MULTI-PURPOSE BEAM

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Abstract

A multi-purpose beam for providing structural support to an assembly, an added measure of protection for conduits such as lines, hoses, and cables, and directs airflow. The inside of the beam has a number of cavities running the length of the beam created by a plurality of dividers. Within these cavities air can be circulated and conduits can be contained that transfer liquids, gases, and power. The shell of the beam and the dividers add a protective layer supporting the conduits and a plurality of openings allows for access ports that tap into the conduits at desirable locations along the length of the beam thus making what ever is conducted by the conduits available external to the multi-purpose beam.
MULTI-PURPOSE BEAM

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] This invention relates to a multi-purpose beam for use in a space environment to support a human habitat module or other space structure. The multi-purpose beam functions to provide structural support, facilitate airflow, and provide a housing to protect conduits while at the same time allowing access to the conduits.

[0003] 2. Description of the Prior Art

[0004] Structural supports are well known in the building trade and have been used in a number of applications. One important application of structural beams is in the construction of space related crafts. In this environment, the beam can take a number of forms. One such form is that of a longeron.

[0005] A longeron is a framing member that runs fore and aft on a structure such as a space based human habitat module. In application, there are usually a number of longerons that are at the structural core of modular space habitats.

[0006] Another application of the beam is as a cross member attached to longerons, or as structural support to other elements of the habitat. The use of beams in such situations deals with the forces on a structure.

[0007] In space applications such as a modular human habitat, the module experiences significant stresses from a number of sources. For example, load stresses due to the mass of equipment interacting with the beams. Also, internal forces due to the pressurization in the case of an inflatable modular habitat. Further, externally applied loads such as those experienced during docking maneuvers or linear attachment of other modules.

[0008] The aforementioned stresses identify the need for a rigid structure. A framework of rigid beams can accomplish this task. In the case of a modular habitat, a structural member is part of the framework that provides a substantially rigid foundation. This can be, for example, part of the structural core, or a translation tube, in the case of an inflatable module.

[0009] While the use of beams is critical to the construction of a module in space, there is an overriding consideration that severely restricts widespread application of beams in that environment. This is due to the weight associated with structural beams.

[0010] The cost to place a structure in space is extremely high. This cost rises in relation to the increase in the weight of the structure launched. Since beams provide structural support, they tend to be heavy and this weight increases the cost associated with a launch of the beams, and the overall space module, into space.

[0011] While recent advances have been made in the use of composites that are lighter in weight and still provide structural support, they too have drawbacks. For example, it is not uncommon for composites to be very expensive. Another drawback is that many composites may work well in one structural application and not in another. Further, some composites are not as easy to work with as traditional structural materials such as aluminum. Even so, solid composite beams may still be too heavy for use in a space environment.

[0012] One way to reduce the weight of the beam has been to hollow out the beam. While hollow beams for structural support are well known as typified by U.S. Pat. No. 6,554,352 to Nagy, they have not been adapted to perform a multiplicity of functions and the internal space, or cavity, remains largely unused.

[0013] Equally well known are systems that transport water, gas, and electricity. Typically this is accomplished by use of a conduit.

[0014] In the case of electrical current, the conduit takes the form of a cable. With regards to transferring liquids, such as water, or gases, such as oxygen or nitrogen, the conduit usually takes the form of a hose or pipe.

[0015] Use of cables, pipes, and hoses in space based applications present unique challenges. In a micro-gravity environment, a leak of a liquid or gas can be catastrophic. This is due to the fact that the leaking material is driven by the force in the container as it is ejected.

[0016] Without a gravitational point of reference, solid materials do not stop moving until they make contact with another object. This could be an electrical panel, a person, or sensitive and necessary equipment on the module. Such contact can be dangerous.

[0017] In the case of a leaking gas, such as nitrogen, the module’s oxygen supply could be displaced resulting in an undesirably lower level of oxygen. Should an oxygen leak occur, then the oxygen rich environment could increase the risk of a fire starting or should a fire occur it might not be easily controlled.

[0018] As to the transfer of electricity, a cable failure could result in fire, critical system failures due to circuit shorts, failure of expensive experiments, or even electrocution.

[0019] Many such problems can result from damaged conduits. One solution is to use highly durable and failure resistant conduits. The down side to this approach is that such conduits are more expensive and typically heavier and less user friendly.

[0020] While structures that support and direct a conduit are generally known as illustrated by U.S. Pat. No. 6,557,807 to Belanger, U.S. Pat. No. 6,467,734 to Brown, U.S. Pat. No. 5,947,424 to Heath, U.S. Pat. No. 5,823,484 to Barnard, U.S. Pat. No. 5,785,457 to Thompson, and U.S. Pat. No. 4,961,553 to Todd, these patents do not claim, disclose, or intimate the use of a structural member to provide protection to the conduit.

[0021] One other issue is the availability of air in a space environment. Terrestrially, airflow can be directed by use of air ducts. However, in a space environment, where every square inch counts, the addition of air ducts does not provide an optimum solution.

[0022] What is needed is a lighter and more versatile beam, a more optimum way to direct airflow, and a way to protect conduits in a space environment. Thus, a structural member that encloses conduits and directs airflow would be ideal.
SUMMARY OF THE INVENTION

[0023] The multi-purpose beam has a tubular like structural member with a cross section being generally oval, circular, box, triangular, or polygonal, or a combination thereof. There is a plurality of dividers inside the tubular like structural member that extend the length of the tubular like structural member and divide the inside into a number of cavities.

[0024] At least one cavity is adapted to direct an airflow and another cavity is adapted to receive a conduit. The conduit can be a power cable, pipe, hose, or any other type of channel through which something is conveyed.

[0025] One or more openings extend from at least one cavity through the tubular like structural member’s external periphery.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] FIG. 1 is an isometric view of the multi purpose beam with dividers, openings and one conduit;

[0027] FIG. 2 is an isometric view of the multi purpose beam with dividers and openings and two conduits;

[0028] FIG. 3 is an isometric cut away view of the multi purpose beam identifying the holes between two adjoining cavities;

[0029] FIG. 4 is a side view of a multi purpose beam configurated as a longeron and providing air, power, and water;

[0030] FIG. 5 is a cross sectional view of the elongated tubular like structural member exhibiting a generally circular cross section;

[0031] FIG. 6 is a cross sectional view of the elongated tubular like structural member exhibiting a generally oval cross section;

[0032] FIG. 7 is a cross sectional view of the elongated tubular like structural member exhibiting one of a variety of polygonal cross sections;

[0033] FIG. 8 is a cross sectional view of the elongated tubular like structural member exhibiting a generally rectangular cross section; and

[0034] FIG. 9 is a cross sectional view of the elongated tubular like structural member exhibiting a generally square shape;

[0035] FIG. 10 is a cross sectional view of the elongated tubular like structural member exhibiting a generally triangular shape;

[0036] FIG. 11 is a cross sectional view of the elongated tubular like structural member exhibiting a shape that is a combination of geometric forms;

[0037] FIG. 12a is an isometric view of four individual shafts;

[0038] FIG. 12b is an isometric view of the elongated tubular like structural member composed of four joined shafts; and

[0039] FIG. 13 is an isometric view of a shaft and a skeletal structure.

DETAILED DESCRIPTION OF THE DRAWINGS

[0040] The present invention may best be understood by reference to the following description taken in conjunction with the accompanying drawings. FIG. 1 is an isometric view of the multi purpose beam 10. The multi purpose beam 10 is composed of an elongated tubular like structural member 12 having a plurality of dividers 14 within the tubular like structural member 12 extending the length 13 of the member 12 and thereby defining a number of cavities 16 where at least one cavity 16 contains a conduit 18. Thus, the cavities 16 are enclosed hollow areas extending the length 13 of the member 12.

[0041] As evident from FIG. 1, the cavities 16 are surrounded by sides defined by the tubular like structural member 12 and the dividers 14. Enclosing the cavities 16 in this manner provides an extra measure of protection for the conduits 18 that are within the cavities 16.

[0042] Extending from the cavities 16 through the external periphery 20 are a plurality of openings 22. These openings 22 serve a number of purposes. First, in the case where air is channeled through a cavity 16 as shown in FIG. 1, the openings allow airflow 15 in and out of the cavity 16. In this way, the cavity 16 directs the airflow 15 to provide air to the modular human habitat. While it may be desirable in some instances to direct other gases through the cavity 16, the term airflow can include air, oxygen, nitrogen or any other gas or combination of gases as needed in the particular application.

[0043] Second, in the instances where the cavity 16 contains a conduit 18, the openings 22 allow access to the conduit 18 to facilitate transfer of whatever is being conducted thought the conduit 18 outside of the multi-purpose beam 10. A conduit 18 is a channel through which something is conveyed. Thus, a conduit 18 can convey liquids, gases, and electricity.

[0044] Finally, the openings 22 assist in reducing the overall weight of the tubular like structural member 12. In concert with weight reduction, the location and number of openings 22 are chosen as not to degrade the structural integrity of the tubular like structural member 12 in the desired application.

[0045] Turning now to FIG. 2, a second conduit 18 is shown residing within a cavity 16. The enclosure around the conduit formed by the dividers 14 and the tubular like structural member 12 allow a user to place specialized conduits 18 within a cavity. For example, on a cavity may only have a liquid conduit 18 such as a hose or pipe that transports water. Another cavity 16 may only have conduits 18 for transporting electricity. Thus, the cavities 16 form an extra barrier between the water and electrical conduits 18. This is a safety feature of the multi purpose beam 10.

[0046] Addressing FIG. 3, part of the tubular like structural member 12 is removed to expose the holes 26 that exist between two adjoining cavities 28 that share a divider 14. The adjoining cavities 28 direct airflow 15 through the cavities 28 and the holes 26 act to equalize the pressure between the adjoining cavities 28 and to better facilitate a more even distribution of heat vis-a-vis the airflow 15. The geometry of the holes is dependent upon the application and is not limited to that identified in the figure.
FIG. 3 also identifies an access port 30. The access port 30 attaches to the conduit 18 to facilitate transfer of whatever the conduit 18 is conveying. In the case of liquids, such as water, the access port 30 conveys the liquid from the conduit 18 through the external periphery 20 to make the water available to a user. In this case, the access port could be a water valve.

In the situation where the water is being provided to regulate the heat produced by equipment, one conduit can supply the water and another conduit can remove the water.

Where the conduit 18 conveys electricity, such as an electrical cable, the access port 30 takes the form of an electrical outlet to make electricity available beyond the external periphery 20. It naturally follows that where the conduit is transferring a gas, such as nitrogen or oxygen, the access port 30 may take the form of a valve attached to the conduit 18, which may be a hose or pipe. In this application, the access port 30 can be a valve that transfers the gas from the conduit 18 or into the conduit 18.

By definition, an access port 30 that connects through an opening to a conduit 18 such that a liquid or gas is accessible through the access port 30 means the gas or liquid can be coming from the conduit 18 and external to the elongated tubular like structural member 12 or going into the conduit 18.

Focusing now on FIG. 4, the multi purpose beam 10 takes the form of a longeron 31. A longeron is a fore and aft framing member of a structure such as a modular space habitat. In FIG. 4, the longeron 31 connects two end caps 32 as would be common in a singular human habitat module in space. The access ports 30 are shown to provide electricity through electric cables 34 to computers 36 and other pieces of electrical equipment 38 and water through water hoses 40 for transferring heat from the electrical equipment 38. Airflow 42 is shown as the air forced through the cavities escapes through the openings 22 into the module. While FIG. 4 identifies a longeron 31, the multi-purpose beam is not limited in its application to just a longeron. The multi-purpose beam can be used as a frame, support, or in any capacity that requires a structural brace or foundation.

FIGS. 5 through 11 exemplify a variety of cross sections 13 of the tubular like structural member 12. FIG. 5 is generally a circular 44 cross section 13. FIG. 6 is generally an oval cross section 42. FIG. 7 is generally a polygon having six sides, a hexagon, although a polygonal cross section 50 is not limited to only six sides. FIG. 8 shows a generally rectangular cross section 43. FIG. 9 is generally a box cross section 46. FIG. 10 identifies a generally triangular cross section 48. Finally, FIG. 11 is an example of a combination of a generally semicircular and generally square cross section 52.

The cross section 13 can take a shape as required by the situation and is not limited to those specifically identified. Further, FIGS. 5 through 9 depict how the dividers 14 can be in a variety of positions. Nothing in this specification is intended to limit the number of dividers 14 or the various positions that the dividers can take within the member 12.

Addressing now FIG. 12a, the preferred embodiment begins with a plurality of hollow elongated shafts 54. FIG. 12b identifies the case where four shafts 54 are used, however this does not restrict the number of shafts 54 that can be used. Each shaft 54 has a length 56, an external periphery 58, and at least one wall 60 defining a cavity 16. Each shaft 54 can take a variety of cross sections 13 as described in FIGS. 5 through 11. One wall 60 of each shaft 54 adjoins a wall 60 of another shaft 54. These form the adjoining walls 62. The shafts 54 are composed of aluminum, but may also be of an aluminum alloy, other generally metallic material, metallic alloy, or a composite material.

Turning now to FIG. 12b, the adjoining walls 62 are fixedly attached, or joined, to one another. Where the shafts 54 are composed of aluminum, the attachment can be facilitated by a number of well-known means including welding and/or bonding with materials having, for example, an epoxy base. In the case where the shafts 54 are made of a composite substance, bonding can be achieved by use of materials such as, again, an epoxy based substance. At least one shaft 54 contains a plurality of openings 22 extending from the cavity 16 through the wall 60 and external periphery 58. Also, at least one cavity 16 is adapted to conduct airflow 15, while at least one cavity 16 is adapted to receive a conduit 18.

When the shafts 54 are joined, the walls perform the same function as the dividers 14 in FIGS. 1 through 3. That is, the walls 60 define the cavities 16 of the elongated tubular like structural member 12. Referring again to FIGS. 12a and 12b, a divider 14 is disposed within, and along the length 56, of a shaft 54 to produce a plurality of cavities 16. A plurality of dividers 14 can be utilized in the shafts 54 as desired. A divider 14, or any number of dividers 14, can be secured within a shaft 54 by a variety of ways including those described above for joining the shafts 54 together. The joined shafts 54 and inserted dividers then define the elongated tubular like structural member 12.

Turning again to FIG. 12b, a conduit 18 is identified within a cavity 16. Furthermore, an access port 30 is shown that accesses whatever is being conducted by the conduit 18. As described above, the access port 30 can take whatever form is necessary to distribute whatever is conducted by the conduit outside of the multi-purpose beam 10 and in the case of a liquid or gas the access port 30 can be used to direct the liquid or gas into the conduit 18. Further, FIG. 12b identifies two cavities 16 conducting an airflow 15 and holes 26 that allow the flow of air to pass between the adjacent connected cavities.

FIG. 13 identifies how the dividers 14 can be utilized to form a skeletal structure 64. The skeletal structure 64 is then inserted by direction 63 into the hollow interior of the elongated tubular like structural member 12. Thus, a plurality of cavities 16 exist within the member 12. The skeletal structure 64 is fixedly attached in place to the elongated tubular like structural member 12 by well known means such as welding and bonding with materials having an epoxy base.

A multi-purpose support beam as disclosed herein does not necessarily depend upon independent shafts 54, independent skeletal structures 64, or independent dividers 14. Techniques such as, but not limited to, injection molding can produce a multi-purpose beam without relying on independent parts.

There has thus been described a novel multi-purpose beam. It is important to note that many configura-
tions can be constructed from the ideas presented. Thus, nothing in the specification should be construed to limit the scope of the claims.

What is claimed is:

1. A multi-purpose beam comprising:

an elongated tubular like structural member having a cross section selected from one of the group comprising generally oval, circular, box, triangular, or polygonal or a combination thereof, an external periphery, a length, and at least one divider disposed within, and along the length of, the elongated tubular like structural member defining a plurality of cavities;

a plurality of openings extending from at least one cavity within the elongated tubular like structural member through the external periphery; and

at least one cavity being adapted to receive a conduit.

2. The multi-purpose beam according to claim 1 wherein at least one cavity adapted to receive a conduit contains a conduit and the conduit conducts electricity.

3. The multi-purpose beam as in claim 2, further comprising at least one access port wherein the access port connects through an opening to the conduit such that electricity is accessible through the access port.

4. The multi-purpose beam according to claim 1 wherein at least one cavity adapted to receive a conduit contains a conduit and the conduit conducts the flow of a liquid.

5. The multi-purpose beam as in claim 4, further comprising at least one access port wherein the access port connects through an opening to the conduit such that the liquid is accessible through the access port.

6. The multi-purpose beam according to claim 1 wherein at least one cavity adapted to receive a conduit contains a conduit and the conduit conducts the flow of a gas.

7. The multi-purpose beam as in claim 6, further comprising at least one access port wherein the access port connects through an opening to the conduit such that the gas is accessible through the access port.

8. The multi-purpose beam according to claim 1 wherein at least one cavity is adapted to direct an airflow.

9. A multi-purpose beam comprising:

an elongated tubular like structural member having a cross section selected from one of the group comprising generally oval, circular, box, triangular, or polygonal or a combination thereof, an external periphery, a length, and a plurality of dividers disposed within, and along the length of, the elongated tubular like structural member defining at least three cavities;

a plurality of openings extending from at least one cavity within the elongated tubular like structural member through the external periphery;

two adjoining cavities having a common divider and a plurality of holes extending from one cavity through the common divider into the other adjoining cavity; and

at least one cavity being adapted to receive a conduit.

10. The multi-purpose beam according to claim 9 wherein at least one cavity adapted to receive a conduit contains a conduit and the conduit conducts electricity.

11. The multi-purpose beam as in claim 10 further comprising at least one access port wherein the access port connects through an opening to the conduit such that electricity is accessible through the access port.

12. The multi-purpose beam according to claim 9 wherein at least one cavity adapted to receive a conduit contains a conduit and the conduit conducts the flow of a liquid.

13. The multi-purpose beam as in claims 12 further comprising at least one access port wherein the access port connects through an opening to the conduit such that the liquid is accessible through the access port.

14. The multi-purpose beam according to claim 9 wherein at least one cavity adapted to receive a conduit contains a conduit and the conduit conducts the flow of a gas.

15. The multi-purpose beam as in claims 14 further comprising at least one access port wherein the access port connects through an opening to the conduit such that the gas is accessible through the access port.

16. The multi-purpose beam according to claim 9 wherein the cavities having adjoining holes conduct an airflow.

17. A multi-purpose beam comprising:

an elongated tubular like structural member comprised of a plurality of hollow elongated shafts each having a cross section selected from one of the group comprising generally oval, circular, box, triangular, or polygonal or a combination thereof, a length, an external periphery, and at least one wall defining a cavity;

at least one wall of each shaft being adjacent to one wall of another shaft and the adjacent walls being fixedly attached to one another;

a plurality of openings extending from at least one cavity within a hollow elongated shaft through the external periphery;

at least one cavity being adapted to conduct an air flow; and

at least one cavity being adapted to receive a conduit.

18. The multi-purpose beam according to claim 17 wherein at least one cavity adapted to receive a conduit contains a conduit that conducts electricity.

19. The multi-purpose beam as in claims 18 further comprising at least one access port wherein the access port connects through an opening to the conduit such that electricity is accessible through the access port.

20. The multi-purpose beam according to claim 17 wherein at least one cavity adapted to receive a conduit contains a conduit that conducts the flow of a liquid.

21. The multi-purpose beam as in claims 20 further comprising at least one access port wherein the access port connects through an opening to the conduit such that the liquid is accessible through the access port.

22. The multi-purpose beam according to claim 17 wherein at least one cavity adapted to receive a conduit contains a conduit that conducts the flow of a gas.

23. The multi-purpose beam as in claims 22 further comprising at least one access port wherein the access port connects through an opening to the conduit such that the gas is accessible through the access port.

24. The multi-purpose beam according to claim 17 wherein at least one cavity directs an airflow.

25. The multi-purpose beam according to claim 17 further comprising at least three shafts wherein holes extend from one cavity through the fixedly attached adjacent wall to another cavity and said cavities connected by the holes are adapted to conduct an airflow.
25. The multi-purpose beam according to claim 17 further comprising at least one divider disposed within, and along the length of, at least one hollow elongated shaft defining a plurality of cavities and at least one cavity being adapted to receive a conduit.

26. A multi-purpose beam comprising:

an elongated tubular like structural member comprised of a hollow elongated shaft having a cross section selected from one of the group comprising generally oval, circular, box, triangular, or polygonal or a combination thereof, a length, an external periphery, and at least one wall defining a hollow interior;

a skeletal structure wherein the hollow interior is adapted to receive the skeletal structure and the skeletal structure being displaced within the hollow interior is fixedly attached to the hollow elongated shaft and defines a plurality of cavities within the shaft;

a plurality of openings extending from at least one cavity as defined by the skeletal structure through the external periphery;

at least one cavity being adapted to conduct an airflow; and

at least one cavity being adapted to receive a conduit.

27. The multi-purpose beam according to claim 26 wherein at least one cavity adapted to receive a conduit contains a conduit that conducts electricity.

28. The multi-purpose beam as in claims 27 further comprising at least one access port wherein the access port connects through an opening to the conduit such that electricity is accessible through the access port.

29. The multi-purpose beam according to claim 26 wherein at least one cavity adapted to receive a conduit contains a conduit that conducts the flow of a liquid.

30. The multi-purpose beam as in claims 29 further comprising at least one access port wherein the access port connects through an opening to the conduit such that the liquid is accessible through the access port.

31. The multi-purpose beam according to claim 26 wherein at least one cavity adapted to receive a conduit contains a conduit that conducts the flow of a gas.

32. The multi-purpose beam as in claims 31 further comprising at least one access port wherein the access port connects through an opening to the conduit such that the gas is accessible through the access port.

33. The multi-purpose beam according to claim 26 wherein at least one cavity conduct an airflow.

34. The multi-purpose beam according to claim 26 wherein there are at least three cavities and a plurality of holes extending from one cavity through the skeletal structure into an adjacent cavity and said cavities being joined by the holes being adapted to conduct an airflow.

35. A method of constructing a multi-purpose beam from at least one divider, at least one conduit, and a plurality of hollow elongated shafts having adjoining walls and a plurality of openings, comprising the steps of:

joining the shafts together at the adjoining walls;

securing at least one divider within the hollow shaft thus producing a plurality of cavities; and

inserting at least one conduit within a cavity.

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