

CEILING SYSTEM WITH INTEGRATED EQUIPMENT SUPPORT STRUCTURE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority to U.S. Patent Application Serial Number 12/589475 filed on October 22, 2009, which is herein incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] Certain interior environments, such as clean rooms and hospital like operating rooms, radiology rooms, and dental suites, require unusually clean air for the protection of the work that takes place in them. Such rooms may also have disparate heating or cooling needs at different points in the room. For instance, electronic equipment may produce excess heat, therefore requiring that cooled air be concentrated in its vicinity. Surgeons may also find it prudent to have available additional heated or cooled air in the immediate vicinity of an operating table, to hold a patient at a stable temperature or dissipate the excess heat created by bright lamps or a team of doctors and nurses surrounding the patient. However, the needs of a given room can change over time, as new technology replaces what was originally installed or the room is converted to uses or configurations other than the original. For these reasons, it is undesirable to have air conditioning and ventilation permanently installed as part of the structure of the building. Additionally, when multiple parties provide equipment for these spaces, there is significant coordination required during the design and construction phase to avoid conflicts and interferences in product and schedule. Instead, modular systems which may be installed or removed with only minor structural alterations are desirable.

[0003] Modular installation has the additional advantage of making construction less expensive and more convenient. Ventilation structures need not be custom fabricated on-site, nor incorporated into the structure during construction. Instead, modular units may be mass-produced at a factory off-site and shipped to the building when it is ready to receive them. On-site fabrication is then limited to such fabrication and alterations as are necessary to attach the

modular units to the building's frame.

[0004] In modern operating rooms equipment such as robotic surgical aids are becoming more and more prevalent. These devices make surgery more precise and less prone to errors caused by the inherent fallibility of human hands. Additionally, even in more conventional clean environments, there is a significant requirement for overhead-supported equipment such as light and equipment booms, automated material handling systems, etc. Typically, such equipment is hung from the building structure and descends through the ceiling in order to preserve valuable floor space. However, this arrangement is subject to the similar problems as hard-wired ventilation: it is expensive, requires a custom installation during building construction, and may limit the possible room configurations based on the nature of the underlying building frame.

SUMMARY OF THE INVENTION

[0005] The present invention solves the problems of the prior art and permits the convenient, cost-effective, and easily alterable installation of surgical aids, or any other form of apparatus, from the ceiling of a room, including an operating or clean room. This is accomplished by providing a truss connected to a modular ventilation plenum, the truss being capable of supporting the apparatus to be hung. The truss's position within the plenum may be selected to allow some flexibility relative to the building's underlying frame, and the plenum itself, being of a modular design, may be mounted in a variety of locations. Both truss and plenum may be assembled off-site, installed after the majority of building construction is complete, and repositioned much more easily than systems tied directly to the underlying structure. In addition, the present invention allows the convenient co-location of two items both required directly over the operating area, with neither interfering with the other: ventilation and equipment support. It also allows installation of a modular equipment support without ventilation, if preferred.

[0006] The present design also includes a suspended grid system of the type commonly found in commercial ceilings within the plenum itself, to preserve the continuity of the ceiling in the room. This grid is designed to accommodate a smaller equipment support

attached to a suspended grid system, allowing the placement of smaller and lighter surgical apparatus, illumination, or similar necessities.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 is a perspective of the plenum from below, as it would appear when installed, including the truss, suspended grid, and grid-based equipment support.

[0008] FIG. 2 is a section taken along line 2-2 of FIG. 1, showing the truss with an appended surgical device.

[0009] FIG. 3 is a section taken along line 3-3 of FIG. 1, showing the equipment support with an appended surgical device.

[0010] FIG. 4 is a perspective view of the truss in isolation.

[0011] FIG. 5 is an elevation view of the truss from one end.

[0012] FIG. 6 is a perspective view of the top of the equipment support, as it would appear from above the suspended grid.

[0013] FIG. 7 is a perspective view of the bottom of the equipment support, as it would appear from below the suspended grid.

[0014] FIG. 8 is a perspective view of the top of the plenum, showing a hole in the center through which air may pass as part of a ventilation system.

[0015] FIG. 9 is a perspective view of the top of the plenum, showing holes in two sides through which air may pass as part of a ventilation system.

[0016] FIG. 10 is a perspective view of the top of the plenum, showing an air handling component, such as a fan/filter unit, mounted to the suspended grid system.

DETAILED DESCRIPTION OF THE DRAWINGS

[0017] Turning now to FIG. 1, a modular unit embodying the present invention is depicted. A plenum 10 may be suspended from hangars 12, which are in turn attached directly to the I-beams or other frame of the building. The hangars 12 may also be attached to a secondary structure (not shown) which in turn attaches to the building's frame. This arrangement permits the placement of plenum 10 in locations other than directly below the building's structural

beams. Alternatively, plenum 10 may also be bolted directly to part of the building or an adapter rather than suspended from hangars 12. Hangars 12 are shown at the corners of plenum 10, but may be placed in other locations, or with greater spatial frequency than is shown.

[0018] The plenum 10 is formed from a perimeter 14 of material, conventionally sheet steel although any sufficiently rigid material will do, using methods well known in the art. The plenum 10 is typically a rectangle or square, and is built in a size chosen to accommodate the heating and cooling needs of the building as well as to accommodate the structure to which it is to be attached. The perimeter 14 is given enhanced rigidity by the presence of lower lip 16 and upper rail 18. The upper rail 18 provides is the primary structural member of the plenum 10. The rail is typically constructed of steel .188 inches thick, formed into a rectangular tube about 3" x 4". The upper rail 18 is welded to sheet steel wall 15, and lower rail 16 is formed by bending wall 15. Grid members 20 may be attached to lower lip 16, forming a grid of supports for the ordinary parts of a suspended ceiling, such as ceiling tiles, lights, and vents for air passage (not shown). Alternatively, grid members may be attached to the sheet steel wall 15 directly. Grid members 20 are conventionally constructed as rectangular tubes or U-shaped channels of stainless steel, or extruded aluminum, but may be constructed of other materials and in other shapes as well. The grid members 20 are sufficiently rigid that they span the plenum 10 without additional support, easing attachment of the plenum 10 to the building structure and installation of the grid members 20. Grid members 20 may also be attached to the building structure, for instance by the use of additional hangars 12, for greater load-bearing capacity.

[0019] The plenum 10 may be sealed at the top to control airflow by plenum roof 22, best shown in FIGS. 8 and 9. This roof is usually sheet metal similar to that found in perimeter 14, but need not be. A hole 24 may appear in the plenum roof 22 to permit air to enter or leave the plenum 10, and therefore the room, or holes 26 may be found in perimeter 14 for the same purpose. An air handling component (not shown) may be mounted adjacent holes 24 or 26, or a duct (not shown) may lead to them. Alternatively, the plenum may have an air handling component 28 mounted directly to the grid members 20, as best shown in FIG. 10, such that the plenum itself does not control airflow. The air handling component may comprise a fan, a filter, air conditioning coils, heating elements, humidifiers, dehumidifiers, or any combination of these

or similar elements, all of which are well known in the art.

[0020] A truss 30, best shown in FIGS. 2 and 4, spans the plenum 10 and is firmly attached to the upper rail 18. In a rectangular plenum 10, the truss 30 preferably spans the shorter dimension, so as to maximize its weight-bearing capacity. In the figures, truss 30 is attached by bolts 32, which allows for easy installation and removal. Any other suitably rigid form of attachment, such as rivets or welding, may be used, although these may not be as convenient. The truss 30 is composed of upper spars 34, lower spars 36, and various cross members 38, which link the spars together and provide rigidity. Diagonal cross members 40 provide resistance to twisting. The truss 30 may be constructed of steel or aluminum that has been cast, extruded, forged, or otherwise formed into structural shapes, such as tubes, I-beams, or U-channels. The truss 30 may also be made of composite materials such as fiberglass or carbon fiber, formed sheet steel, or any other suitably sturdy material. The truss 30 may even employ several different types of material in its construction. The spars 34, 36 and cross members 38, 40 are preferably welded together if metal, and glued or molded as a single piece if composite, but they may also be joined by bolts, rivets, or other means known in the art. The precise choice of materials and design for the truss 30 will be determined by such factors as the required strength, the need to minimize weight, and the manufacturing cost. These considerations are well understood in the art. It will be understood that no particular configuration of spars and cross members, nor any particular material choice, is required to practice the spirit of the invention.

[0021] The truss 30 may also be installed as part of the perimeter 14 of a plenum, or even between two neighboring plenums 10, forming a part of the perimeter 14 of each. In this configuration, the truss 30 may be open to airflow. The truss 30 may also be closed to airflow, for instance by attachment of a sheet of metal across one or both sides of the truss 30.

[0022] The truss 30 may incorporate dedicated passageways for routing of electrical conduits or lines supplying such things as natural gas, refrigerant, water, gases such as oxygen or nitrogen, or vacuum.

[0023] An equipment interface plate 42 is mounted to the truss 30 between the lower spars, and provides a mounting location for heavy equipment 44, such as robotic surgical aids. This plate is most commonly metal, but may be any material of suitable strength. Preferably, the

equipment interface plate 42 has a bolt-hole pattern 43 which matches that of heavy equipment 44 to permit convenient installation and removal without the need for adapters or jigs. The holes may be threaded or clearance holes. The equipment interface plate 42 may be welded to truss 30, or bolted for easier installation and removal. Other attachment methods, such as riveting, are also possible. It may be manufactured "blank," without any bolt-hole pattern 43, and then machined to match whatever heavy equipment 44 is ultimately selected.

[0024] The weight of the heavy equipment 44 is transferred by the truss 30 to the upper rail 18 (and to some degree, to the remainder of perimeter 14), and thence to the hangars 12 and into the building's structure. The truss 30 may be independent of the grid members 20, so that any movement in the truss 30 is not directly transferred to the grid members 20, and vice versa. This may be advantageous when, for instance, a light (not shown) attached to grid members 20 is manually adjusted; the movement of the light will have a minimal effect on the heavy equipment 44 suspended from the truss 30. When the truss 30 and grid members 20 are structurally independent, they may be loaded independently of each other, with reference only to the total load that the plenum 10 and hangars 12 can support. On the other hand, the truss 30 and grid members 20 may be linked together. This configuration provides maximum load-bearing capacity and maximum lateral stability for the heavy equipment 44 mounted on the truss 30.

[0025] The truss 30 shown in the drawings, when constructed out of welded tube steel and connected to the plenum 10, can support at least 900 lbs of heavy equipment 44 and can bear at least 8000 ft-lbs of torque about an axis running parallel to the spars 34, 36.

[0026] Lighter apparatus 46 may also be attached to the plenum 10 at the grid members 20, either on the top or bottom of these members, by the use of apparatus mount 48. The grid members are obviously not capable of supporting the same amount of weight as the truss 30 due to their flatter construction, and in addition, they must bear the weight of multiple other items, such as lighting. However, apparatus mount 48 is also more versatile than truss 30. It allows the positioning of lighter apparatus 46 in more places, including some not reachable by truss 30, and also permits the repositioning of lighter apparatus 46 much more conveniently. Similar to the operation of truss 30, apparatus mount 48 transfers the weight of lighter apparatus 46 to the grid members 20, which then transfer it to the lower rail 16, then through perimeter 14

and into hangars 12. When used unreinforced, the grid can bear around 300 lbs. in weight. This amount may be raised considerably by hanging a stud 12 from the building's structure and attaching it to the grid members 20 directly for additional support.

[0027] Apparatus mount 48 is comprised of frame 50 and support plate 52. As with the other components of the plenum 10, these advantages are best achieved if apparatus mount 48 is bolted to the grid members 20, but it may also be attached in other ways. Similar to equipment interface plate 42, the support plate 52 may be welded to frame 50, but it may also be bolted, riveted, or otherwise attached.

[0028] It is also possible for the plenum to be installed with no air-conditioning function at all, purely as a hanger for ceiling-mounted equipment. In that case, the truss 30 or apparatus mount 48 can be mounted within the plenum 10, but without any air-handling component 28, plenum roof 22, or holes 26. This system is modular, convenient, and inexpensive, and may be employed anywhere, whether in a clean room, operating room, or ordinary office or industrial environment that requires equipment to be hung from above.

WHAT IS CLAIMED IS:

1. A modular unit for use in a ceiling, comprising:
 - a. a plenum having walls defining a perimeter of material, said walls supported by a rail;
 - b. a grid of supports attached to said plenum, said supports defining a suspended ceiling; and
 - c. a truss separate from said grid of supports attached to said rail, said truss configured to support ceiling-mounted equipment and transmit the load of said equipment to said plenum.
2. The unit of claim 1, wherein said plenum is suspended from a building ceiling.
3. The unit of claim 2, wherein the plenum is suspended from said ceiling by a plurality of hangers.
4. The unit of claim 1, wherein said truss includes an equipment interface plate to which said ceiling mounted equipment can be attached.
5. The unit of claim 1 including an apparatus mount which is attachable to said grid of supports, said apparatus mount capable of supporting said ceiling mounted equipment.
6. The unit of claim 1, wherein said truss is attached to said grid of supports.
7. The unit of claim 1, wherein an air handling component is positioned within said perimeter.
8. The unit of claim 1 further comprising a top attached to a top margin of said perimeter along the entire perimeter, forming a substantially airtight seal therewith.

9. The unit of claim 8, wherein the perimeter has at least one side and a hole therein to permit air to flow into the unit and thence into a room below.
10. The unit of claim 8, wherein the top has a hole to permit air to flow into the unit and thence into a room below.
11. The unit of claim 10 wherein an air handling component is positioned proximate said hole.
12. The unit of claim 1, wherein the truss comprises structural steel shapes.
13. The unit of claim 1, wherein the truss comprises structural aluminum shapes.
14. The unit of claim 13 wherein at least two of said shapes are welded to one another.
15. A modular unit for use in a ceiling, comprising:
 - a. a plenum having perimeter of material formed into a rectangular box;
 - b. a grid of supports attached to perimeter, said supports defining a suspended ceiling; and
 - c. an apparatus mount attached to at least one of said supports.
16. The unit of claim 15, wherein said grid of supports is attached to a bottom margin of said perimeter.
17. The unit of claim 15, wherein the grid of supports comprises extruded aluminum.
18. The unit of claim 15, wherein the grid of supports comprises sheet steel formed into a tubular configuration.

19. The unit of claim 15, wherein the grid of supports comprises sheet steel formed into an inverted U-channel configuration.

20. The unit of claim 15, wherein the apparatus mount includes a support plate so configured as to rigidly attach to an item of apparatus.