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- (71) Applicant: **COMMSCOPE TECHNOLOGIES LLC**
[US/US]; 1100 Commscope Place SE, Hickory, NC 28602 (US).
- (72) Inventors: **MALEY, Gregory, J.**; 7216 Kelly Place, Downers Grove, IL 60516 (US). **BISIULES, Peter, J.**; 1427 Blanchan Avenue, Lagrange Park, IL 60526 (US).
- (74) Agents: **AYERS, D. Randal** et al.; Myers Bigel & Sibley, P.A., P.O. Box 37428, Raleigh, North Carolina 27627 (US).

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(54) Title: RADIO ANTENNA ELEMENT ARM RETAINING CLIP

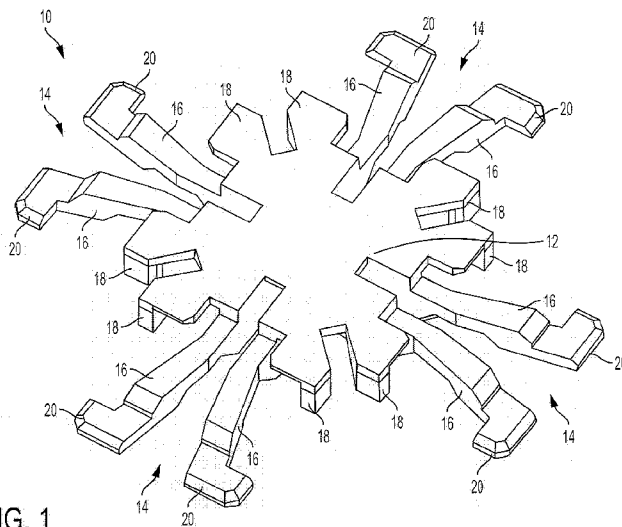


FIG. 1

(57) Abstract: A clip for securing a radiating arm to a printed circuit boards of a radio frequency antenna element of a base station antenna. The radiating arm may be configured to receive signals or radiate signals from a feed network associated with the at least one RF antenna member. The radiating arm can be secured to the printed circuit board without the use of solder or adhesives.

TITLE

Radio Antenna Element Arm Retaining Clip

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 5 62/103,289, filed on January 14, 2015, the entire contents of which are incorporated herein by reference in their entirety.

BACKGROUND

[0002] Various aspects of the present disclosure may relate to radiating elements, and, 10 more particularly, to an apparatus for securing radio antenna element arms to radiating elements.

[0003] Antennae for wireless voice and/or data communications may typically include an array of radio antenna elements (i.e., radiating elements) connected by one or more feed networks. For quality transmission and reception of Radio Frequency (RF) signals, one or more diversity techniques may be employed. One such diversity technique is polarization 15 diversity, which may be particularly effective in combating multi-path fading. Crossed RF antenna members (forming a radiating element) may be used to employ polarization diversity. Each of the crossed RF antenna members may include a printed circuit board (PCB) and a radiating arm extending therefrom. Solder and/or adhesives may be typically used to attach the radiating arm to a desired location along the printed circuit board. 20 However these attachment techniques may be costly, insecure, and may affect RF performance of the radiating element, and, in turn, the overall antenna.

[0004] As such, it would be advantageous to have an apparatus to connect a radiating arm to a radiating element in a more secure, cost efficient manner.

25 SUMMARY OF THE DISCLOSURE

Various aspects of the present disclosure may be directed to a clip for securing one or more radiating arms to at least one RF antenna member of a base station antenna. In one aspect, the clip may include a central body and a retaining assembly extending radially therefrom. The retaining assembly may be configured to be connected to at least one of the 30 one or more radiating arms.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0005] The following detailed description of the disclosure will be better understood when read in conjunction with the appended drawings. For the purpose of illustrating the disclosure, there are shown in the drawings embodiments which are presently preferred. It should be understood, however, that the disclosure is not limited to the precise arrangements and instrumentalities shown.

[0006] In the drawings:

[0007] Fig. 1 is a perspective view of a retaining clip, according to an aspect of the present disclosure;

10 [0008] Fig. 2 is a cross-sectional view of one radiating arm, coupled to a PCB via tabs of a pair of deflectable fingers of the retaining clip, according to an aspect of the present disclosure;

[0009] Fig. 3 is a perspective view of one radiating arm coupled to a PCB via a pair of tabs extending from deflectable fingers of the retaining clip, according to an aspect of the present disclosure;

[0010] Fig. 4 is a view of an underside of the retaining clip coupling one radiating arm to a PCB of an antenna member, according to an aspect of the present disclosure;

[0011] Fig. 5 is a perspective view of a full assembly of a radiating element including four radiating arms attached to two crossed PCBs of respective antenna members, via the retaining clip, according to an aspect of the present disclosure;

[0012] Fig. 6 is a top view of a full assembly of an RF radiating element including four radiating arms attached to two crossed PCBs via the retaining clip, according to an aspect of the present disclosure;

25 [0013] Fig. 7 is a side view of a full assembly of an RF radiating element including four radiating arms attached to two crossed PCBs via the retaining clip, according to an aspect of the present disclosure;

[0014] Fig. 8 is an illustration of the retaining clip connected to a first PCB; according to an aspect of the present disclosure;

30 [0015] Fig. 9 is an illustration of a second PCB being crossed with the first PCB to prevent lateral movement of the retaining clip, according to an aspect of the present disclosure;

[0016] Fig. 10 is an illustration showing radiating arms coupled to the first and second PCBs using the retaining clip, according to an aspect of the present disclosure; and

[0017] Fig. 11 is a perspective view of a full assembly of an RF radiating element including four radiating arms attached to two crossed PCBs via the retaining clip, according to an aspect of the present disclosure; and

[0018] Fig. 12 is a cross-sectional view of the second PCB being crossed with the first PCB to prevent lateral movement of the retaining clip, according to an aspect of the present disclosure.

DETAILED DESCRIPTION OF VARIOUS EMBODIMENTS

[0019] Certain terminology is used in the following description for convenience only and is not limiting. The words “lower,” “bottom,” “upper” and “top” designate directions in the drawings to which reference is made. Unless specifically set forth herein, the terms “a,” “an” and “the” are not limited to one element, but instead should be read as meaning “at least one.” The terminology includes the words noted above, derivatives thereof and words of similar import. It should also be understood that the terms “about,” “approximately,” “generally,” “substantially” and like terms, used herein when referring to a dimension or characteristic of a component of the disclosure, indicate that the described dimension/characteristic is not a strict boundary or parameter and does not exclude minor variations therefrom that are functionally similar. At a minimum, such references that include a numerical parameter would include variations that, using mathematical and industrial principles accepted in the art (e.g., rounding, measurement or other systematic errors, manufacturing tolerances, etc.), would not vary the least significant digit.

[0020] Aspects of the present disclosure may be directed to a retaining clip for securing one or more radiating arms to one or more PCBs of an antenna member of a base station antenna. Referring to Fig. 1, the retaining clip 10 may include a central body 12, and four retaining assemblies 14 extending radially from the central body 12. Each of the four retaining assemblies 14 may include two deflectable fingers 16 positioned between arm supports 18. Each of the two deflectable fingers 16 may include a tab 20 located at an end opposite the central body 12 of the retaining clip 10. The retaining clip 10 may be made from a thermoplastic, or other resilient plastic material.

[0021] As discussed above, an antenna member may include a PCB and a radiating arm extending therefrom. The radiating arm may serve to receive signals, or radiate signals from

a feed network of a feedboard, through the PCB, to the environment. Figs. 2 and 3 illustrate one such radiating arm 22a coupled to one such PCB 24 via the retaining clip 10. As best seen in Fig. 2 (a cross-sectional view of the coupling with an upper portion of the radiating arm 22 removed), respective tabs 20 of the deflectable fingers 16 of one of the retaining assemblies 14 may be secured in side voids or holes 26 located on opposing side portions of the radiating arm 22. As shown in Fig. 3, a capture 27 on the PCB 24 may be secured in a top hole 30 located on the upper portion of the radiating arm 22. For increased stability, an end of the radiating arm 22 may rest between the arm supports 18 of the retaining assembly 14.

10 [0022] Fig. 4 is an illustration of the underside of the retaining clip 10 connecting a radiating arm 22 to the PCB 24. The deflectable fingers 16 of the retaining clip 10 may be able to secure the radiating arm 22 to the PCB 24, at least in part, because of an outward biasing force causing the tabs 20 to be retained in side holes 26 of the radiating arm 22, thus, at least in part, locking the radiating arm 22 in a center position on the PCB 24. Such secure centering on the PCB 24 may result in optimal electrical RF performance.

[0023] Other radiating arms may be attached in a similar fashion as described above. For example, another radiating arm 22b may be connected to the opposite end of the PCB 24 to which the radiating arm 22a is attached. Further, radiating arms 22c, 22d may be attached to opposing ends of another PCB 28. Such additional attachments may result in a full assembly of an RF radiating element 50 as shown in Figs. 5-7. As best seen in Fig. 5, a perspective view of the full assembly of the RF radiating element 50, a portion of each of the first and second PCBs 24, 28 may be connected to a ground plane on a feedboard 52, which may include a feed network. Notches and/or other cut outs may be included in each PCB 24, 28 to facilitate sliding the PCBs 24, 28 together, which may create a cross-polarized radiating element (or referred to herein as simply an RF radiating element). The PCBs 24, 28 may be fit together such that the PCBs 24, 28 are at approximately right angles to each other. However, it should be noted that the PCBs 24, 28 may be connected such that angles of other degrees may be formed as well. Accordingly, the retaining assemblies 14 may be positioned to secure PCBs 24, 28 at such other angles as well. Further, the retaining clip 10 may be configured to include fewer or more than four retaining assemblies 14 to be employed with other types of base station antenna element configurations.

30 [0024] Figs. 8-12 illustrate a method for connecting radiating arms 22a-d to the each of the PCBs 24, 28 according to an aspect of the present disclosure. As shown in Fig. 8, the

retaining clip 10 may be connected to a first PCB 24 by sliding one of the retaining assemblies 14 underneath the capture 27 of the first PCB 24; and then pivoting the retaining assembly 14 at an opposing end of the retaining clip 10. The opposing retaining assembly 14 may then be slid underneath another capture of the first PCB 24.

5 [0025] As shown in Fig. 9, a second PCB 28 may be engaged to the first PCB 24 through a slot of the first PCB 24. As best seen in Fig. 12, such an engagement of the second PCB 28 to the first PCB 24 may also serve to prevent lateral movement of the retaining clip 10, by, for example, slidably engaging either of the PCBs 24, 28 in one or more cavities of the retaining clip 10.

10 [0026] Referring now to Fig. 10, each of the radiating arms 22 may be slid onto each of the retaining assemblies 14, and locked into place, at least in part by the outward force of the tabs retaining the arms to the retaining clip 10 and the first and second PCBs 24, 28. Upon connection of all radiating arms 22a-d, a full assembly may be realized, as shown in Fig. 11.

[0027] The above method described in succession in connection with Figs. 8-12 .

15 However, it should be noted that the above method may be performed in any order in still keeping with the invention.

[0028] Various aspects of the disclosure have now been discussed in detail; however, the disclosure should not be understood as being limited to these aspects. It should also be appreciated that various modifications, adaptations, and alternative aspects thereof may be
20 made within the scope and spirit of the present disclosure.

CLAIMS

What is claimed is:

1. A clip for securing at least one radiating arm to at least one antenna member, the clip comprising:
5 a central body; and
one or more retaining assemblies extending radially from the central body, wherein at least one of the one or more retaining assemblies is configured to be connected to the at least one radiating arm, the at least one radiating arm being configured to radiate a signal from a feed network associated with the at least one antenna member.
10
2. The clip of claim 1, wherein at least one of the one or more retaining assemblies comprises at least one deflectable finger configured to engage at least one hole in the at least one radiating arm.
- 15 3. The clip of claim 2, wherein the at least one retaining assembly includes at least one tab positioned at an end of the at least one deflectable finger opposite the central body.
4. The clip of claim 1, wherein at least one of the one or more retaining assemblies includes at least first and second deflectable fingers configured to engage respective holes in
20 the at least one radiating arm.
5. The clip of claim 4, wherein each of the at least first and second deflectable fingers is configured to be biased away from each other.
- 25 6. The clip of claim 1, wherein the clip is made from a resilient plastic.
7. The clip of claim 1, further comprising first and second arm supports coupled to the central body, wherein a portion of the at least one radiating arm is configured to rest between the first and second arm supports, the first and second arm supports being configured to
30 prevent lateral movement of the at least one radiating arm attached to the clip.
8. The clip of claim 1, wherein the antenna member is part of a crossed dipole element.

9. An apparatus comprising:
a clip configured to be connected to at least one first radiating arm and at least one radiating element, the at least one radiating element including:
a first printed circuit board and
5 a second printed circuit board coupled to the first printed circuit board,
wherein the at least one first radiating arm is configured to receive a radio frequency (RF) signal, or radiate a radio frequency (RF) signal from a feed network of at least one of the first or second printed circuit boards.
- 10 10. The apparatus of claim 9, wherein the clip includes at least first and second deflectable fingers for engaging two or more first opposing side holes of the at least one first radiating arm.
11. The apparatus of claim 10, wherein the clip is further configured to be connected to at
15 least one second radiating arm including two or more second opposing side holes, wherein the clip includes third and fourth deflectable fingers configured to engage the two or more second opposing side holes.
12. The apparatus of claim 11, wherein at least one of first, second, third, or fourth
20 deflectable fingers comprises at least one tab configured to be inserted into the two or more first opposing side holes or the two or more second opposing side holes.
13. The apparatus of claim 12, wherein the clip further comprises first and second arm supports positioned between the second and third deflectable fingers, wherein a portion of the
25 at least one radiating arm is configured to rest between the first and second arm supports, the first and second arm supports being configured to prevent lateral movement of the at least one radiating arm attached to the clip..
14. The apparatus of claim 9, wherein the clip is made from a resilient plastic.
- 30 15. A clip for securing at least one radiating arm to at least one antenna member, the clip comprising:
a central body; and

one or more retaining assemblies extending radially from the central body, wherein at least one of the one or more radiating assemblies is configured to be connected to the at least one radiating arm, and wherein the at least one radiating arm is configured to receive a radio frequency (RF) signal, or radiate an RF signal from a feed network associated with the at least one antenna member, the at least one antenna member including a first printed circuit board including one or more captures.

16. The clip of claim 15, wherein at least one of the one or more retaining assemblies comprises at least one deflectable finger configured to engage side holes positioned on opposing sides of the at least one radiating arm.

17. The clip of claim 16, wherein at least one of the one or more captures is configured to be inserted into a top hole of the at least one radiating arm, the top hole being positioned between the opposing side holes of the at least one radiating arm.

18. The clip of claim 16, further comprising at least one tab positioned at an end of the at least one deflectable finger opposite the central body, the at least one tab configured to be inserted into the at least one hole.

19. The clip of claim 15, wherein at least one of the one or more retaining assemblies includes at least first and second deflectable fingers configured to engage respective holes in the at least one radiating arm.

20. The clip of claim 15, further comprising first and second arm supports configured to prevent lateral movement of the at least one radiating arm attached to the clip.

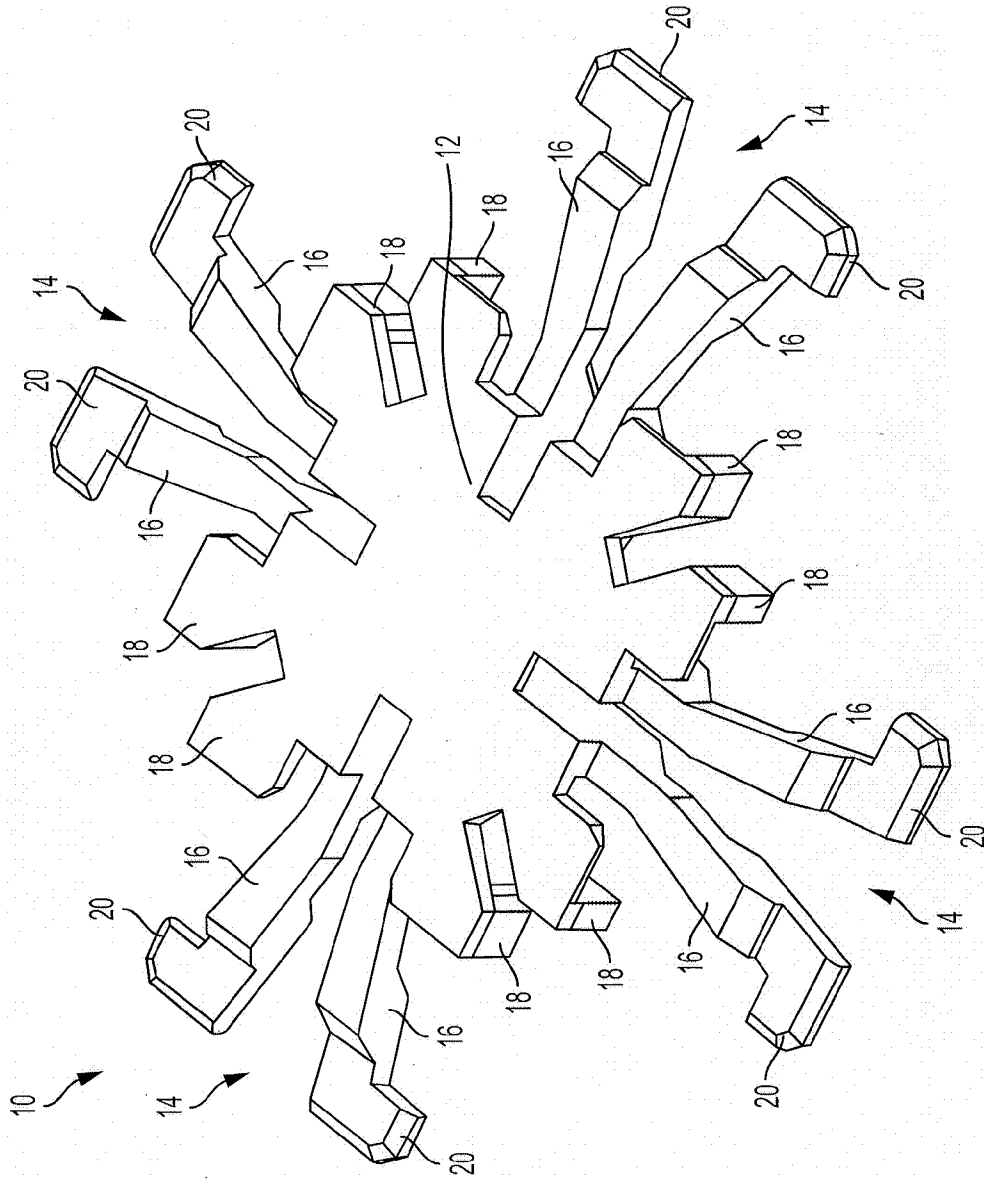


FIG. 1

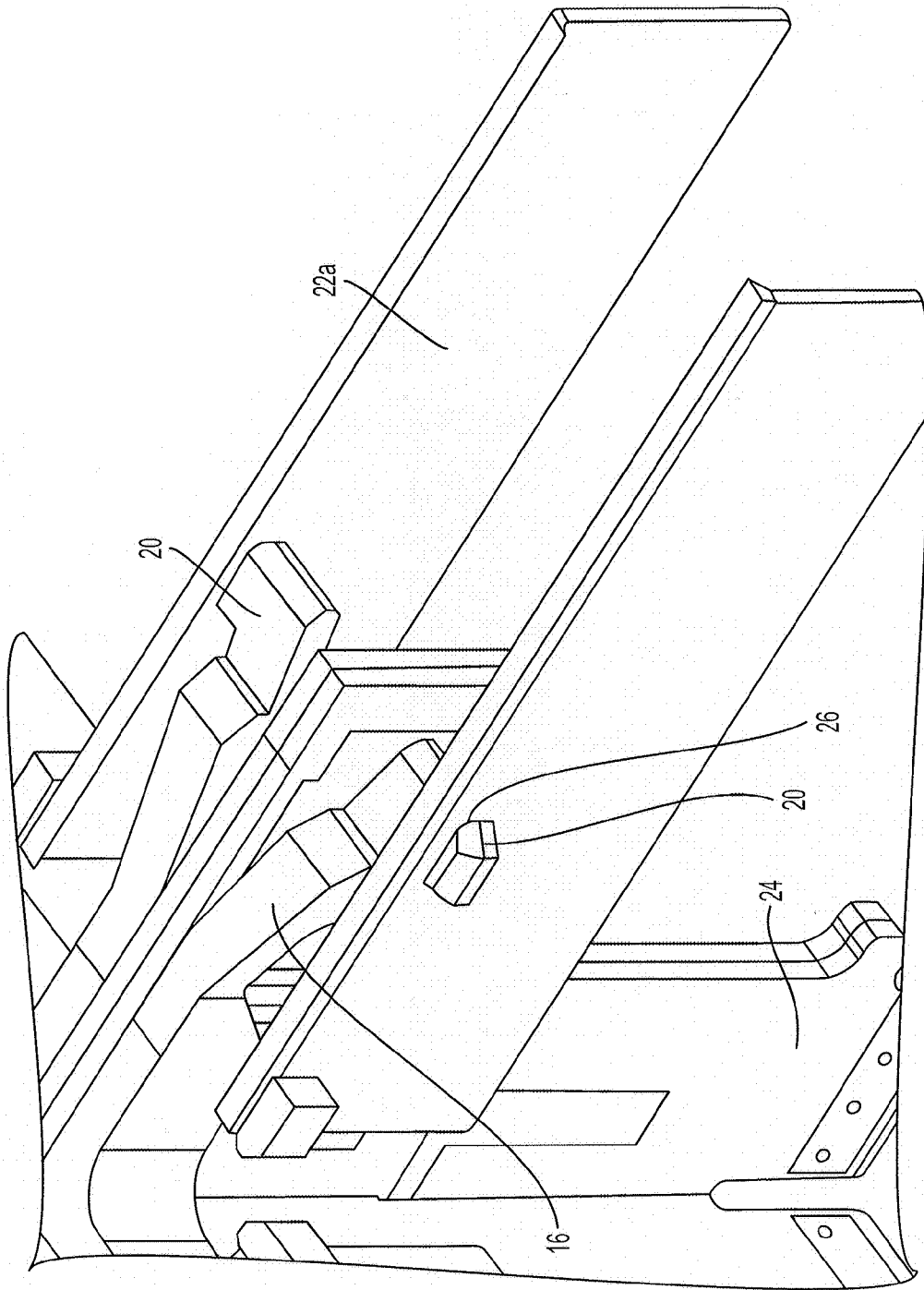


FIG. 2

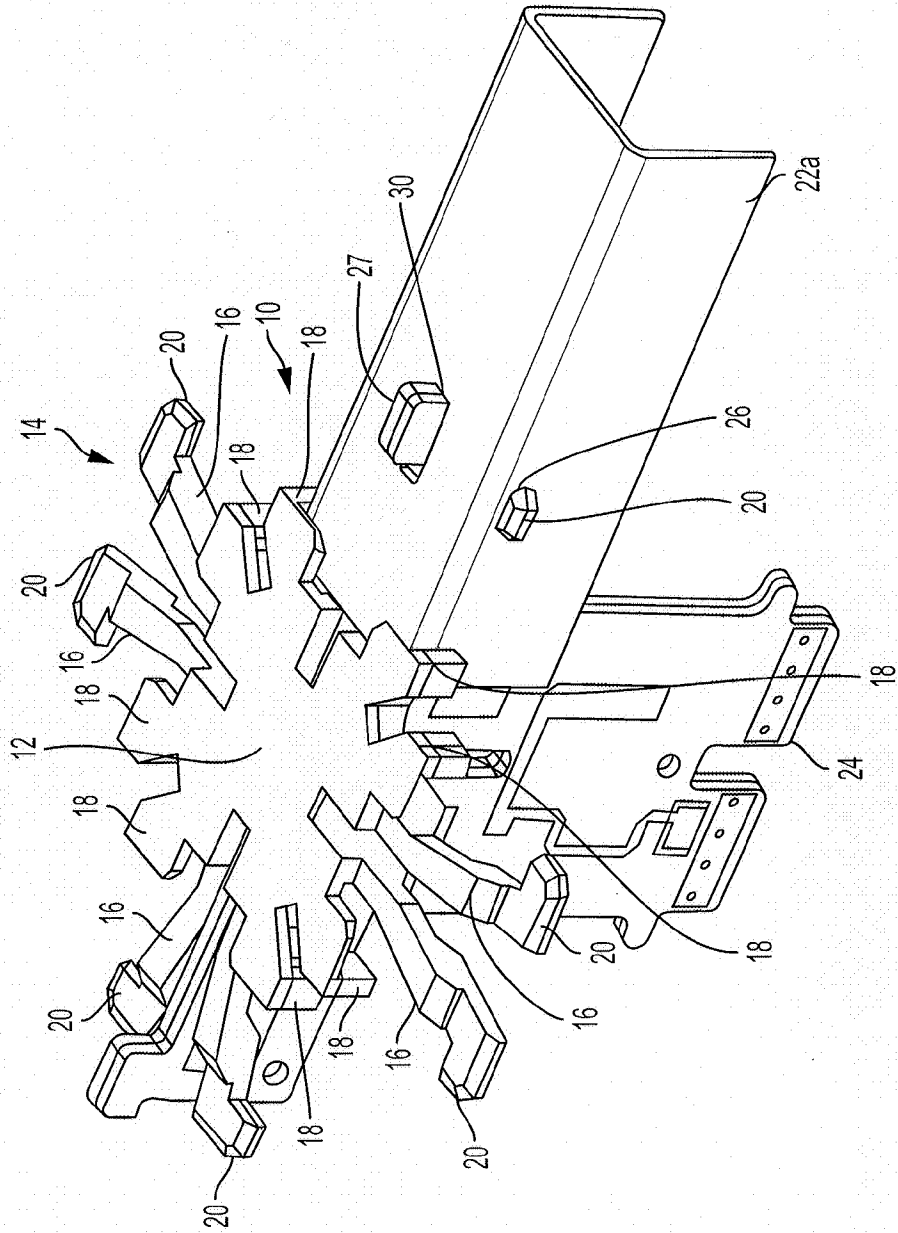


FIG. 3

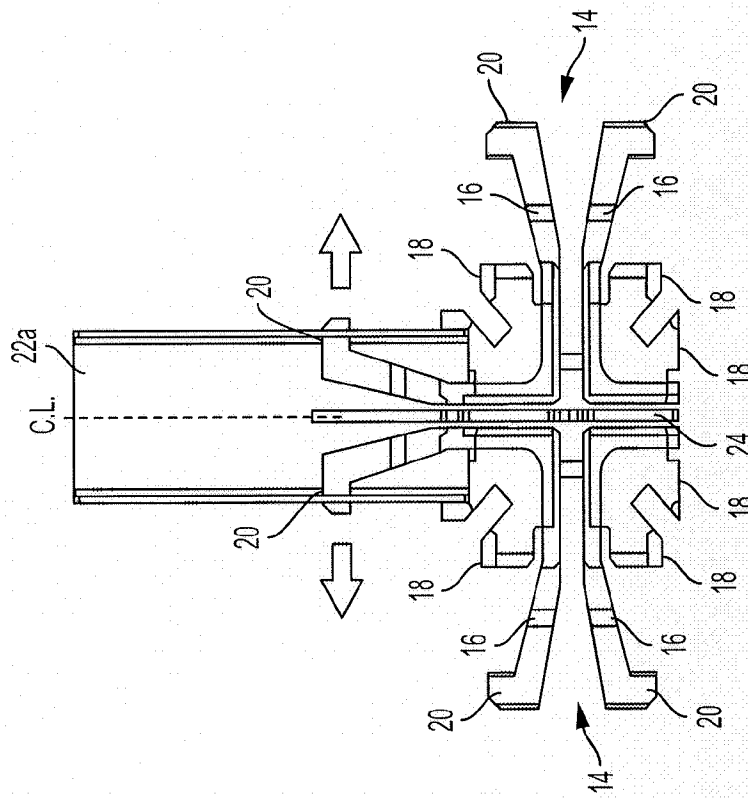


FIG. 4

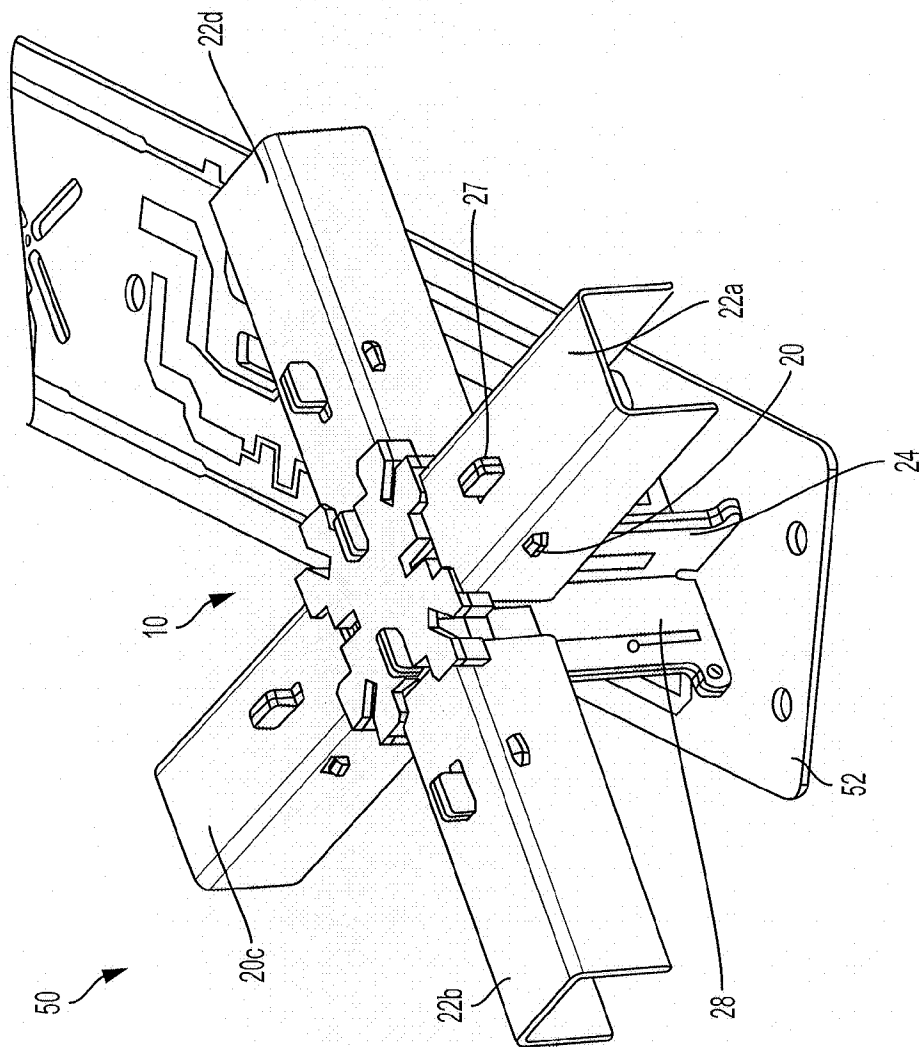


FIG. 5

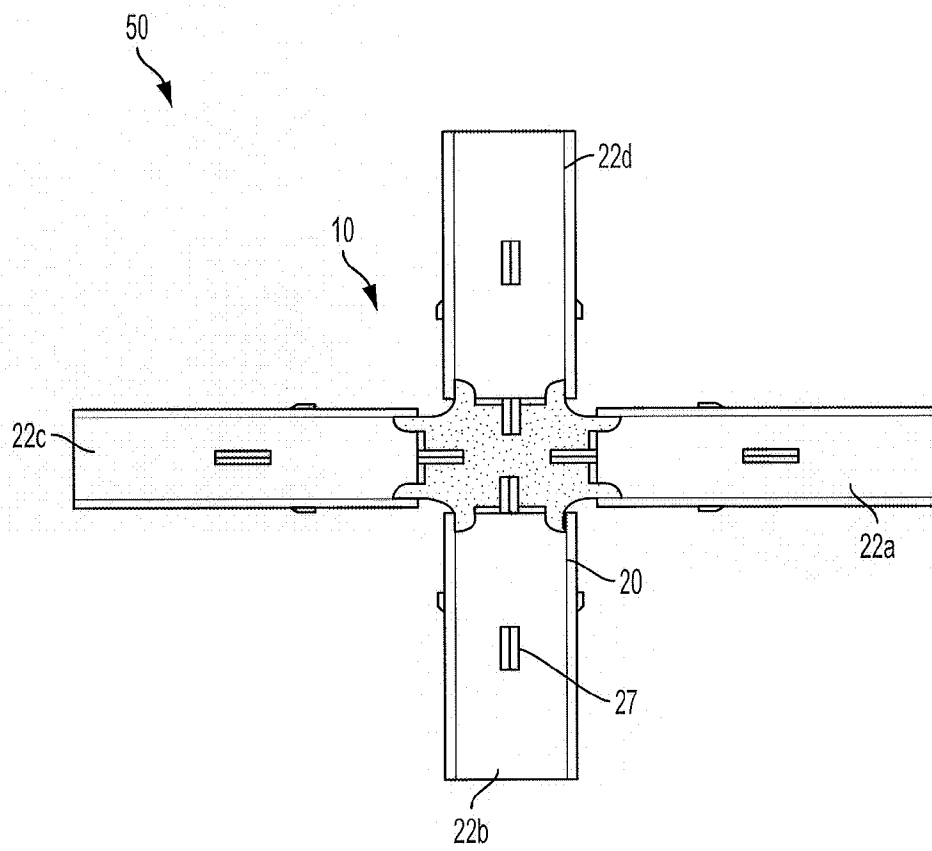


FIG. 6

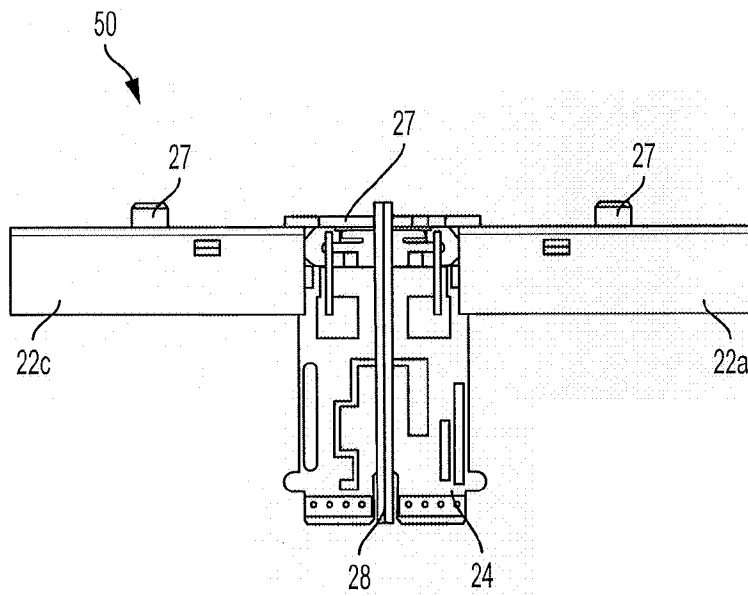


FIG. 7

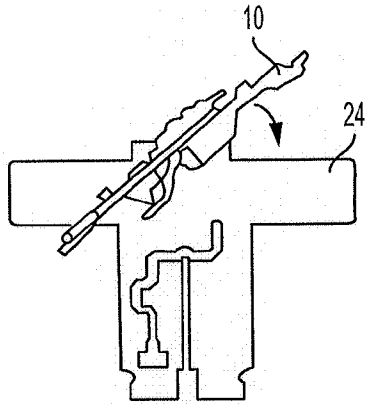


FIG. 8

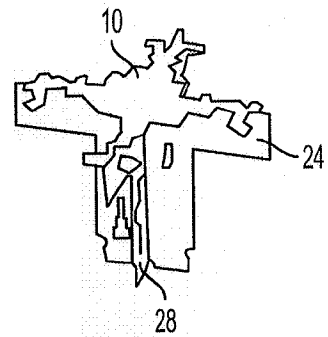


FIG. 9

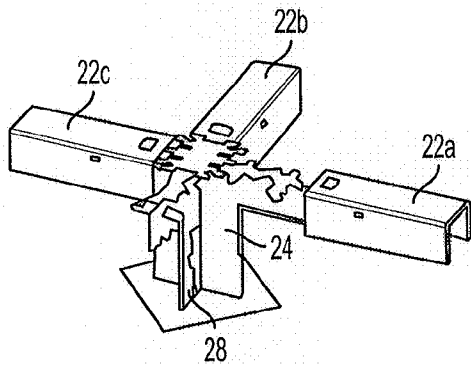


FIG. 10

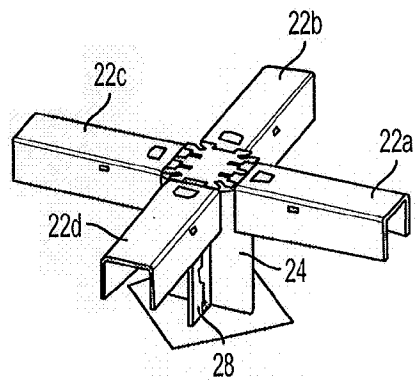


FIG. 11

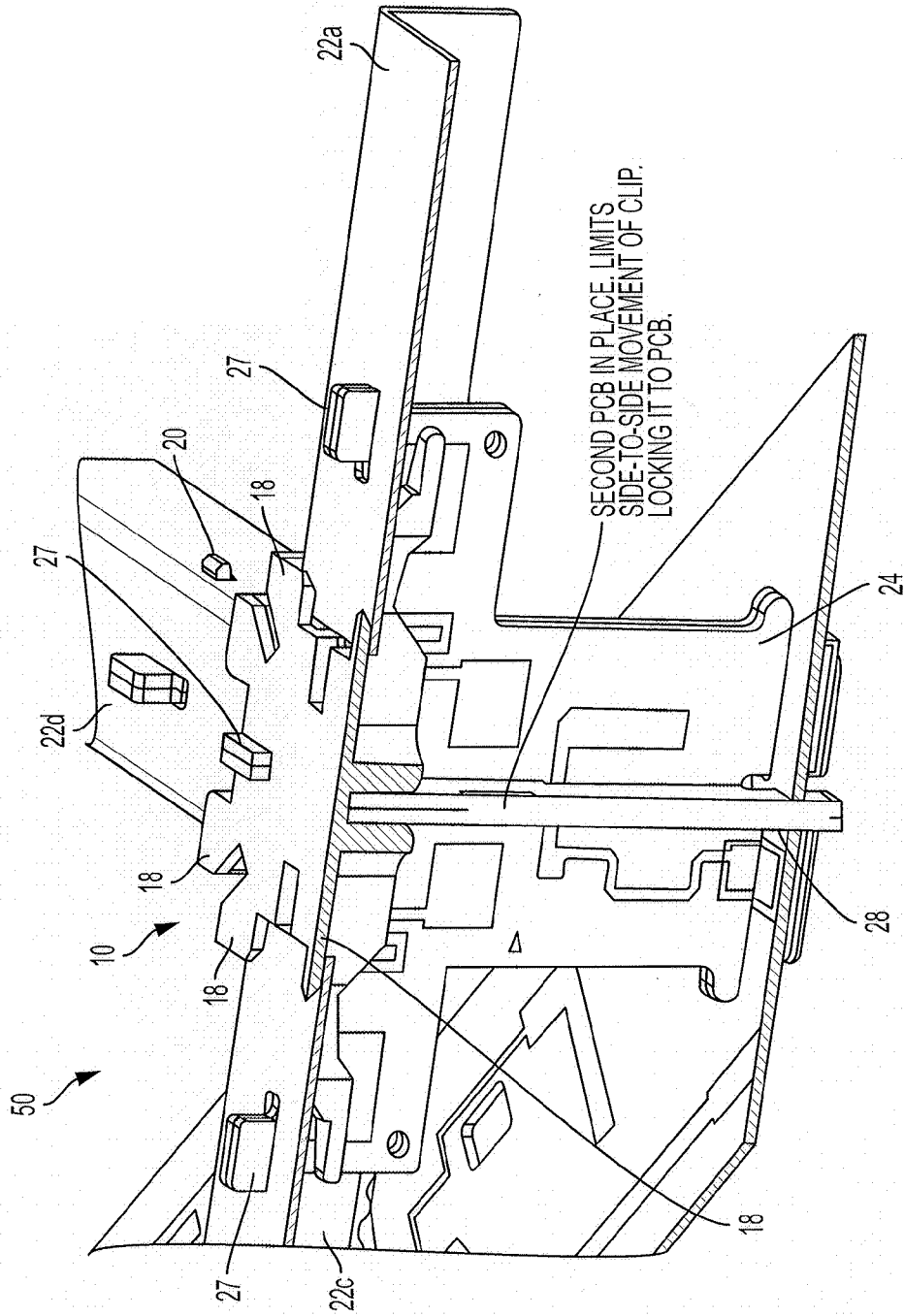


FIG. 12

A. CLASSIFICATION OF SUBJECT MATTER**H01Q 1/12(2006.01)i, H01Q 1/20(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHEDMinimum documentation searched (classification system followed by classification symbols)
H01Q 1/12; H01Q 9/16; H01Q 1/38; H01Q 1/32; H01Q 21/26; H01Q 9/04; H01Q 1/24; H01Q 1/20Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility modelsElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: clip, retaining assemblies, polarization diversity**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006-0232490 A1 (PETER JOHN BISIULES et al.) 19 October 2006 See abstract, paragraph [0084] and figures 3a-3e.	9, 14
A		1-8, 10-13, 15-20
A	US 5864318 A (JOHN COSENZA et al.) 26 January 1999 See abstract, column 5, lines 35-57 and figure 2A.	1-20
A	WO 2014-084659 A1 (KMW INC.) 05 June 2014 See paragraphs [0016]-[0019] and figures 1-3.	1-20
A	US 2013-0314292 A1 (GREGORY JOSEPH MALEY) 28 November 2013 See paragraphs [0021]-[0025] and figures 1-2.	1-20
A	US 2007-0229385 A1 (GANG YI DENG et al.) 04 October 2007 See paragraphs [0020]-[0024] and figures 1a-9	1-20

 Further documents are listed in the continuation of Box C. See patent family annex.

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"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

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Name and mailing address of the ISA/KR

International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea

Facsimile No. +82-42-481-8578

Authorized officer

Jang, Gijeong

Telephone No. +82-42-481-8364



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/012646

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006-0232490 A1	19/10/2006	AU 2003-228312 A1	13/10/2003
		AU 2003-295509 A1	09/07/2004
		AU 2003-295509 A8	09/07/2004
		AU 2004-201942 A1	20/01/2005
		AU 2004-201942 B2	19/11/2009
		AU 2010-200290 A1	18/02/2010
		AU 2010-200653 A1	11/03/2010
		BR PI0402509 A	31/05/2005
		CA 2456937 A1	26/12/2004
		CN 101080848 A	28/11/2007
		CN 101080848 B	12/09/2012
		CN 1577974 A	09/02/2005
		CN 1577974 B	14/03/2012
		CN 1833337 A	13/09/2006
		CN 1833337 B	31/10/2012
		EP 1496569 A1	12/01/2005
		EP 1509969 A1	02/03/2005
		EP 1751821 A1	14/02/2007
		EP 2051331 A1	22/04/2009
		EP 2099096 A2	09/09/2009
		EP 2099096 A3	04/05/2011
		JP 2005-020715 A	20/01/2005
		JP 2008-507163 A	06/03/2008
		JP 2010-016855 A	21/01/2010
		KR 10-1085814 B1	22/11/2011
		KR 10-2005-0001432 A	06/01/2005
		KR 10-2011-0074728 A	01/07/2011
		KR 10-2011-0074729 A	01/07/2011
		KR 10-2011-0074730 A	01/07/2011
		KR 10-2011-0074731 A	01/07/2011
		MX PA04005651 A	23/03/2005
		NZ 532804 A	29/07/2005
		RU 2004119173 A	10/01/2006
		US 2004-0183739 A1	23/09/2004
		US 2004-0252071 A1	16/12/2004
		US 2004-0263392 A1	30/12/2004
		US 2005-0001778 A1	06/01/2005
		US 2005-0179610 A1	18/08/2005
		US 2006-0232489 A1	19/10/2006
		US 2008-0088521 A1	17/04/2008
		US 2008-0111757 A1	15/05/2008
		US 2009-0224994 A1	10/09/2009
		US 6822618 B2	23/11/2004
		US 6924776 B2	02/08/2005
		US 7283101 B2	16/10/2007
		US 7358922 B2	15/04/2008
		US 7405710 B2	29/07/2008
		US 7498988 B2	03/03/2009
		US 7535430 B2	19/05/2009

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/012646

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		US 7659859 B2	09/02/2010
		US 7692601 B2	06/04/2010
		US 8164536 B2	24/04/2012
		WO 03-083992 A1	09/10/2003
		WO 2004-055938 A2	01/07/2004
		WO 2004-055938 A3	07/04/2005
		WO 2005-062428 A1	07/07/2005
		WO 2005-122331 A1	22/12/2005
US 5864318 A	26/01/1999	None	
WO 2014-084659 A1	05/06/2014	CN 104798253 A	22/07/2015
		EP 2928014 A1	07/10/2015
		JP 2015-535667 A	14/12/2015
		KR 10-2014-0069971 A	10/06/2014
		US 2015-0263415 A1	17/09/2015
US 2013-0314292 A1	28/11/2013	US 9054410 B2	09/06/2015
US 2007-0229385 A1	04/10/2007	EP 2005522 A2	24/12/2008
		EP 2005522 B1	09/09/2015
		US 7629939 B2	08/12/2009
		WO 2007-126831 A2	08/11/2007
		WO 2007-126831 A3	25/09/2008