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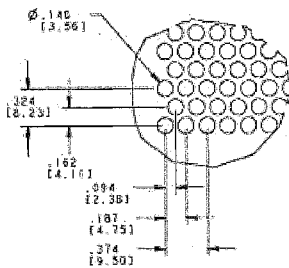
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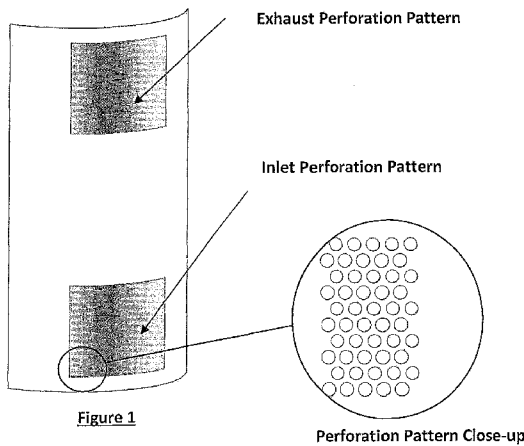
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[Continued on next page]

(54) Title: RRH CONCEALMENT MODULE/METHODS IN NATURAL CONVECTION



(57) Abstract: A concealed remote radio head assembly for use in a wireless radio network system, including remote radio heads, baffles, mounting baffles, head baffles and radome baffles for directing air around the radio heads.



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## RRH Concealment Module/Methods in Natural Convection

### INTRODUCTION

A wireless radio network system consists of a base band unit (BBU), a remote radio head (RRH or sometimes referred to as RRU) and an antenna. As more wireless capacity is required, additional wireless sites are necessary to handle the ever-growing need for additional bandwidth and coverage. As these wireless sites move closer to urban areas and within municipalities, hiding or concealing this network equipment is often preferred. In many cases local zoning regulations require the concealment of said equipment. This concealment becomes a challenge for any active components that are generating heat. This is especially true for the remote radio head (RRH) modules, the device that broadcasts the radio frequency signal in a wireless system. These devices require adequate cooling and ventilation to operate properly. *Note: In this invention the BBU is considered to be located somewhere outside of the concealment, not at the top of the tower. If the BBU is joined with the RRH it would be considered to be part of the RRH and viewed as the same module.*

### Background.

Current Concealment methods do not provide adequate cooling. When RRHs are placed inside a concealment, there are usually very little or no openings in the concealment radome to provide adequate ventilation. In instances where there are openings in the concealment radomes, they are typically too small and located below the RRHs with no

exhaust vents to allow the heated air to be released. This lack of proper ventilation and airflow will result in the overheating of the RRHs, and a shortened product life.

RRH orientation also plays a large role in proper cooling. When RRHs are placed inside a concealment, they are typically not positioned to ensure that the RRHs dissipated heat does not flow from one RRH into the cooling air of another RRH.

Currently known strategies to cope with inadequate cooling have performance and cost disadvantages. With current concealed solutions not providing adequate cooling, the RRHs are often placed at ground level or outside of the concealment module. Such ground installations result in higher power consumption and energy costs, as well as decreased performance due to the transmission losses from long RF jumper cables connecting the RRHs to the antennas at the top of the tower. Additional real estate is also needed to mount the RRHs when placed at ground level. When RRHs are placed outside of the concealment module but still on the tower structure, the RRHs lose the aesthetic advantages of concealment and often violate zoning requirements.

There are also issues with accessibility. Most concealment modules are large, long cylinders. Accessing the equipment within the concealment becomes difficult as the entire cylinder must be removed. These concealment cylinders are often very heavy and require a mechanical advantage to be removed.

#### Description of the Invention.

One way to overcome the limitations of concealing RRHs or any active heat generating components is to ensure proper ventilation, air-flow direction, and equipment orientation. One aspect of this invention relates to concealing groups of RRHs or radio

modules inside a single concealed compartment. Multiple groups of RRH can be concealed using proper spacing and orientation.

The concealment panels have optimized ventilation areas to allow proper inlet and outlet air flow and cooling. The ventilation panels have associated baffle components to ensure that all air is flowing over the heat generating equipment. The equipment is also orientated so that the exhaust air that has been heated does not flow into the ventilation panels of adjacent equipment.

The RRH modules are enclosed behind optimized ventilation panels. The panels contain strategically sized openings to provide maximum open area, best manufacturability, insect resistance, and clog resistance. The ventilation patterns are created in pairs for each RRH module. One set of ventilation patterns below the RRH for inlet air flow and a second set of ventilation patterns above the RRH to exhaust the heated air. The ventilation patterns are optimized to prevent heated air from bleeding into the ventilation area of an adjacent RRH module.

In order to achieve proper air flow velocity over a concealed RRH, air baffling is required to prevent cool air from bleeding off into other areas within the concealment. In this invention, there may be (4) components to the airflow baffling. First, there is a baffle plate which is under the RRH and blocks any airflow from going around the pole (Air Baffle-Pole). Second, the mounting bracket that mounts the RRH to the pole is configured to also force air over the back of the RRH and any associated heatsink fins (Air Baffle-Bracket). The lower edge of the mounting bracket may cooperate with the baffle plate to direct airflow. Third, there is an air baffle hood that forces the air out the exhaust perforation (Air Baffle-Hood). Forth, there is a baffle that closes off the inside of the

radome and fills the gap between the radome and the RRH (Air Baffle-Radome). This baffle may be constructed out of a thermally conductive material that would allow the conduction of heat away from the RRH to the outside surface offering an additional cooling technique. (See Figures 2,3,4)

Once proper airflow is generated for each RRH module, the RRHs should be orientated so that the hot air exiting the exhaust perforation of one RRH module does not enter the inlet perforation of another RRH module. This is very important when stacking multiple configurations of RRHs. In this invention, each grouping of RRHs are equally spaced and assembled within a round concealed compartment. For example, if there are (3) RRH in a grouping, each RRH is angularly spaced 120 degrees from each other within the module. When stacking a second set of RRH above the first set or module, the RRHs would follow the same angular spacing as the module below, but the entire module would be rotated  $\frac{1}{2}$  the angular spacing of the RRHs. In this example the top module would be rotated 60 degrees from the module below. This same formula would apply regardless of the number of RRHs assembled and regardless of the number groupings of RRUs. (See Figure 5).

What is claimed is:

1. An apparatus comprising:
  - a. a concealment module, the concealment module including an inlet panel and an outlet panel, the outlet panel located higher than the inlet panel;
  - b. a remote radio head disposed with the concealment module, mounted on a support, and located between the inlet panel and the outlet panel;
  - c. a first baffle, located under the remote radio head to prevent cool air from the inlet panel from being diverted to a space between the remote radio head and the support;
  - d. a second baffle, located to direct cooling air over a back of the remote radio head;
  - e. a third baffle, located on top of the remote radio head to direct heated cooling air to the outlet panel; and
  - f. a fourth baffle, located to direct cooling air over the front of the remote radio head.
2. The apparatus of claim 1, wherein the second baffle further comprises a bracket for mounting the remote radio head to the support.
3. The apparatus of claim 1, wherein the fourth baffle further comprises a thermally conductive material, and thermally couples heatsink fins on the front of the remote radio head to the concealment module.

4. The apparatus of claim 1, wherein the concealment module includes a plurality of inlet panels and a plurality of outlet panels, the apparatus further comprising:
- a. a plurality of remote radio heads disposed with the concealment module;
  - b. a plurality of second baffles, each associated with one of the plurality of remote radio heads;
  - c. a plurality of third baffles, each associated with one of the plurality of remote radio heads and one of the plurality of outlet panels;
  - d. a plurality of fourth baffles, each associated with one of the plurality of remote radio heads;
5. An concealed remote radio head assembly, comprising:
- a. a cylindrical concealment module, the concealment module including first, second and third pairs of perforated panels, wherein in each pair of perforated panel comprises an inlet panel and an outlet panel, wherein the outlet panel is located higher than the inlet panel, the pairs of perforated panels being substantially equally spaced about a circumference of the concealment module;
  - b. first, second and third remote radio heads disposed with the concealment module, mounted on a support, each remote radio head associated with the respective first, second and third pairs of perforated panels;
  - c. a first baffle, located under the first, second and third remote radio heads to prevent cool air from the inlet panels from being diverted to a space between the remote radio heads and the support;

d. first, second and third mounting baffles, each mounting the respective first, second and third remote radio head to the support and configured to direct cooling air over a back of its respective remote radio head;

e. first, second and third hood baffles, located on top of the respective first, second and third remote radio heads to direct heated cooling air to the respective first, second and third outlet panels; and

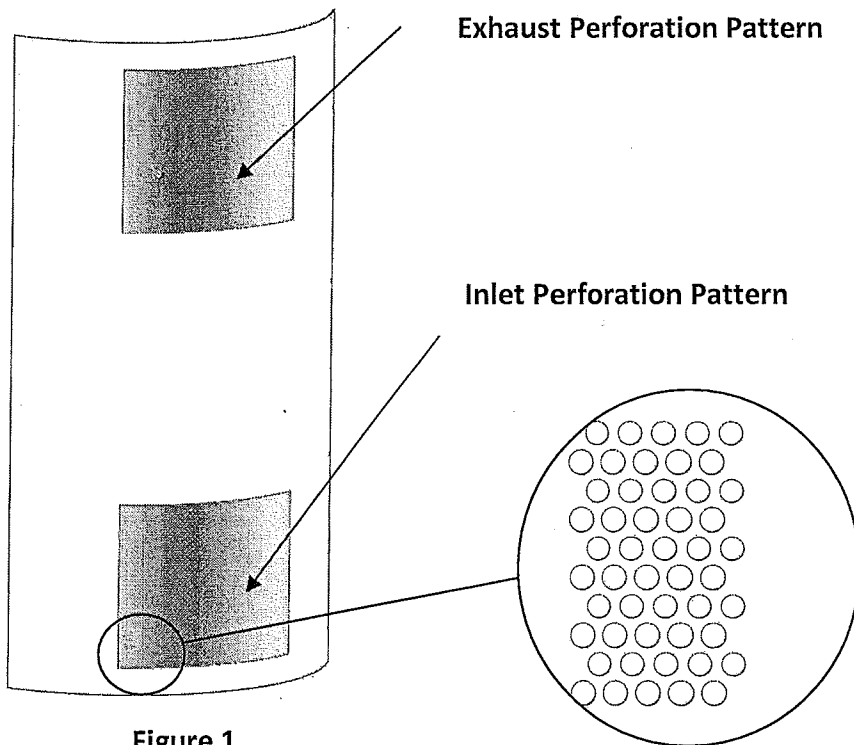
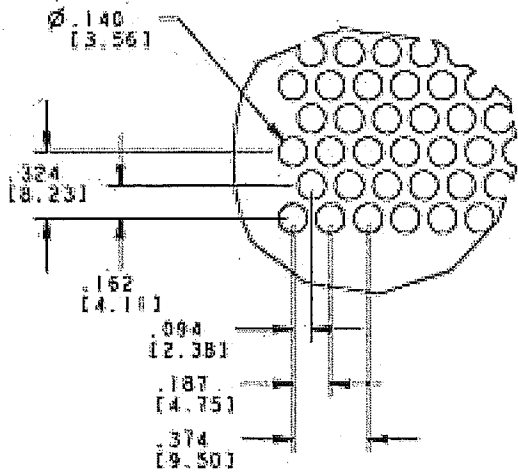
f. first, second and third radome baffles, located to direct cooling air over the front of the respective first, second and third remote radio heads.

6. An assembly comprising first and second remote radio head assemblies as claimed in claim 5, wherein the second remote radio head assembly is located above the first remote radio head assembly, the first and second remote radio head assemblies being oriented rotationally such that the pairs of perforated panels of the second remote radio head assembly is offset from the pairs of perforated panels of the first remote radio head assembly.

7. A tower-mountable assembly, comprising:

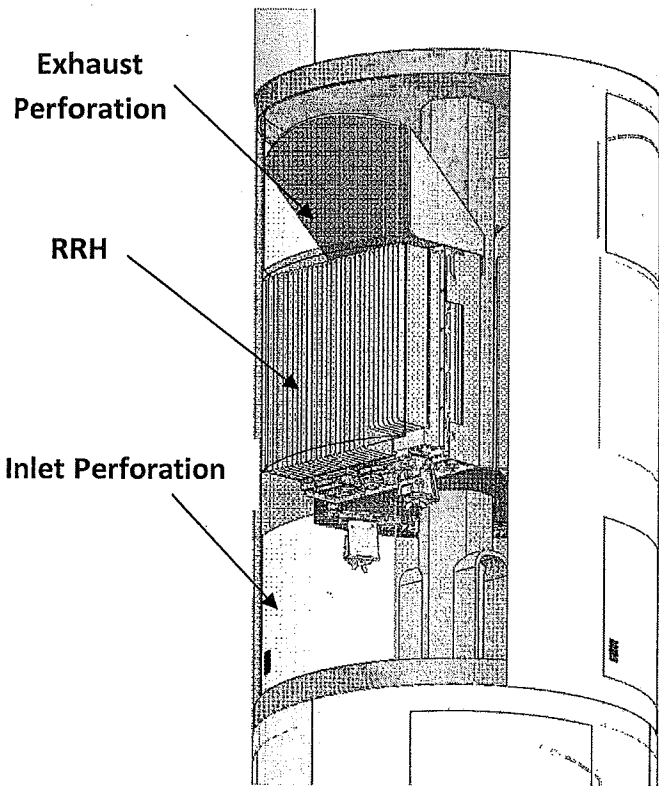
a. a cylindrical concealment module, the concealment module including first, second and third pairs of perforated panels, wherein in each pair of perforated panel comprises an inlet panel and an outlet panel, wherein the outlet panel is located higher than the inlet panel, the pairs of perforated panels being substantially equally spaced about a circumference of the concealment module;

- b. first, second and third electronics modules disposed with the concealment module, mounted on a support, each electronics module generating heat and being associated with the respective first, second and third pairs of perforated panels;
- c. a first baffle, located under the first, second and third electronics modules to prevent cool air from the inlet panels from being diverted to a space between the electronics modules and the support;
- d. first, second and third mounting baffles, each mounting the respective first, second and third electronics module to the support and configured to direct cooling air over a back of its respective electronics module; and
- e. first, second and third hood baffles, located on top of the respective first, second and third electronics modules to direct heated cooling air to the respective first, second and third outlet panels.

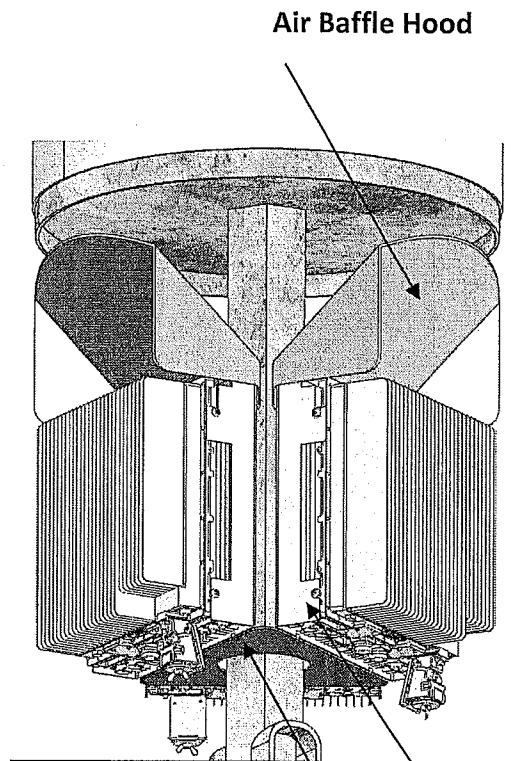


**Figure 1**

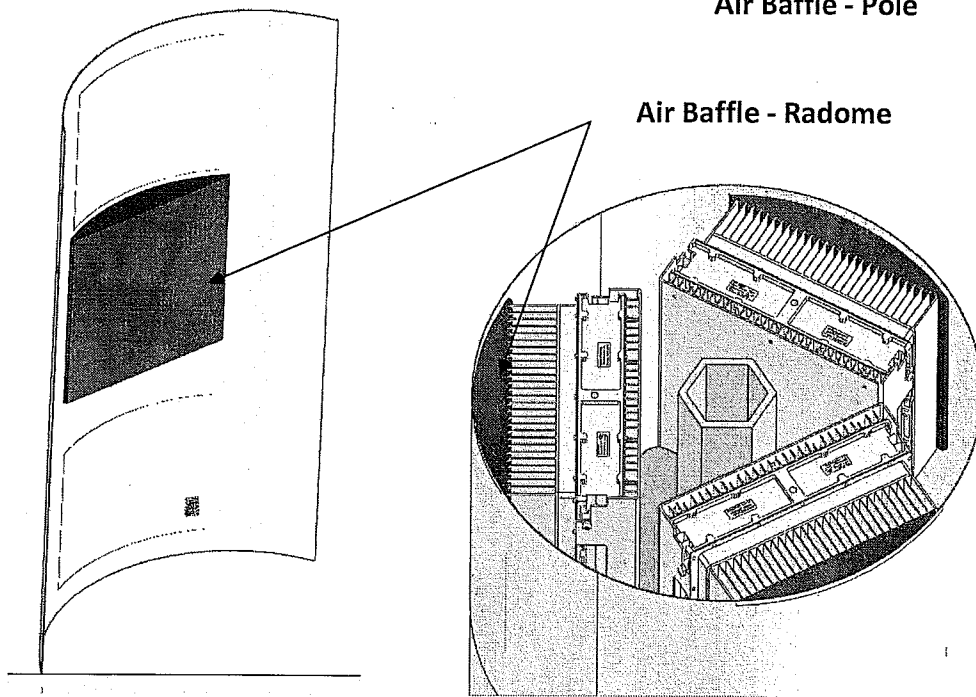
**Perforation Pattern Close-up**



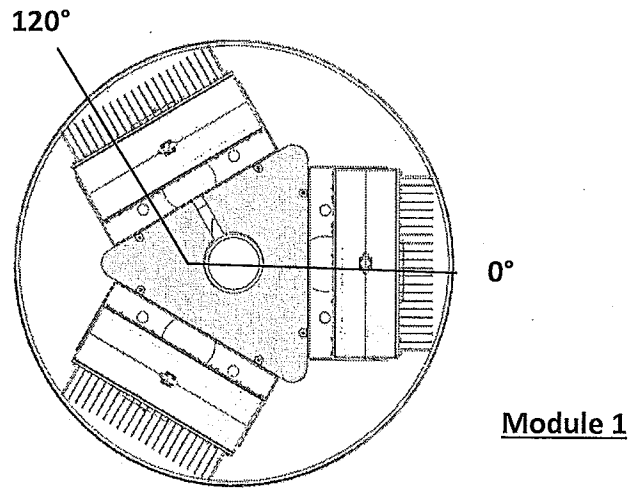
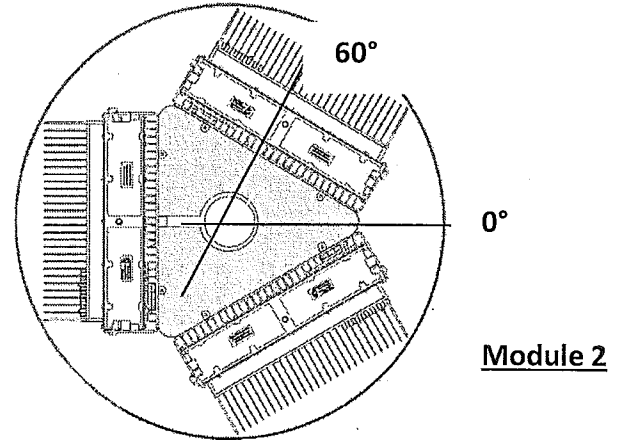
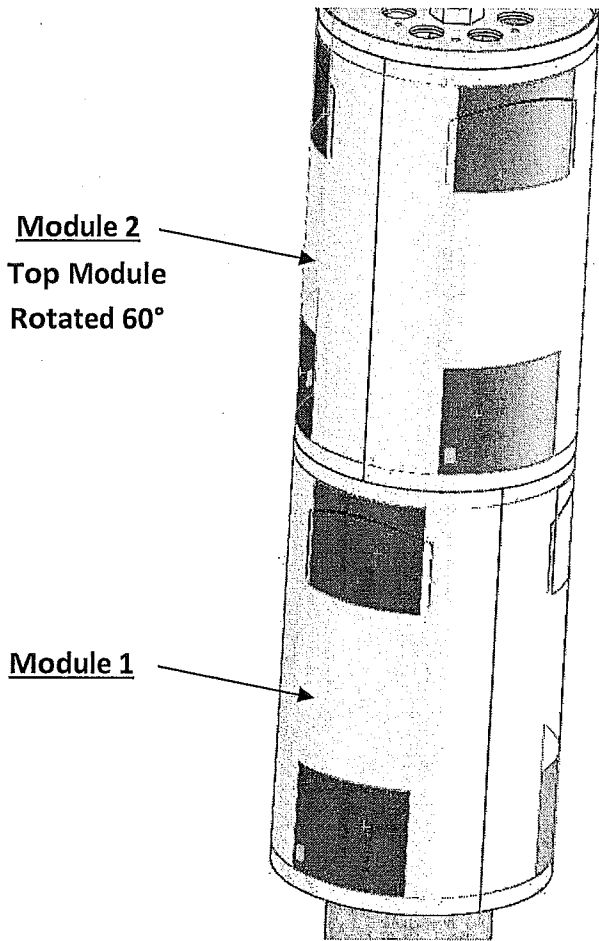
**Figure 2**



**Figure 3**



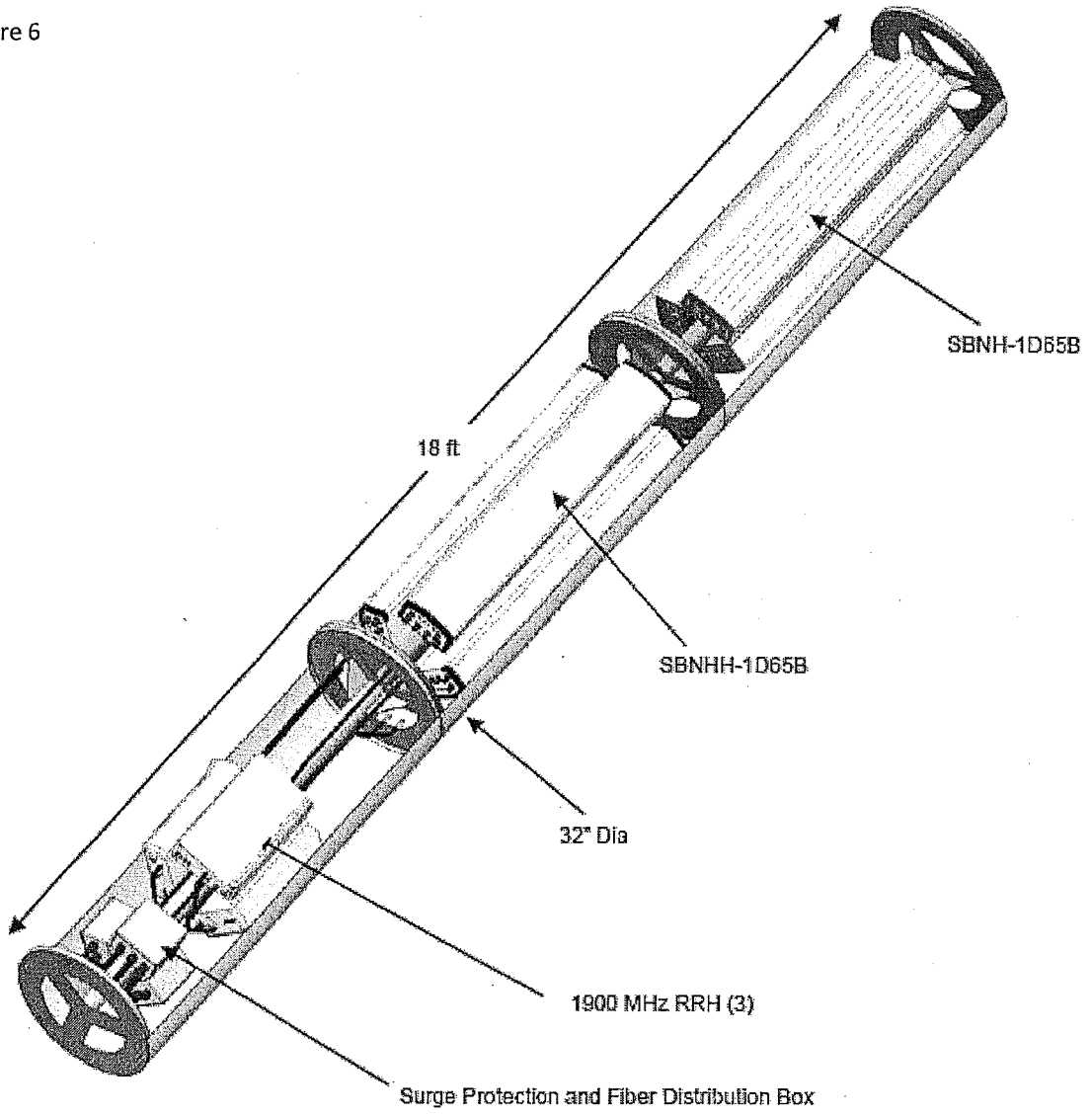
**Figure 4**



Top Views

Figure 5

Figure 6



**A. CLASSIFICATION OF SUBJECT MATTER****H05K 7/20(2006.01)i, H01Q 1/00(2006.01)i**

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)

H05K 7/20; H04W 16/26; H04B 1/59; H04W 36/30; H04J 3/00; G06F 13/20; G06F 13/42; H04Q 7/36; H04W 36/32; H01Q 1/00

Documentation 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 models

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

eKOMPASS(KIPO internal) &amp; Keywords:remote radio head, RRH, concealment module, panel, baffle, cooling air

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012-0196522 A1 (JI-HYEON CHOI et al.) 02 August 2012 See abstract, paragraphs [0029]-[0034], [0040], claims 1, 5 and figures 2-3.	1-7
A	KR 10-2012-0072857 A (LS CABLE LTD.) 04 July 2012 See paragraphs [0021]-[0040], claims 1, 3 and figure 2.	1-7
A	US 2012-0208541 A1 (XILIANG LUO et al.) 16 August 2012 See paragraphs [0032]-[0096], claim 1 and figure 3.	1-7
A	US 2008-0168199 A1 (DAVID J. CONYERS et al.) 10 July 2008 See paragraphs [0031]-[0051] and claim 1.	1-7
A	JP 2008-506321 A (UTSTARCOM TELECOM CO., LTD.) 28 February 2008 See paragraphs [0017]-[0048] and claim 1.	1-7

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

\* Special categories of cited documents:

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

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

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"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

"&amp;" document member of the same patent family

Date of the actual completion of the international search

02 October 2014 (02.10.2014)

Date of mailing of the international search report

**02 October 2014 (02.10.2014)**

Name and mailing address of the ISA/KR

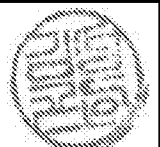
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**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2014/042118**

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