielektrische Stabantenne auf ihrer dem Behälter zugewandten Seite mit einer korrosionsbeständigen und für die elektromagnetischen Wellen durchlässigen Schutzschicht, vorzugsweise aus Email, Kunststoff oder Keramik, überzogen ist. Diese bekannte Konstruktion ermöglicht die Montage der dielektrischen Stabantenne in relativ dünnen Rohrstutzen unter Beibehaltung eines erforderlichen geringen Öffnungswinkels.

Es hat sich herausgestellt, daß insbesondere bei Füllstandmessungen in explosionsgefährdeten Bereichen, also Ex-Zonen 0 und 1, dielektrische Stabstrahler aus Sicherheitsgründen nicht ohne weiteres einsetzbar sind. Der dielektrische Stab kann sich nämlich insbesondere beim Befüllvorgang des Behälters durch Reibung aufladen, so daß als Folge hoher elektrostatischer Feldstärke ein Funke entsteht, der zu einem Zünden des explosionsfähigen Gemisches führen kann.

Der Erfindung liegt die Aufgabe zugrunde, eine Antenneneinrichtung für ein Füllstandmeß-Radargerät anzugeben, das in explosionsgefährdeten Bereichen ohne weiteres einsetzbar, druckfest und korrosionsbeständig ist. Darüber hinaus soll sich die Antenneneinrichtung durch eine gute Bündelung der Mikrowellen auszeichnen.

Diese Aufgabe wird durch eine Antenneneinrichtung mit den Merkmalen des Anspruchs 1 gelöst.

Weiterbildungen der Erfindung sind Gegenstand der Unteransprüche.

Die Erfindung beruht darauf, mindestens ein zum Bündeln der vom HF-Strahler ausgesandten Mikrowellen geeignetes metallisches Element auf oder innerhalb

eines aus nicht leitendem Material bestehenden, stabförmigen Trägerkörpers anzuordnen und den Trägerkörper samt metallischem Element mit einer Korrosionsschutzschicht zu umgeben.

Zur Erzielung einer sehr guten Richtwirkung kann auf der dem Behälter zugewandten Seite des HF-Strahlers eine Vielzahl von nebeneinander liegenden metallischen Elementen angeordnet sein.

Als metallisches Element eignet sich insbesondere eine schleifenförmige Leitung, deren Schleifenebene orthogonal zur Hauptabstrahlrichtung des HF-Strahlers angeordnet ist. Die schleifenförmigen Leitungen sind vorzugsweise kreisrund ausgebildet und auf den zylinderförmig gestalteten Trägerkörper aufgewickelt oder auf gedampft. Die schleifenförmigen Leitungen liegen somit auf der Außenfläche des massiv gestalteten Trägerkörpers an. Hierdurch wird eine hohe Druckfestigkeit der Antenneneinrichtung sichergestellt. Der zylinderförmige Trägerkörper kann in Richtung Behälter verjüngt ausgebildet sein, so daß sich die auf der Außenfläche des Trägerkörpers aufliegenden schleifenförmigen Leitungen in ihrem Durchmesser ebenfalls verkleinern. Hierdurch wird die Abstrahlcharakteristik entsprechend dem Prinzip von Yagi-Antennen verbessert.

Die einzelnen metallischen Elemente, also beispielsweise die kreisrunden Leitungen auf dem Trägerkörper, sind vorzugsweise mit einem gemeinsamen Antennenmasseanschluß der Antenneneinrichtung elektrisch verbunden. Hierdurch wird wirksam vermieden, daß sich der aus nichtleitendem Material bestehende Trägerkörper stark elektrostatisch aufladen kann. Die Antenneneinrichtung ist somit Ex-Zone 0 und Ex-Zone 1 tauglich.

Obwohl vorzugsweise kreisrunde Leitungen als metallische Elemente zum Bündeln der vom HF-Strahler ausgesandten Mikrowellen auf den Trägerkörper aufgebracht werden, haben sich auch andere metallische Elemente zur Bündelung der Mikrowellen als geeignet erwiesen. So können anstelle der schleifenförmigen Leitungen auch scheibenförmige metallische Elemente in den Trägerkörper eingebracht werden. Anstelle der schleifenförmigen oder scheibenförmigen metallischen Elemente sind auch stabförmige metallische Elemente geeignet. Wesentlich ist lediglich, daß diese metallischen Elemente von einem stabförmigen Trägerkörper gehalten werden, in dem oder auf dem die metallischen Elemente sitzen. Der Trägerkörper ist dabei so gestaltet, daß die metallischen Elemente vollständig innerhalb des Trägerkörpers sitzen oder der Trägerkörper unmittelbar bis an die Innenbegrenzungen der metallischen Elemente heranreicht.

Anstelle dieser als Direktoren wirkenden metallischen Elemente zur Bündelung der Mikrowellen kann die Antenneneinrichtung nach der Erfindung auch mit einer Wendelleitung oder Wendelleitungen als metallischem Element ausgebildet sein. Diese Wendelleitung ist ebenfalls um den zylinderförmigen Trägerkörper gewickelt. Eine so ausgebildete Antenneneinrichtung arbeitet nach Art der bekannten Helical-Antenne. Die vom HF-Strahler ausgesandten Mikrowellen werden durch diese Wendelleitung zirkular polarisiert.

Da bei Reflexion am Füllgut die Drehrichtung der Polarisation umgekehrt wird, ist es zweckmäßig, für den Empfang eine getrennte Helical-Antenne zu verwenden. Hierfür wird eine zweite Wendelleitung mit zur ersten Wendelleitung entgegengesetztem Wicklungssinn vorgesehen und diese zweite Wendelleitung einem HF-Empfänger zugeordnet. Der zweite Wendelleiter wird vorzugsweise koaxial zum ersten Wendelleiter angeordnet und durch eine Isolationsschicht von diesem getrennt.

Als HF-Strahler hat sich ein Hohlwellenleiter als günstig erwiesen. Der Trägerkörper mit den metallischen Elementen weist vorzugsweise eine Verlängerung auf, die in diesem Hohlwellenleiter sitzt. Hierdurch ergibt sich ein äußerst kompakter Aufbau der Antenneneinrichtung.

Die Dicke der Korrosionsschutzschicht ist vorzugsweise kleiner gleich 2 mm. Zusammen mit den galvanisch an die Antennenmasse angeschlossenen metallischen Elementen ist hierdurch nur ein geringes elektrostatisches Aufladen der Antenneneinrichtung möglich. Die Antenneneinrichtung darf somit in explosionsgefährdeter Umgebung eingesetzt werden.

Die um den stabförmigen Trägerkörper aufgebrachte Korrosionsschutzschicht setzt sich vorzugsweise ringförmig mindestens über einen Teil des Befestigungsflansches der Antenneneinrichtung fort. Damit wird auch der Befestigungsflansch vor Korrosion geschützt.

In einer Weiterbildung bestehen die Korrosionsschutzschicht und der Trägerkörper aus dem gleichen Material.

Als Material kommen beispielsweise PTFE (Polytetraflourethylen), PVDF (Polyvinylidenflourid), Keramik, Email oder dergleichen in Betracht.

Die Erfindung wird nachfolgend im Zusammenhang mit Ausführungsbeispielen näher erläutert. Es zeigen:

Fig. 1 die schematische Darstellung einer Yagi-Antenne mit stabförmigem HF-Strahler, Reflektor und Direktoren,

Fig. 2 die Yagi-Antenne gemäß **Fig.** 1, jedoch mit schleifenförmigem HF-Strahler,

Fig. 3 eine Yagi-Antenne mit schleifenförmigem HF-Strahler, schleifenförmigem Reflektor sowie schleifenförmigen Direktoren,

Fig. 4 einen stabförmigen Trägerkörper samt integrierter Yagi-Antenne gemäß **Fig.** 3,

Fig. 5 die Antenneneinrichtung gemäß **Fig.** 4 mit Korrosionsschutzschicht,

Fig. 6 ein Ausführungsbeispiel für eine Antenneneinrichtung nach der Erfindung mit Hohlwellenleiter als HF-Strahler, Trägerkörper, schleifenförmigen Direktoren und Korrosionsschutzschicht,

Fig. 7 ein weiteres Ausführungsbeispiel zum Bündeln der Mikrowellen mit stabförmigem Trägerkörper, auf dem Trägerkörper aufgewickelter Wendelleitung sowie Wendelleitung und Trägerkörper umgebender Schutzschicht, und

Fig. 8 eine Antenneneinrichtung gemäß **Fig.** 7 mit zwei Wendelleitungen mit jeweils entgegengesetzt zueinander verlaufenden Wicklungsrichtungen.

In den nachfolgenden Figuren bezeichnen gleiche Bezugszeichen, sofern nicht anders angegeben, gleiche Teile mit gleicher Bedeutung.

In **Fig.** 6 ist ein konkretes Ausführungsbeispiel für eine Antenneneinrichtung zur Füllstandmessung in Füllstandmeß-Radargeräten gezeigt. Diese Antenneneinrichtung beruht im wesentlichen auf dem Prinzip einer Yagi-Antenne. Zur Erläuterung der Funktionsweise solcher Yagi-Antennen wird auf die **Fig.** 1 bis 3 Bezug genommen. Die **Fig.** 4 und 5 zeigen, wie das Prinzip der Yagi-Antenne auf die Antenneneinrichtung nach der Erfindung angewendet werden kann.

In **Fig.** 1 ist eine Yagi-Antenne schematisch dargestellt. Die Antenneneinrichtung weist einen HF-Strahler 1 in Form eines stabförmigen Dipoles auf. Zur Erzielung einer besseren Richtcharakteristik in Hauptabstrahl-

richtung A sind vor dem HF-Strahler 1 eine Vielzahl von Direktoren 3 angeordnet. Die Direktoren 3 sind im Abstand zueinander angeordnete und parallel zum HF-Strahler liegende elektrisch leitende Stäbe. Im Ausführungsbeispiel von **Fig.** 1 sind insgesamt sechs Direktoren 3 vor dem HF-Strahler 1 angeordnet. In bezug auf die Hauptabstrahlrichtung A hinter dem HF-Strahler 1 ist ein weiteres parasitäres Element, nämlich ein Reflektor 2, angeordnet. Der Reflektor 2 ist ebenfalls ein elektrisch leitender Stab. Der HF-Strahler 1, der Reflektor 2 und die Direktoren 3 werden jeweils mittig von einem Trägerkörper 4, hier einer Antennenträgerstange, gehalten. Der HF-Strahler 1, der Reflektor 2 und die Direktoren 3 sind über diesen Trägerkörper 4, der aus Metall bestehen kann, üblicherweise galvanisch miteinander verbunden, was jedoch für die Antennenfunktion nicht erforderlich ist. Anstelle des Reflektors 2 in Form eines leitenden Stabes, kann auch eine elektrisch leitende Fläche als Reflektor 2 eingesetzt werden.

Allgemein gilt für solche Yagi-Antennen, daß ihr Gewinn um so größer ist, je länger die Antenne ist, also je mehr Direktoren die Antenne aufweist. Der Öffnungswinkel wird mit zunehmender Anzahl der parasitären Direktoren bzw. Reflektoren kleiner.

Aus diesem Grundprinzip der Yagi-Antenne gemäß **Fig.** 1 sind zahlreiche Varianten ableitbar. So kann z. B. der HF-Strahler 1 statt des üblichen gestreckten Dipols oder Faltdipols aus einer eine Wellenlänge langen Schleife bestehen. Diese Schleif e ist vorzugsweise kreisrund oder quadratisch ausgebildet, kann aber auch andere Formen, wie z. B. Vielecke, Dreiecke, Rechtecke usw. annehmen. Ein Ausführungsbeispiel einer Antenneneinrichtung mit HF-Strahler 1 in kreisrunder Schleifenform zeigt **Fig.** 2 schematisch. Im übrigen entspricht die Antenneneinrichtung gemäß **Fig.** 2 der Yagi-Antenne von **Fig.** 1.

Darüber hinaus ist es auch möglich, die Reflektoren 2 und Direktoren 3 in Schleifenform auszubilden. Eine solche Antenneneinrichtung zeigt **Fig.** 3. Die kreisrunden Leiterschleifen des HF-Strahlers 1, des Reflektors 2 und der Direktoren 3 sind jeweils randseitig auf einem als Stange ausgebildeten Trägerkörper 4 in nicht näher dargestellter Weise befestigt. Statt der Leiterschleifen können auch scheibenförmige Elemente als HF-Strahler 1, Reflektor 2 und Direktoren 3 eingesetzt werden. Die Schleifenebene B bzw. Plattenebene ist orthogonal zur Hauptabstrahlrichtung A angeordnet.

Auf dem Prinzip der Yagi-Antenne beruht die Antenneneinrichtung für ein Füllstandmeß-Radargerät nach der Erfindung. Die Antenneneinrichtung weist neben einem HF-Strahler 1 zum Abstrahlen der Mikrowellen entlang einer Hauptabstrahlrichtung A mindestens ein metallisches Element zum Bündeln der Mikrowellen auf. Das mindestens eine metallische Element wird jedoch auf oder innerhalb eines aus nicht leitendem Material bestehenden, stabförmigen Trägerkörpers angeordnet und dieser Trägerkörper samt metallischem Element von einer Korrosionsschutzschicht umgeben.

Die prinzipielle Anordnung des oder der metallischen Elemente auf oder innerhalb des aus nichtleitendem Material bestehenden stabförmigen Trägerkörpers zeigt **Fig.** 4. Der zylinderförmige Trägerkörper 4 ist vorzugsweise von massiver Gestalt und verjüngt sich vorzugsweise in Hauptabstrahlrichtung A. Auf dem Trägerkörper 4 sind jeweils im Abstand zueinander kreisrunde Leiterschleifen aufgebracht. Dies kann durch Aufwikkeln der entsprechenden Leiterschleifen oder durch Aufdampfen von metallischen Leiterbahnen erfolgen. Die einzelnen Leiterschleifen sind zentrisch zur Längsachse des zylinderförmigen Trägerkörpers 4 angeordnet. Die Leiterschleifen sind über eine leitende Verbindung 5, die sich in Längsrichtung an der Außenseite des Trägerkörpers erstreckt, miteinander elektrisch verbunden. In **Fig.** 4 stellt die am weitesten links dargestellte Leiterschleife den Reflektor 2, die rechts daneben liegende Leiterschleife den HF-Strahler 1 dar. Die rechts von diesem HF-Strahler 1 liegenden Leiterschleifen sind Direktoren 3.

Obwohl die in **Fig.** 4 dargestellte Anordnung bereits prinzipiell dazu geeignet ist, bei Einspeisung von HF-Energie in den HF-Strahler 1 Mikrowellen in die Hauptabstrahlrichtung A abzustrahlen, ist es für die Füllstandmessung, insbesondere in aggressiven Medien, notwendig, den Trägerkörper 4 samt Leiterschleifen mit einer Korrosionsschutzschicht zu umgeben. Dies zeigt **Fig.** 5. Die Korrosionsschutzschicht ist mit dem Bezugszeichen 6 gekennzeichnet und ist mit Ausnahme der in **Fig.** 5 links dargestellten Stirnseite des Trägerkörpers 4 vollständig um den Trägerkörper 4 samt Leiterschleifen aufgebracht. Die Korrosionsschutzschicht 6 endet fluchtend auf der linken Stirnseite des Trägerkörpers 4 in Form eines Flansches 6a.

Obwohl die Antenneneinrichtung gemäß **Fig.** 5 sowohl Leiterschleifen für einen Reflektor, einen HF-Strahler und Direktoren enthalten könnte, stellen in **Fig.** 5 die Leiterschleifen ausschließlich Direktoren 3 dar, die galvanisch über die leitende Verbindung 5 miteinander verbunden sind. Die in **Fig.** 5 gezeigte Anordnung kann einem HF-Strahler eines bekannten Füllstandmeßgerätes zugeordnet werden.

Eine besonders bevorzugte Ausführungsform der gesamten Antenneneinrichtung nach der Erfindung zeigt **Fig.** 6. Dort ist ein Hohlwellenleiter 9 vorgesehen, der einen becherartigen Metallmantel aufweist. An der zylindrischen Seitenwandung dieses becherartigen Metallmantels befindet sich ein Koaxialanschluß 10 zum Einkoppeln von HF-Energie. Der becherartige Metallmantel des Hohlwellenleiters 9 endet an seiner offenen Seite mit einem Flansch 8, an dem der flanschartige Fortsatz 6a der in **Fig.** 5 dargestellten Schutzschicht 6 anliegend aufgebracht wird. Der Trägerkörper 4 mit den aufgebrachten metallischen Elementen, hier wieder in Form der kreisrunden Leiterschleifen, erstreckt sich in das Innere des becherartigen Metallmantels des Hohlleiters 9. Die leitende Verbindung 5 ist mit einem Antennenmasseanschluß 14, hier der metallischen Wandung des Hohlleiters 9 elektrisch in Verbindung.

Die in **Fig.** 4 dargestellte Antenneneinrichtung zeichnet sich durch eine hohe Druckbeständigkeit aufgrund der massiven Ausbildung der Antenneneinrichtung aus. Darüber hinaus ist aufgrund der vorgesehenen Korrosionsschutzschicht 6 eine hohe Korrosionsbeständigkeit der Antenneneinrichtung gewährleistet. Vorzugsweise wird die Korrosionsschutzschicht 6 gerade so dick ausgeführt, daß sich diese insbesondere bei Befüllvorgängen des Behälters nicht stark elektrostatisch aufladen kann. Als Schichtdicke für die Korrosionsschutzschicht 6 haben sich Dicken von kleiner gleich 2 mm als günstig erwiesen.

Ein weiteres Ausführungsbeispiel der Antenneneinrichtung nach der Erfindung ist in den **Fig.** 7 und 8 dargestellt. Das metallische Element zur Bündelung der Mikrowellen ist in **Fig.** 7 ein Wendelleiter 11, der auf den zylinderförmig gestalteten Trägerkörper 4 aufgewickelt bzw. aufgedampft ist. Der Trägerkörper 4 samt Wendelleiter 11 ist von einer Korrosionsschutzschicht 6 umge-

ben, ähnlich wie es in **Fig. 5** gezeigt ist. Die HF-Energie wird in den Wendelleiter **11** unmittelbar am Fußpunkt des Wendelleiters **11** über den Innenleiter eines Koaxialkabels eingespeist. Der Masseanschluß des Koaxialkabels wird am Fußpunkt mit einer metallischen Reflektorplatte verbunden.

In **Fig. 8** ist eine ähnliche Anordnung wie in **Fig. 7** gezeigt, allerdings ist jetzt zusätzlich zu dem ersten Wendelleiter **11** ein zweiter Wendelleiter **12** vorgesehen. Der zweite Wendelleiter **12** weist im Vergleich zum ersten Wendelleiter **11** einen entgegengesetzten Wicklungssinn auf. Die Verwendung zweier Wendelleiter **11, 12** ist deshalb notwendig, da die vom HF-Strahler über den Wendelleiter **11** ausgesandten Mikrowellen eine zirkulare Polarisation aufweisen und bei Reflexion am Füllgut die Drehrichtung der Polarisation reversiert wird. Die am Füllgut reflektierten Mikrowellen werden dann über den zweiten Wendelleiter **12** in einem zugeordneten HF-Empfänger empfangen.

Im Ausführungsbeispiel von **Fig. 8** weist der zweite Wendelleiter **12** einen etwas größeren Durchmesser als der erste Wendelleiter **11** auf. Beide Wendelleiter **11, 12** sind zueinander koaxial angeordnet und von einer Isolierschicht **13** getrennt.

Die Herstellung einer solchen Anordnung kann dadurch erfolgen, daß beispielsweise auf den zylinderförmigen Trägerkörper **4** der erste Wendelleiter **11** in Form von einer schraubenförmigen Metallbahn aufgedampft oder aufgewickelt wird. Über den Trägerkörper **4** samt erstem Wendelleiter **11** wird dann die Isolierschicht **13** zylinderförmig aufgebracht. Auf diese Isolierschicht **13** wird schließlich der zweite Wendelleiter **12** aufgebracht und die gesamte Konstruktion abschließend von der Korrosionsschutzschicht **6**, gegebenenfalls mit flanschartigem Fortsatz **6a**, umgeben. Die in **Fig. 8** dargestellte Anordnung erfüllt die gleichen Anforderungen bezüglich Korrosions-, Druckbeständigkeit und Explosionssicherheit, wie die im Zusammenhang mit **Fig. 6** beschriebene Antenneneinrichtung.

Obwohl in den vorgenannten Ausführungsbeispielen von massiv gestalteten Trägerkörpern **4** die Rede war, ist es bei druckunempfindlichen Applikationen möglich, den Trägerkörper **4** hohl auszubilden. Die metallischen Elemente, also z. B. die schleifenförmigen Direktoren **3** und Wendelleiter **11, 12**, könnten auf der Außen- oder Innenseite eines solchen hohlen Trägerkörpers aufgebracht sein. Bei Verwendung einer Korrosionsschutzschicht **6** wäre es möglich, diese als Korrosionsschutzhohlkörper auszubilden und auf der Innenseite dieses Korrosionsschutzhohlkörpers die metallischen Elemente **3, 5** bzw. **11** anzubringen.

Darüber hinaus könnte im Falle druckunempfindlicher Applikationen der Trägerkörper **4** auch aus Hartschaum bestehen.

Bezugszeichenliste

1 HF-Strahler
2 Reflektor
3 Direktor
4 Trägerkörper
4a Verlängerung
5 leitende Verbindung
6 Korrosionsschutzschicht
6a Fortsatz der Korrosionsschutzschicht
7 Bohrung
8 Flansch
9 Hohlwellenleiter
10 Koaxialanschluß
11 erste Wendelleitung
12 zweite Wendelleitung
13 Isolierschicht
14 Antennenmasseanschluß
A Hauptabstrahlrichtung
B Schleifenebene

Patentansprüche

1. Antenneneinrichtung für ein Füllstandmeß-Radargerät mit einem HF-Strahler (1) zum Abstrahlen von Mikrowellen entlang einer Hauptabstrahlrichtung (A) in einen Innenraum eines Behälters und mit mindestens einem auf der dem Behälter zugewandten Seite des HF-Strahlers (1) angeordneten, metallischen Element (3; 11) zum Bündeln der Mikrowellen, **dadurch gekennzeichnet**, daß das mindestens eine metallische Element (3; 11) auf oder innerhalb eines aus nichtleitendem Material bestehenden, stabförmigen Trägerkörpers (4) angeordnet ist, und daß der Trägerkörper (4) samt metallischem Element (3; 11) von einer Korrosionsschutzschicht (6) umgeben ist.

2. Antenneneinrichtung nach Anspruch 1, dadurch gekennzeichnet, daß auf der dem Behälter zugewandten Seite des HF-Strahlers (1) eine Vielzahl von nebeneinanderliegenden, metallischen Elementen (3) angeordnet ist.

3. Antenneneinrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß das metallische Element (3) eine schleifenförmige Leitung ist, deren Schleifenebene (B) orthogonal zur Hauptabstrahlrichtung (A) des HF-Strahlers (1) angeordnet ist.

4. Antenneneinrichtung nach Anspruch 2 oder 3, dadurch gekennzeichnet, daß die schleifenförmigen Leitungen kreisrund ausgebildet sind, daß der Trägerkörper (4) eine zylinderförmige Gestalt aufweist und massiv ausgebildet ist, und daß die kreisrunden Leitungen auf der Außenfläche des Trägerkörpers (4) aufliegen.

5. Antenneneinrichtung nach Anspruch 4, dadurch gekennzeichnet, daß der zylinderförmige Trägerkörper (4) in Richtung Behälter verjüngt ausgebildet ist.

6. Antenneneinrichtung nach einem der Ansprüche 1 bis 5, dadurch gekennzeichnet, daß das oder die metallischen Elemente (3; 11) über eine leitende Verbindung (5) mit einem Antennenmasseanschluß (14) der Antenneneinrichtung elektrisch verbunden sind.

7. Antenneneinrichtung nach Anspruch 1, dadurch gekennzeichnet, daß das metallische Element (11) als erste Wendelleitung (11) ausgebildet und um den Trägerkörper (4) gewickelt ist.

8. Antenneineinrichtung nach Anspruch 7, dadurch gekennzeichnet, daß eine zweite Wendelleitung (12) mit zur ersten Wendelleitung (11) entgegengesetztem Wicklungssinn vorgesehen ist, und daß diese zweite Wendelleitung (12) einem HF-Empfänger zugeordnet ist.

9. Antenneneinrichtung nach Anspruch 8, dadurch gekennzeichnet, daß der zweite Wellenleiter (12) koaxial zum ersten Wellenleiter (11) angeordnet ist, und daß der erste Wellenleiter (11) und der zweite Wellenleiter (12) durch eine Isolationsschicht (13) voneinander getrennt sind.

10. Antenneneinrichtung nach Anspruch 1 oder 2,

dadurch gekennzeichnet, daß das oder die metallischen Elemente (3) plattenförmig ausgebildet sind und Plattenebenen aufweisen, die orthogonal zur Hauptabstrahlrichtung (A) der Mikrowellen ausgebildet sind.

11. Antenneneinrichtung nach einem der Ansprüche 1 bis 9, dadurch gekennzeichnet, daß die das oder die metallischen Elemente (3; 11) bildenden Leitungen auf dem Trägerkörper (4) aufgewickelt sind.

12. Antenneneinrichtung nach einem der Ansprüche 1 bis 9, dadurch gekennzeichnet, daß die das oder die metallischen Elemente (3; 11) bildenden Leitungen auf den Trägerkörper (4) aufgedampft sind.

13. Antenneneinrichtung nach einem der Ansprüche 1 bis 12, dadurch gekennzeichnet, daß der HF-Strahler (1) ein Hohlwellenleiter (9) ist, und daß der Trägerkörper (4) eine im Hohlwellenleiter (9) sitzende Verlängerung (4a) aufweist.

14. Antenneneinrichtung nach Anspruch 13, dadurch gekennzeichnet, daß der Hohlwellenleiter (9) einen Flansch (8) aufweist, und daß sich die Korrosionsschutzschicht (6a) ringförmig über mindestens einen Teil dieses Flansches (8) fortsetzt.

15. Antenneneinrichtung nach einem der Ansprüche 1 bis 14, dadurch gekennzeichnet, daß die Korrosionsschutzschicht (6) kleiner gleich 2 mm dick ist.

16. Antenneneinrichtung nach Anspruch 15, dadurch gekennzeichnet, daß die Korrosionsschutzschicht (6) und der Trägerkörper (4) aus dem gleichen Material bestehen.

17. Antenneneinrichtung nach einem der Ansprüche 1 bis 16, dadurch gekennzeichnet, daß der Trägerkörper 4 als Hohlkörper ausgebildet ist und die metallischen Elemente (3; 11) an der Innen- oder Außenseite dieses Hohlkörpers angebracht sind.

18. Antenneneinrichtung nach Anspruch 1 bis 17, dadurch gekennzeichnet, daß die Korrosionsschutzschicht (6) als Korrosionsschutzhohlkörper ausgebildet ist, die zugleich den Trägerkörper bildet, und daß die metallischen Elemente (3; 11) an der Innenseite des Korrosionsschutzhohlkörpers angebracht sind.

Hierzu 3 Seite(n) Zeichnungen

ZEICHNUNGEN SEITE 1

Nummer: DE 44 43 055 A1
Int. Cl.[6]: H 01 Q 19/30
Offenlegungstag: 20. Juni 1996

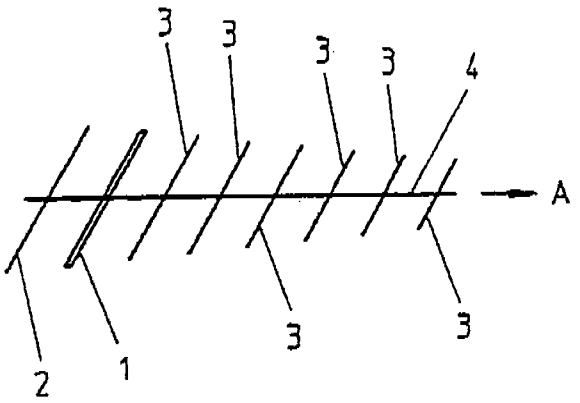


Fig.1

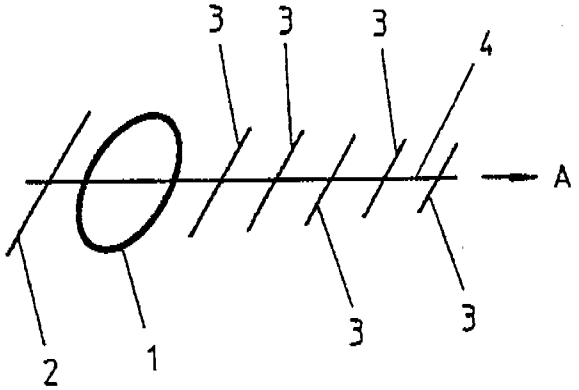


Fig.2

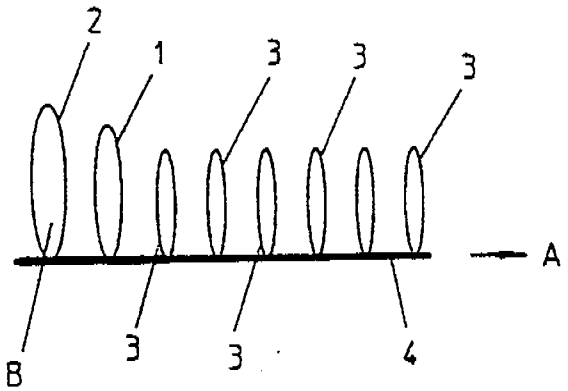


Fig.3

Nummer: DE 44 43 055 A1
Int. Cl.[6]: H 01 Q 19/30
Offenlegungstag: 20. Juni 1996

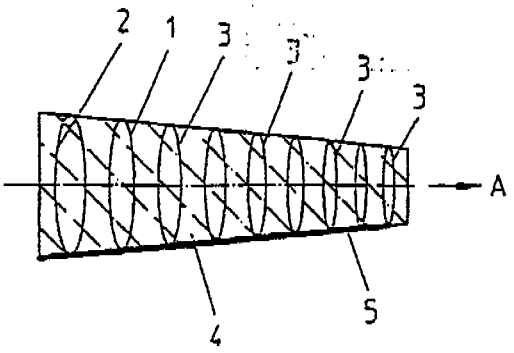


Fig.4

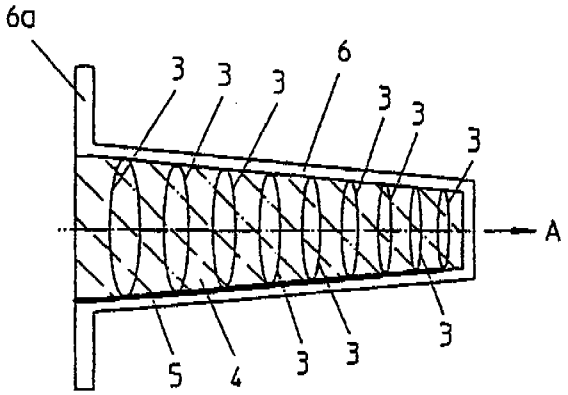


Fig.5

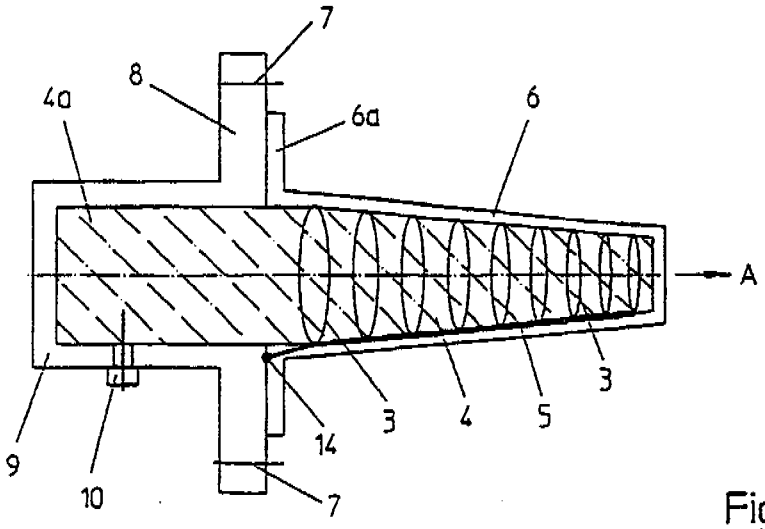


Fig.6

Nummer: DE 44 43 065 A1
Int. Cl.[6]: H 01 Q 19/30
Offenlegungstag: 20. Juni 1996

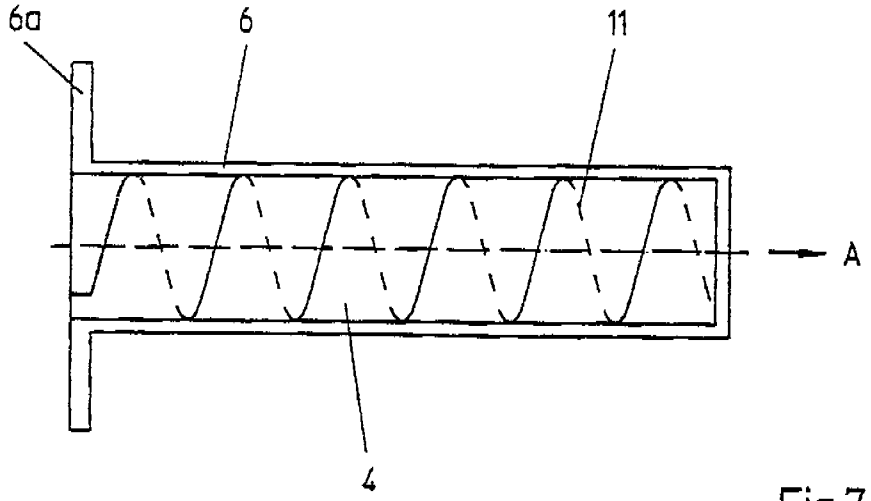


Fig.7

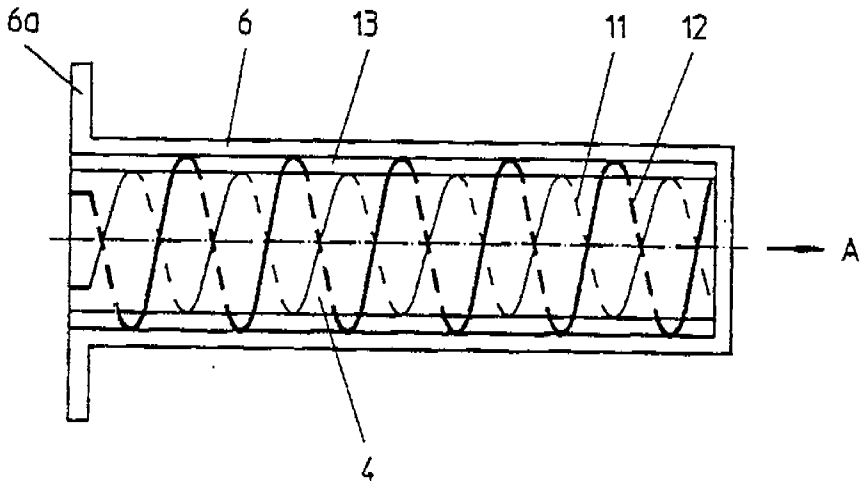


Fig.8

132

Industria y Comercio
SUPERINTENDENCIA

ADMIS

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
No. 11-003771- -00000-0000
Fecha: 2011-01-14 16:31:59 Dep. 2020 DIR.NUEVASCR
Tra. 11 PATENTEIYII Eve: 378 FASENACIONALI
Act. 411 PRESENTACION Folios: 131

PATENTE DE INVENCIÓN ☐ **MODELO DE UTILIDAD** ☐

- ☐ Indicación que se solicita una patente.
- ☐ Datos de identificación del solicitante o de la persona que presenta la solicitud
- ☐ Descripción de la invención
- ☐ Dibujos de ser estos pertinentes
- ☐ Comprobante de pago de las tasas establecidas (De ser el caso formato de descuento)

Completa ☐ Incompleta ☐

PATENTE DE INVENCIÓN PCT ☑ **MODELO DE UTILIDAD PCT** ☐ **Art.33 Decisión 486/00, Circular Única**

- ☑ Indicación que se solicita una PCT
- ☑ Copia de la solicitud en español, tal como fue presentada inicialmente (capítulo descriptivo, reivindicatorio, resumen)
- ☑ Dibujos de ser estos pertinentes
- ☑ Comprobante de pago de las tasas establecidas (de ser el caso formato de descuento)

Completa ☑ Incompleta ☐

DISEÑO INDUSTRIAL ☐ **(Art. 119 Decisión 486/00)**

- ☐ Indicación que se solicita Diseño industrial
- ☐ Datos de identificación del solicitante o de la persona que presenta la solicitud
- ☐ Representación gráfica y fotográfica del Diseño industrial o muestra del material que incorpora el diseño
- ☐ Comprobante de pago de las tasas establecidas

Completa ☐ Incompleta ☐

ESQUEMA DE TRAZADO ☐ **(Art. 92 Decisión 486/00)**

- ☐ Indicación que se solicita un esquema de trazado
- ☐ Datos de identificación del solicitante o de la persona que presenta la solicitud
- ☐ Representación gráfica de un esquema de trazado
- ☐ Comprobante de pago de las tasas establecidas

Completa ☐ Incompleta ☐

Industria y Comercio
SUPERINTENDENCIA

Bogotá D.C.,
2020

Doctor(a)
URIBE RESTREPO JUAN CARLOS
Apoderado(a) y/o Representante de
FRACARRO RADIOINDUSTRIE S.P.A.

REFERENCIA		
	Radicación No.	11 003771
	Solicitud internacional	PCT/IB2009/005885
	Fecha inicio fase nacional	17/01/2011
	Trámite	11
	Evento	378
	Actuación	430
	Oficio No.	003854

Como resultado del examen de forma, realizado con fundamento en el artículo 38 de la Decisión 486 de la Comisión de la Comunidad Andina, artículo 27 del Tratado de Cooperación en Materia de Patentes (PCT), regla 51 bis del Reglamento y Circular Única de la Superintendencia de Industria y Comercio, se le comunica que:

1. La solicitud no contiene el poder debidamente otorgado, con el lleno de los requisitos exigidos por los artículos 63 y subsiguientes del Código de Procedimiento Civil. Adicionalmente, deberá presentar el documento que acredita la existencia y representación legal de la sociedad solicitante, cuando ésta fuere persona jurídica.

2. La solicitud no contiene la copia del documento en que consta la cesión del derecho a la patente del inventor al solicitante o a su causante, conforme a lo establecido por el artículo 26 literal k) de la Decisión 486 de la Comisión de la Comunidad Andina. Cuando se trate de documentos otorgados en el extranjero, estos deberán legalizarse de conformidad con lo dispuesto por los artículos 259 y 260 del Código de Procedimiento Civil. Cuando se trate de las declaraciones a que hace referencia la Regla 4.17 ii) del Tratado de Cooperación en Materia de Patentes PCT., el alcance de las tales declaraciones se determinará según indiquen claramente una cesión de derechos del inventor al solicitante o su causante, de conformidad con lo dispuesto en el numeral 5.2.15 del Capítulo Quinto, Título X de la Circular Única de Superintendencia de Industria y Comercio.

En cumplimiento de lo dispuesto por el artículo 39 de la Decisión 486, se le requiere para que dentro del término de dos meses siguientes a la fecha de notificación del presente oficio, complete los requisitos anteriormente enunciados. En caso de no dar cumplimiento al presente requerimiento, la solicitud se consideraró abandonada y perderá su prelación.

Continua en la página siguiente...

Notifíquese el presente oficio conforme a lo dispuesto en el numeral 5.2, literal e), del capítulo quinto del título primero de la Circular Unica No.10 de 2001.

JOSE LUIS SALAZAR LOPEZ
Director de Nuevas Creaciones (c)

El anterior requerimiento fue notificado por fijación en lista de fecha 23 MAR. 2011.
adpa11

Sede Centro: Carrera 13 No. 27-00 Pisos 2, 5 , 7 y 10 PBX: 5870000
Sede CAN: Av. Cra 50 No. 26-55 int. 2 Tel: 5880070
Call Center 6513240. Línea 01800-910165
Web: www.sic.gov.co e-mail: info@sic.gov.co
Bogotá D.C. - Colombia