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(54) **ANTENNA FLOOR TILE FOR A RAISED FLOOR SYSTEM**

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(51) **Int. Cl.**

H01Q 1/44	(2006.01)
H01Q 1/40	(2006.01)
H01Q 1/00	(2006.01)
E04F 15/024	(2006.01)
E04F 15/02	(2006.01)

(52) **U.S. Cl.**

CPC ***H01Q 1/007*** (2013.01); ***E04F 15/02429*** (2013.01); ***H01Q 1/40*** (2013.01); ***H01Q 1/44*** (2013.01); *E04F 2015/02105* (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/007; H01Q 1/12; H01Q 1/40; H01Q 1/44; H01Q 1/2291

See application file for complete search history.

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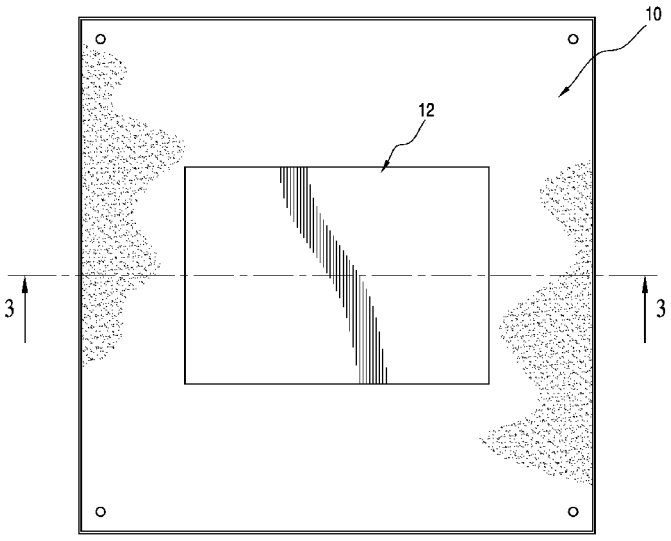
(57) **ABSTRACT**

An antenna floor tile for a raised floor system comprises a frame; an insert supported by the frame, the insert including a top surface; a recess disposed below the top surface; an antenna attached to the insert within the recess; and a protective layer disposed over the antenna.

14 Claims, 4 Drawing Sheets



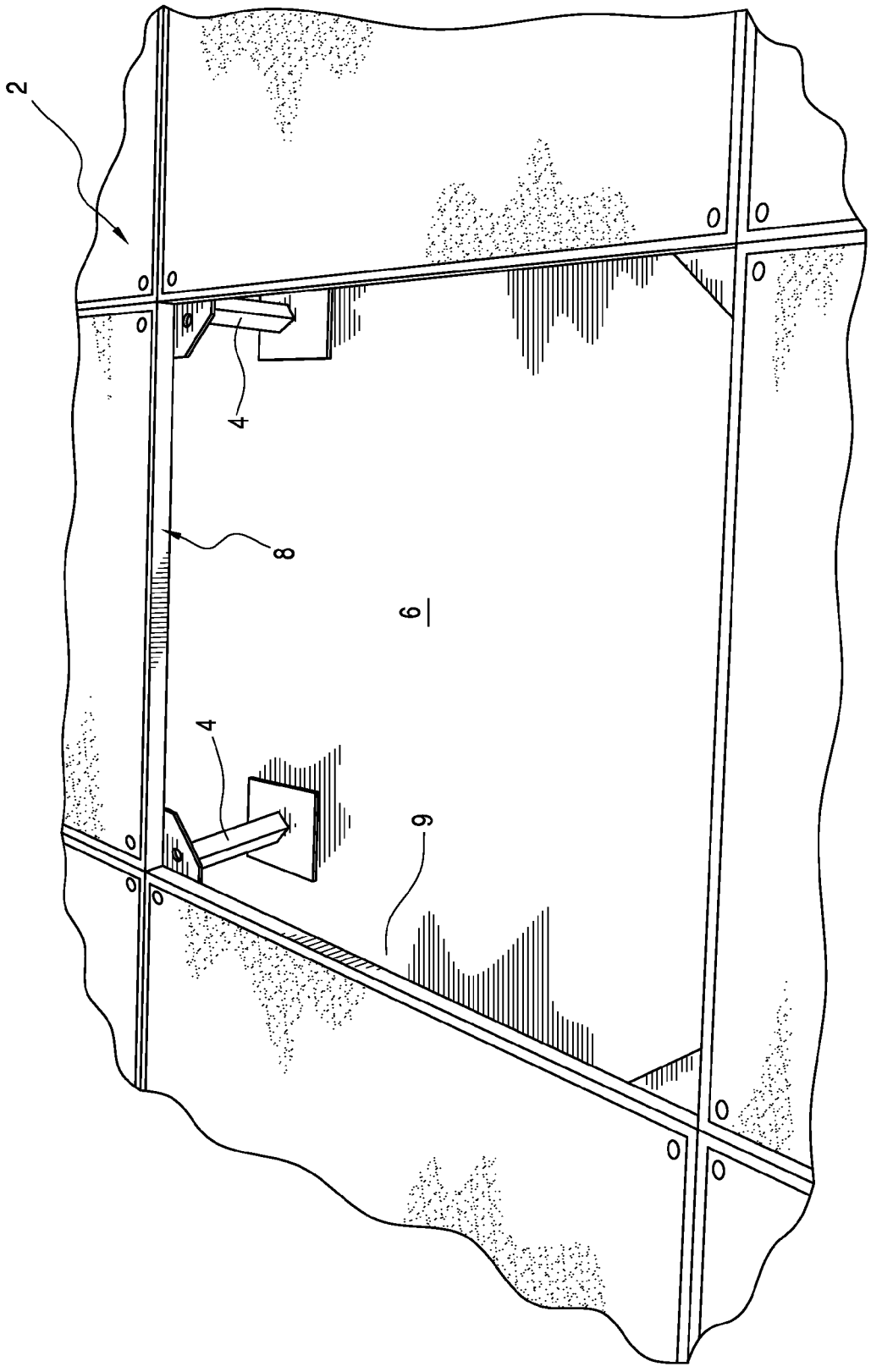


FIG. 1

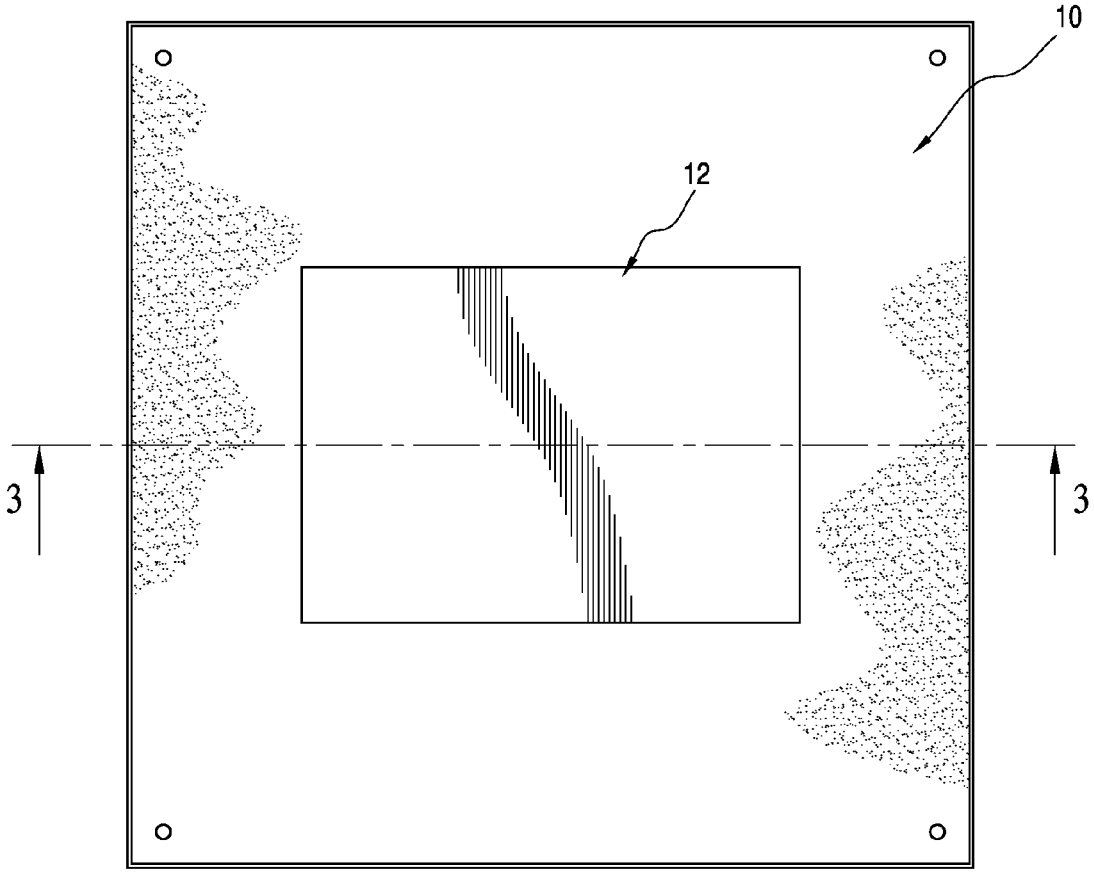


FIG. 2

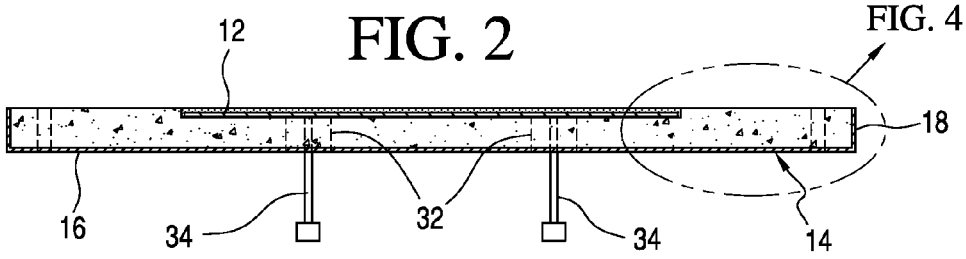


FIG. 3

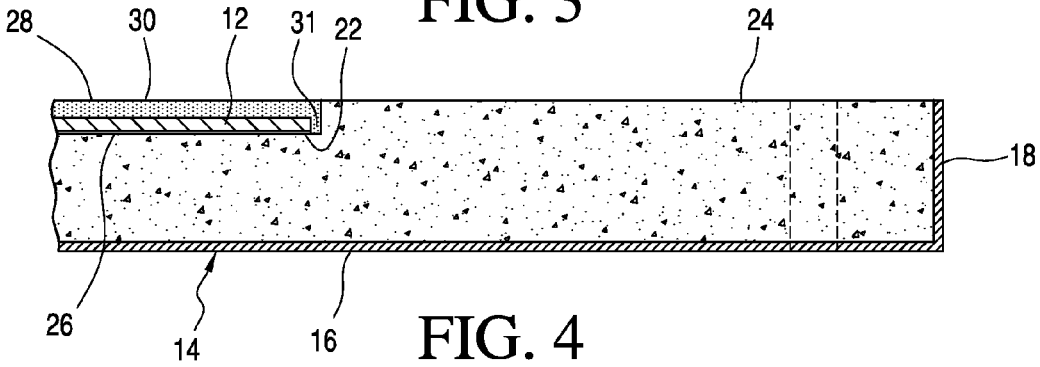


FIG. 4

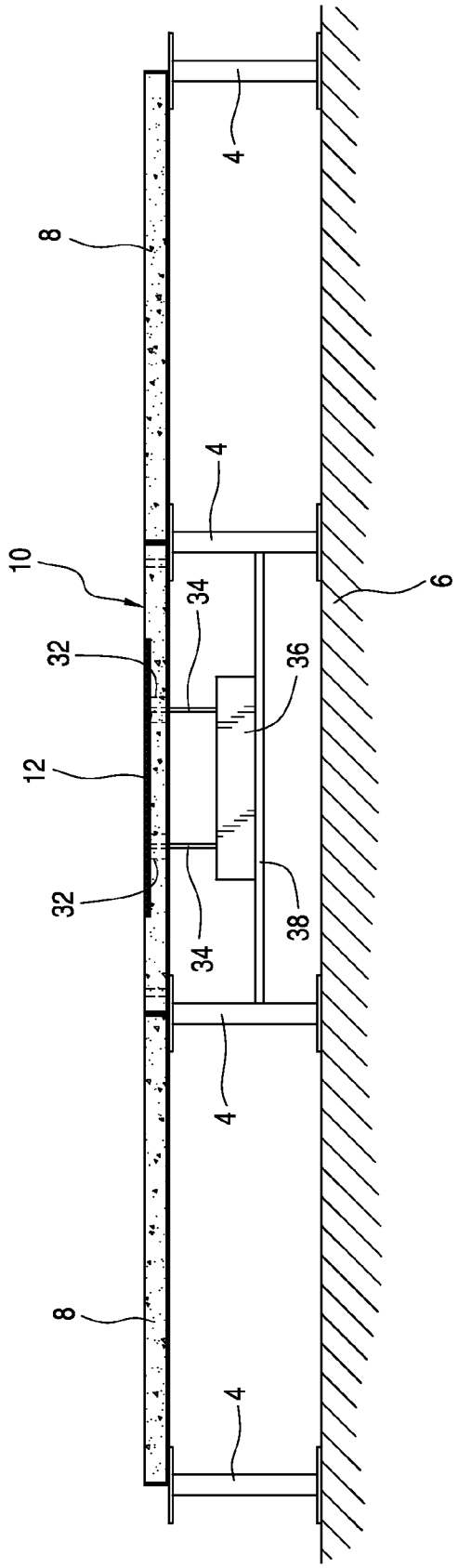


FIG. 5

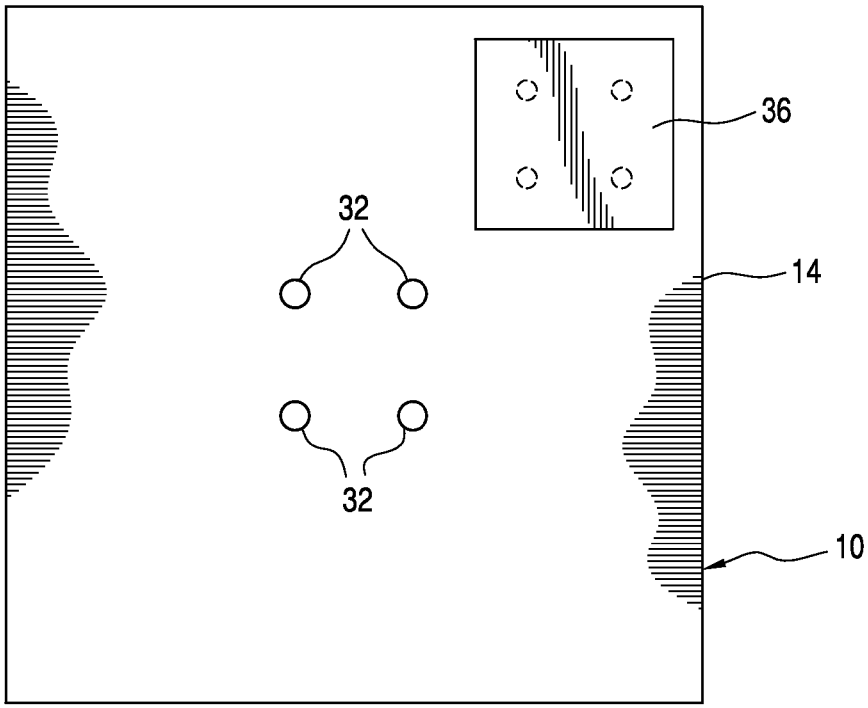


FIG. 6

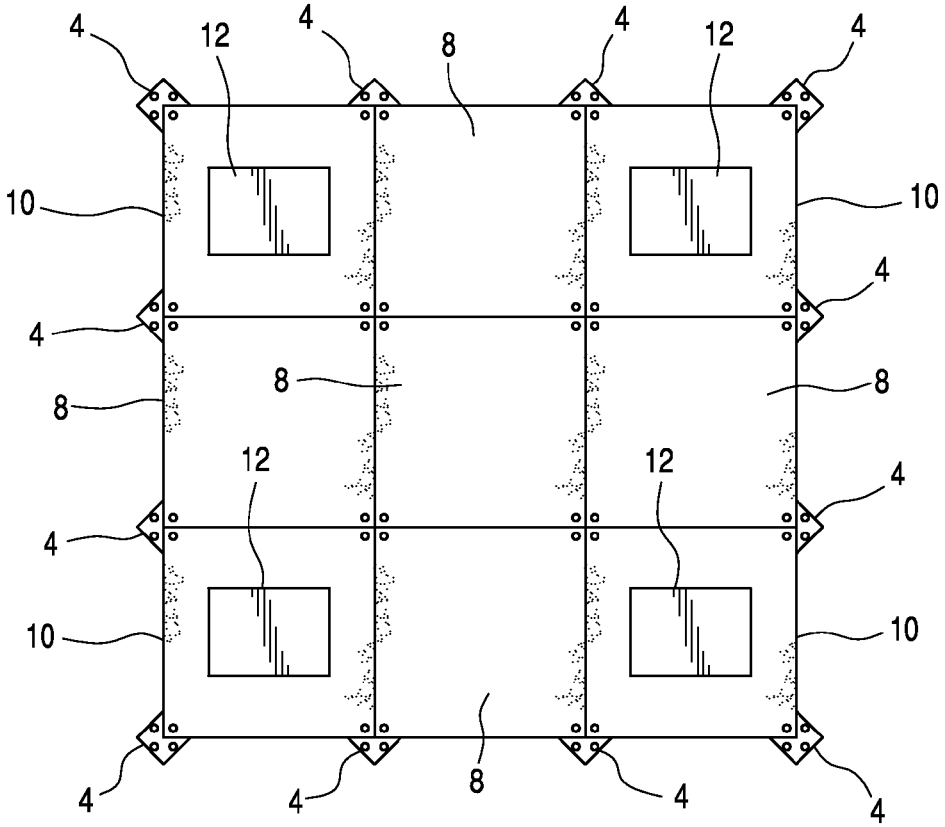


FIG. 7

ANTENNA FLOOR TILE FOR A RAISED FLOOR SYSTEM

RELATED APPLICATION

This is a nonprovisional application of Ser. No. 62/068,261, filed Oct. 24, 2014, the priority benefit of which is hereby claimed and whose disclosure is hereby incorporated by reference.

FIELD OF THE INVENTION

The present invention is generally directed to floor tiles for a raised floor system and in particular to floor tiles incorporating RF antennas for providing Wi-Fi or cellular wireless coverage to users inside a building.

SUMMARY OF THE INVENTION

The present invention provides an antenna floor tile for a raised floor system comprising a frame; an insert supported by the frame, the insert including a top surface; a recess disposed below the top surface; an antenna attached to the insert within the recess; and a protective layer disposed over the antenna.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a raised floor system with one tile removed.

FIG. **2** is a top view of an antenna floor tile made in accordance with the present invention.

FIG. **3** is a cross-sectional view taken along line **3-3** of FIG. **2**.

FIG. **4** is an enlarged view of a section taken from FIG. **3**.

FIG. **5** is a cross-section through the raised floor system of FIG. **1**, incorporating the antenna floor tile of FIG. **2**.

FIG. **6** is an underside view of an antenna floor tile, showing an access point attached to an underside of the tile frame.

FIG. **7** is a plan view of a raised floor system incorporating a plurality of antenna floor tiles in a pattern.

DETAILED DESCRIPTION OF THE INVENTION

A conventional raised floor system **2** is shown in FIG. **1**. A plurality of pedestals **4** supported on a subfloor **6** of a building are arranged to support a plurality of floor tiles **8**. A floor tile **8** is typically 24"×24"×1.25".

The raised floor system **2** provides space **9** below the floor tiles **8** for routing power and communication cables, pipes, HVAC, and other amenities to various points on the floor. The floor tiles **8** are easily removable individually by lifting to gain access to the space **9** below.

Referring to FIGS. **2**, **3** and **4**, the raised floor system **2** includes an antenna floor tile **10** made in accordance with the present invention. The antenna floor tile **10** is a standard floor tile **8**, modified as will be described below, to receive a standard RF antenna **12**, preferably low profile and substantially flat or planar. The antenna floor tile **10** advantageously fits into the raised floor tile system **2**.

The antenna **12** is typically used for Wi-Fi (wireless local area network technology based on the IEEE 802.11 standards) or cellular systems to provide wireless coverage for users of the systems within the building. An example of the

antenna **12** has an overall rectangular shape, measuring about 13.8"×6.3"×1.2", a dual band 2.4/5 GHz antenna, Model No. M6030030O32402A, available from TESSCO Communications Incorporated, Hunt Valley, Md.

Referring to FIGS. **3** and **4**, the antenna floor tile **10** includes a metal frame **14** with a base wall **16** and side walls **18** attached to the outside edge of the base wall **16**. An insert **20**, preferably made of concrete, is supported by the frame **14**. The insert **20** may also be made of wood or other suitable materials.

A recess **22** is provided below the top surface **24** of the insert **20**. The recess **22** is configured to receive the antenna **12** and preferably centered over the insert **20**. The recess may be 0.125-0.25" deep, depending on the thickness or profile of the specific antenna used, and preferably includes a flat or planar bottom surface to dispose the antenna **12** below the top surface **24** of the insert **20**.

The antenna **12** is attached to the insert **20** at the bottom of the recess **22**, preferably with construction adhesive **26**. The construction adhesive **26** advantageously provides a cushion to the antenna **12** and serves to seal the antenna holes **32**.

Referring to FIG. **4**, a protective layer **28** is disposed over the antenna **12**. The protective layer **28** is preferably a two-part epoxy applied to fill in the recess **22** over and around the edges of the antenna **12** and including the gap **31** between the edges of the antenna and the side walls of the recess **22**. The protective layer **28** advantageously provides a smooth top surface **30**. The protective layer **28** bonds with the antenna **12** and the insert material, such as concrete, providing a durable protective coating, advantageously sealing the antenna **12** from the environment. The top surface **30** of the protective layer **28** is preferably flush with the top surface **24** of the insert **20**. The protective layer **28** may also be a sheet of durable plastic, such as Plexiglas.

Holes **32** are provided through the thickness of the insert **20** within the area of the recess **22** to allow the leads **34** of the antenna **12** to extend below the raised floor tile system **2** into the space **9** below. The number of the holes **32** depends on the number of connectors attached to the antenna **12** and the type of wireless radio (access point) used.

Referring to FIG. **5**, the antenna leads **34** are connected to an access point (radio) **36** disposed below in the space **9**. The access point **36** may be attached to a wire tray **38** or, as shown in FIG. **6**, to the underside of the frame **14** with standard screws (not shown).

Referring to Fig. to FIG. **7**, a plurality of the antenna floor tiles **10** is shown arranged in a pattern for a specific application. The pattern of the antenna floor tiles **10** will vary based on the building design and layout and the number of users. Each antenna **12** is connected to a separate radio **36**. The cluster of antennas **12** is needed because one antenna does not provide full coverage for Wi-Fi or DAS. The number of antennas **12** (which correspond to the number of access points) is determined by performing a site survey. One antenna for one radio will cover a certain area. Therefore, there is a correlation between the antenna floor tiles **10** used and the coverage achieved. Square footage of the building, material of the building and number of users of the Wi-Fi system are factors that play into determining the antenna floor tile layout.

The antenna **12** propagates the RF signal from the antenna to the client (user device) and receives the RF signal from the client device. The antenna **12** connects to the radio **36** that provides the wireless signal via coaxial cables **34**. The

number of connectors attached to the antenna **12** depends on the type of wireless radio being used. There are typically 3, 4 or 6 cables.

The antennas **12** can be designed for different communication systems, such as Wi-Fi and DAS (Distributed Antenna System) for LTE Cellular systems for indoors to operate with all of the carriers (AT&T, Verizon, Sprint, T-Mobile, international carriers, etc.).

Once the entire standard raised floor system **2** is installed and the building is constructed and based on RF testing, existing standard floor tiles **8** are replaced with the antenna floor tiles **10** to provide RF coverage as needed. The radios **36** are located under the antenna floor tile **10** supported by metal cage trays and power is run to the radio under the flooring. If the building space is rearranged at any time, the antenna floor tiles **10**, along with the respective radios **36** can be repositioned to provide the proper RF coverage. With the raised floor system, all of the cables that are typically placed overhead are now routed advantageously beneath the floor. Advantageously, ladders will not be used to maintain the antennas **12** and the access points **36**.

The antenna floor tile **10** may be future-proofed by using antenna designs for radios that have not been released yet but still work for existing products. An example is 802.11ac wave **2** technology, which will use up to 8 ports. The antenna **12** can be designed to work with this future technology but the current technology will be used. In other words, the antenna **12** will be designed with 8 ports but only 4 to 6 maximum will be used until the new technology requiring 8 leads is available. For a DAS implementation, current technology starts at 698 MHz but the antennas **12** can be designed to operate down to 570 MHz, when the FCC opens up the frequency spectrum down to 570 MHz.

While this invention has been described as having preferred design, it is understood that it is capable of further modification, uses and/or adaptations following in general the principle of the invention and including such departures from the present disclosure as come within known or customary practice in the art to which the invention pertains, and as may be applied to the essential features set forth, and fall within the scope of the invention or the limits of the appended claims.

We claim:

1. An antenna floor tile for a raised floor system, comprising:

a) a floor tile including a frame having a base wall and side walls attached to outer edges of said base wall;

b) an insert supported by said frame, said insert including a top surface, said insert is disposed within said frame;

c) said insert including a recess with an opening into said top surface;

d) an antenna disposed within said recess; and

e) a protective layer disposed over said antenna.

2. The antenna floor tile as in claim **1**, wherein antenna leads from said antenna extend through the thickness of said insert.

3. The antenna floor tile as in claim **1**, and further comprising an adhesive layer disposed between said antenna and said insert.

4. The antenna floor tile as in claim **1**, wherein said protective layer includes epoxy.

5. The antenna floor tile as in claim **1**, wherein said protective layer is flush with said top surface.

6. The antenna floor tile as in claim **1**, wherein said recess is rectangular in top view and centered on said top surface.

7. The antenna floor tile as in claim **2**, wherein:

a) said insert includes openings through said recess; and

b) said antenna leads extend through said openings.

8. The antenna floor tile as in claim **1**, and further comprising a radio attached to an underside of said frame.

9. The antenna floor tile as in claim **1**, wherein said protective layer includes a plastic glass.

10. The antenna floor tile as in claim **1**, wherein said insert is made of concrete.

11. The antenna floor tile as in claim **1**, wherein said antenna is rectangular in overall shape.

12. The antenna floor tile as in claim **1**, wherein said antenna is low profile and substantially planar.

13. The antenna floor tile as in claim **1**, wherein said antenna is configured for a Wi-Fi or cellular system.

14. The antenna floor tile as in claim **6**, wherein said recess includes a flat bottom surface.

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