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AIR-CONTAINMENT SYSTEM BEAM

Abstract

An air-containment system beam includes a body having a first channel configured to receive a beam connector, a second channel configured to receive an air-containment panel, a third channel configured to receive at least one of a cabinet seal or a ceiling seal, and a fourth channel configured to receive at least one of a cabinet support or a ceiling panel support. The air-containment system beam further may include a fifth channel configured to receive at least one lighting support.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit under 35 U.S.C. § 119 to Chinese Patent Application No. 202410179006.3, filed Feb. 8, 2024, and titled AIR-CONTAINMENT SYSTEM BEAM, which is hereby incorporated herein by reference in its entirety for all purposes.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present disclosure relates to air-containment systems, and more particularly to a data center air-containment system beam that is configured to support a variety of components.

2. Discussion of Related Art

[0003] To control the flow of air throughout a data center, and to optimize the airflow through equipment racks provided in the data center, it may be desirable to contain the air in aisles to conserve energy and to lower cooling cost by managing airflow. As a result, air-containment systems have been developed to contain and manage air within the data center.

[0004] The prevailing structures and methods for air-containment within data centers are limited to containment structures that are self-supporting or supported by other data center equipment, e.g., equipment racks.

[0005] In one known freestanding air-containment system, fully configured IT equipment racks can be deployed or removed from the system, as necessary. This type of freestanding air-containment system is difficult to customize to meet various customer demands.

[0006] Another type of air-containment system includes a barrier between the hot exhaust and cold intake air streams in the IT environment. The separation of the hot and cold air streams in the IT environment increases the efficiency and effectiveness of the cooling system that supports the critical IT equipment. The separation also allows for an elevated supply-air temperature to be provided by the cooling system since the mixing of hot and cold air is eliminated. This type of system is compatible with row, room, or external cooling solutions and available for cold or hot aisle containment.

[0007] Another type of air-containment system includes structural ceilings used to hang components of the air-containment system. Such structural ceilings are prefabricated and offer limited flexibility in design and arrangement.

SUMMARY OF THE INVENTION

[0008] One aspect of the present disclosure is directed to an air-containment system beam, comprising a body including a first channel configured to receive a beam connector, a second channel configured to receive an air-containment panel, a third channel configured to receive at least one of a cabinet seal or a ceiling seal, and a fourth channel configured to receive at least one of a cabinet support or a ceiling panel support.

[0009] Embodiments of the air-containment system beam further may include a fifth channel configured to receive at least one lighting support. The fifth channel may be an open channel positioned at a corner of the body. The first channel may be a closed channel positioned within a middle of the body. The second channel may be an open channel positioned at a side of the body. The third channel may be an open channel positioned at a top or a bottom of the body. The fourth channel may be an open channel positioned at a top or a bottom of the body. The third channel may include at least one of an upwardly facing channel formed in the body and a downwardly facing channel formed in the body. The fourth channel may include at least one of an upwardly facing channel formed in the body and a downwardly facing channel formed in the body. The beam may be fabricated from extruded PVC material. The air-containment system beam further may include a connector configured to secure a first beam to a second beam. The connector may include a straight connector configured to connect mating ends of the first beam and the second beam along a common axis. The connector may include an angled connector configured to connect mating ends of the first beam and the second beam, with the second beam being perpendicular to the first beam.

An air-containment structure includes the air-containment system beam.
[0010] Another aspect of the present disclosure is directed to a method of fabricating an air-containment system beam. In one embodiment, the method comprises: forming a first channel in an extruded body, the first channel being configured to receive a beam connector; forming a second channel in the body, the second channel being configured to receive an air-containment panel; forming a third channel in the body, the third channel being configured to receive at least one of a cabinet seal or a ceiling seal; and forming a fourth channel in the body, the fourth channel being configured to receive at least one of a cabinet support or a ceiling panel support.
[0011] Embodiments of the method further may include forming a fifth channel in the body, with the fifth channel being configured to receive at least one lighting support. The fifth channel may be an open channel positioned at a corner of the body. The first channel may be a closed channel positioned within a middle of the body. The second channel may be an open channel positioned at a side of the body. The third channel may be an open channel positioned at a top or a bottom of the body. The fourth channel may be an open channel positioned at a top or a bottom of the body. The method of claim **15**, wherein the third channel includes at least one of an upwardly facing channel formed in the body and a downwardly facing channel formed in the body. The fourth channel may include at least one of an upwardly facing channel formed in the body and a downwardly facing channel formed in the body. The beam may be fabricated from extruded PVC material. The method further may include securing a connector to a first beam and to a second beam. The connector may include a straight connector configured to connect mating ends of the first beam and the second beam along a common axis. The connector may include an angled connector configured to connect mating ends of the first beam and the second beam, with the second beam being perpendicular to the first beam.
[0012] The present disclosure will be more fully understood after a review of the following figures, detailed description and claims.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0013] In the drawings, each identical or nearly identical component that is illustrated in various figures is represented by a like numeral. For purposes of clarity, not every component may be labeled in every drawing. For a better understanding of the present disclosure, reference is made to the figures which are incorporated herein by reference and in which:
[0014] FIG. **1** is a perspective view of an air-containment system beam of an embodiment of the present disclosure;
[0015] FIG. **2** is a cross-sectional view of the beam shown in FIG. **1**;
[0016] FIG. **3** is a perspective cross-sectional view of an air-containment system beam of another embodiment of the present disclosure, the beam being shown supporting components of an air-containment system;
[0017] FIG. **4** is a cross-sectional view of the beam shown in FIG. **3**;
[0018] FIG. **5** is a perspective view of a mounting rail connector;
[0019] FIG. **6** is a side view of a ceiling seal;
[0020] FIG. **7** is a side view of a cabinet seal;
[0021] FIG. **8** is a perspective view of a multi-wall panel;
[0022] FIG. **9** is a cross-sectional view of a panel connector;
[0023] FIG. **10** is a cross-sectional view of a mounting rail;
[0024] FIG. **11** is a cross-sectional view of a lighting mounting rail;
[0025] FIG. **12** is a perspective view of a light emitting diode (LED) module;
[0026] FIG. **13** is a perspective view of a portion of an air-containment system showing corner

brackets used to secure adjacent beams at a corner of the air-containment system;
[0027] FIG. **14** is another perspective view of the portion of the air-containment system shown in FIG. **13**;
[0028] FIG. **15** is a perspective view of connectors used to connect butt ends of adjacently placed beams;
[0029] FIG. **16** is a perspective view of a tool used to secure a corner bracket to a beam; and
[0030] FIGS. **17-22** are perspective views showing exemplary configurations of air-containment systems.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0031] For the purposes of illustration only, and not to limit the generality, the present disclosure will now be described in detail with reference to the accompanying figures. This disclosure is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the drawings. The disclosure is capable of other embodiments and of being practiced or being carried out in various ways. Also the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of “including,” “comprising,” “having,” “containing,” “involving,” and variations thereof herein, is meant to encompass the items listed thereafter and equivalents thereof as well as additional items.
[0032] A typical data center may be designed to house a number of equipment racks, which are designed to house electronic equipment including but not limited to data processing, networking and telecommunications equipment. Each equipment rack may be configured to include a frame or housing adapted to support the electronic equipment. The housing includes a front, a back, opposite sides, a bottom and a top. The front of each equipment rack may include a front door so as to enable access into the interior of the equipment rack. The sides of the equipment rack may include one or more panels to enclose the interior region of the rack. The back of the equipment rack may also include one or more panels or a back door to provide access to the interior of the equipment rack from the back of the rack. In certain embodiments, the side and back panels, as well as the front door and the rear door, may be fabricated from perforated sheet metal, for example, to allow air to flow into and out of the interior region of the equipment rack. In other embodiments, the front door may include a removable panel.
[0033] The equipment racks are modular in construction and configured to be rolled into and out of position, e.g., within a row of the data center. Once in position, electronic equipment may be positioned in the interior region of the equipment rack. For example, the equipment may be placed on shelving secured within the interior region of the equipment rack. Cables providing electrical and data communication may be provided through the top of the equipment rack either through a cover (or “roof”) at the top of the equipment rack having openings formed therein or through an open top of the equipment rack.
[0034] Data centers may be configured with rows of equipment racks arranged such that cool air is drawn into the racks from a cool aisle and warm or hot air is exhausted from the racks into a hot aisle. In one embodiment, the equipment racks may be arranged in two rows with the fronts of the equipment racks in a near row being arranged in a forward direction and the backs of the equipment racks in a far row being arranged in a rearward direction. However, as stated above, in a typical data center, there may be multiple rows of equipment racks in which the rows may be arranged with the fronts of the equipment racks facing one another to define the cold aisle and with the backs of the equipment racks facing one another to define the hot aisle. In other configurations, the hot or cold aisle may be disposed between a wall and a row of equipment racks. For example, a row of equipment racks may be spaced from a wall with the backs of the equipment racks facing the wall to define a hot aisle between the wall and the row of equipment racks.
[0035] To address the heat build-up and hot spots within the data center or equipment room, and to address climate control issues within the data center or room in general, a cooling system may be

provided. In one configuration, the cooling system may be provided as part of the data center infrastructure. In another configuration, the data center's cooling system may be supplemented with the CRAC and/or CRAH. With yet another configuration, a modular cooling system may be provided in which modular cooling racks are interspersed within the rows of equipment racks.
[0036] In one embodiment, a management system may be provided to monitor and display conditions of the equipment racks, including the cooling racks. The management system may operate independently to control the operation of the equipment and cooling racks, and may be configured to communicate with a higher level network manager or with a management system associated with the data center. In certain circumstances, it may be desirable control the airflow within the hot and cold aisles, and in the hot aisles in particular. Typically, heat generated from electronic components housed within the equipment racks is exhausted out of the backs of the equipment racks into the hot aisles. It may be desirable to contain the hot air for conditioning by a cooling unit, such as the modular cooling unit described above.
[0037] At least some embodiments of the present disclosure are directed to an air-containment system including a frame structure that is easy to assemble and provides a single, integrated unit that encloses the aisle while facilitating the conveyance of cooling, electrical, and communication/networking equipment. In one embodiment, the air-containment system includes a frame structure having end frames and cross frames that can be easily assembled without the use of tools. The air-containment system further includes cantilevered arms that support equipment, including cable trays specifically designed to support cables. The air-containment system further includes an air duct support that is integrated with roof or ceiling panels.
[0038] Embodiments of the present disclosure are directed to a beam used to fabricate an air-containment system. The beam can be used to mount an air-containment system of IT equipment racks or to hang from a ceiling support structure, with flexible transmission between a horizontal roof and a vertical duct. In some embodiments, the beam is fabricated from extruded polyvinylchloride (PVC) material, which can be cut onsite to desired lengths as needed. The beam, along with associated panels and accessories, can be used to create other types of containment.
[0039] In some embodiments, the beam is designed to simplify and reduce the time and cost of installing the air-containment system.
[0040] In some embodiments, the beam can be used with one or more corner connectors to create a frame of the air-containment system. Such a corner connector can be secured in place with screw fasteners by a tool, such as a hex wrench.
[0041] In some embodiments, the beam enhances the ability to design and fit the air-containment system around obstructions.
[0042] In some embodiments, the other accessories, such as panels, seals, hanging kits and rack support kits, can be used with the beam to create and construction many kinds of horizontal and vertical air-containment structures.
[0043] Referring now to the drawings, and more particularly to FIGS. **1** and **2**, an air-containment system beam, sometimes simply referred to herein as a beam, is generally indicated at **10**. In one embodiment, the beam **10** is fabricated from extruded plastic material, such as PVC, and is used to support components of an air-containment system. Specifically, the beam **10** is designed to include several discrete channels, each being provided to releasably secure and support a particular component. The beam **10** is designed to provide flexibility to the person designing the air-containment system. Since the beam **10** is fabricated from plastic material, an installer can easily cut the beam to a desired length during installation on location. A skill saw or other type of saw can be used by the person installing the air-containment system to cut the beam to a desired length.
[0044] In one embodiment, the beam **10** includes a body **12** having several individual channels, each provided for a specific purpose. In the shown embodiment, the body **12** of the beam **10** includes a first channel **14**, a second channel **16**, two third channels **18**, **20**, two fourth channels **22**, **24**, and a fifth channel **26**. The first channel **14** is formed centrally within the body **12** along the

length of the body. The first channel **14** is provided to receive a beam connector, such as beam connector **28**, to secure an end of the beam **10** with an end of an adjacently placed beam. The beam connector **28** used to secure the ends of the beams together is described below. The first channel **14** defines a cavity or recess through which a body of the beam connector is secured thereby securing the adjacent beams to one another. As shown, the first channel **14** is a closed channel positioned within a middle or centrally of the body, and includes several inwardly extending flanges, each indicated at **30**, which are used to engage and position the body of the beam connector.

[0045] The beam connector **28** can be configured to include a body having a cross section that is sized and shaped to fit within the opening formed by the first channel **14**. The flanges **30** of the beam **10** are provided to engage an outer surface of the body of the beam connector **28**. The arrangement is such that the body of the beam connector **28** can move axially within the opening of the first channel **14**, with the flanges **30** preventing lateral movement of the beam **10** with respect to the beam connector. The beam connector **28** can be configured to connect and secure beams that are co-axial with respect to one another or perpendicular with respect to one another to form corners of the air-containment system.

[0046] The body **12** of the beam **10** further includes the second channel **16** formed along a side of the body. The second channel **16** is provided to receive a portion, such as panel portion **32**, of an air-containment panel, which is described below. The second channel **16** defines a slot that is designed and configured to receive the panel portion **32** of the air-containment panel therein. The air-containment panel is provided to enclose the space defined by the air-containment system. The second channel **16** is an open channel positioned at the side of the body and includes two oppositely positioned open recesses, each indicated at **34**, which are used to receive structural elements of the panel portion **32** of the air-containment panel to secure and support the panel portion (and the panel) to the beam **10**.

[0047] The panel can be configured to include the panel portion **32**, which are disposed on peripheral edges of the panel. Each panel portion **32** has a cross section that is sized and shaped to fit within the second channel **16**. Specifically, the panel portion **32** includes features that are sized to fit within the recesses **34** formed in the second channel **16**. The panel portion **32** extends from the panel, with the panel forming part of the air-containment system. The arrangement is such that the panel portion **32** of the panel can move axially within the second channel **16**, with the features of the panel portion preventing lateral movement of the beam **10** with respect to the panel.

[0048] The body **12** of the beam **10** further includes the two third channels **18**, **20**, which are formed along a top and a bottom of the body, respectively. As shown, the third channel **18** is an upwardly facing open channel provided to receive a ceiling seal portion **36** of a ceiling seal. The third channel **20** is a downwardly facing open channel provided to receive a cabinet seal portion **38** of a cabinet seal. The third channels **18**, **20** each define a slot that is designed and configured to receive its respective seal portion **36**, **38** thereby creating an airtight seal to contain air within the air-containment system. Third channel **18** includes two oppositely positioned open recesses, each indicated at **40**, which are used to receive the ceiling seal portion **36** of the ceiling seal to secure the ceiling seal in place. Similarly, third channel **20** includes two oppositely positioned open recesses, each indicated at **42**, which are used to receive cabinet seal portion **38** of the cabinet seal to secure the cabinet seal in place.

[0049] The ceiling seal can be configured to include the ceiling seal portion **36**, which is configured to engage and releasably connect to the ceiling seal within the third channel **18**. The ceiling seal portion **36** has a cross section that is sized and shaped to fit within the third channel **18**. Specifically, the ceiling seal portion **36** includes features that are sized to fit within the recesses **40** formed in the third channel **18**. In one embodiment, the ceiling seal forms an inverted U-shape seal that is designed to engage and seal a ceiling. The cabinet seal can be configured to include the cabinet seal portion **38**, which is configured to engage and releasably connect to the cabinet seal within the third channel **20**. The cabinet seal portion **38** has a cross section that is sized and shaped

to fit within the third channel **20**. Specifically, the cabinet seal portion **38** includes features that are sized to fit within the recesses **42** formed in the third channel **20**. The cabinet seal forms a sheet or barrier for the air-containment system.

[0050] The body **12** of the beam **10** further includes the two fourth channels **22**, **24** formed along a top and a bottom of the body, respectively. As shown, the fourth channels **22**, **24** are located next to their respective third channels **18**, **20**, with the fourth channels **22**, **24** being narrower than the third channels **18**, **20**. The fourth channel **22** is an open channel provided to receive a ceiling support **44**. The fourth channel **24** is an open channel provided to receive a cabinet support **46**. The fourth channels **22**, **24** each define a slot that is designed and configured to receive its respective support **44**, **46** thereby providing support to the ceiling and cabinet.

[0051] The ceiling support **44** can be configured to include a body having a cross section that is sized and shaped to fit within the fourth channel **22**. Similarly, the cabinet support **46** can be configured to include a body having a cross section that is sized and shaped to fit within the fourth channel **46**.

[0052] The body **12** of the beam **10** further includes the fifth channel **26** formed at a corner of the body between the side of the body having the second channel **16** and the bottom of the body having the third channel **20**. The purpose of the fifth channel is to support a lighting fixture to illuminate the interior of the air-containment system. The fifth channel **26** defines a slot that is designed and configured to receive a flange **48** or other type of support structure of the lighting fixture to releasably secure the lighting fixture in place. As shown, the fifth channel **26** is an open channel positioned at a corner of the body **12**.

[0053] The lighting fixture can be configured to include the flange **48** and a light emitting diode (LED) module supported by the flange. As shown, the flange **48** has a cross section configured to be releasably secured within the fifth channel **26** of the body **12** of the beam **10**. The LED module is provided to illuminate the interior of the air-containment system.

[0054] Referring to FIGS. **3** and **4**, an air-containment system beam of another embodiment is generally indicated at **50**. In the shown embodiment, as with beam **10**, the beam **50** is fabricated from extruded plastic material and is used to support components of an air-containment system. The beam **50** is constructed similarly as beam **10** with the differences noted below. The beam **50** is designed to include several discrete channels, each being provided to support a particular component. The beam **50** is designed to provide flexibility to the person designing the air-containment system. Since the beam **50** is fabricated from plastic material, an installer can easily cut the beam to a desired length during installation.

[0055] In one embodiment, the beam **50** includes a body **52** having several individual channels, each provided for a specific purpose. In the shown embodiment, the body **52** of the beam **50** includes a main channel **54**, two first channels **56**, **58**, two second channels **60**, **62**, two third channels **64**, **66** and two fourth channels **68**, **70**. The main channel **54** provides structural integrity to the beam **50**, and extends along a length of the beam. As shown, the main channel **54** divides the beam **10** between an upper portion and a lower portion. A height of beam **50** is greater than a height of beam **10**, with the main channel **54** providing added support and rigidity to the beam to enable the beam to support greater weights.

[0056] The body **52** of the upper portion of the beam **50** includes the first channel **56** formed within the body above the main channel **54** and along the length of the body of the beam. The first channel **56** is provided to receive a beam connector, similar to beam connector **28**, to secure an end of the beam **50** with an end of an adjacently placed beam. The first channel **56** defines a cavity or recess through which a body of the beam connector is secured thereby securing the adjacent beams to one another. As shown, the first channel **56** is a closed channel, and can be sized to snugly fit the body of the beam connector.

[0057] The body **52** of the lower portion of the beam **50** further includes the first channel **58** formed within the body below the main channel **54** and along the length of the body of the beam.

The first channel **58** is provided to receive a beam connector, similar to beam connector **28**, to further secure an end of the beam **50** with an end of an adjacently placed beam. The first channel **58** defines a cavity or recess through which a body of the beam connector is secured thereby securing the adjacent beams to one another. As shown, the first channel **58** is a closed channel, and can be sized to snugly fit the body of the beam connector.

[0058] The body **52** of the upper portion of the beam **50** further includes the second channel **60** formed along a side of the body of the beam. The second channel **60** is provided to receive an air-containment panel, and defines a slot that is designed and configured to receive a flange or other type of support structure of the air-containment panel therein. The second channel **60** is an open channel positioned at the side of the body. Similarly, the body **52** of the lower portion of the beam **50** further includes the second channel **62** formed along a side of the body. The second channel **62** is provided to receive a lighting fixture to illuminate an interior of the air-containment system. The second channel **62** defines a slot that is designed and configured to receive a flange or other type of support structure of the air-containment panel therein. The second channel **62** is an open channel positioned at the side of the body **52** below the second channel **62**.

[0059] The body **52** of the upper portion of the beam **50** further includes the third channel **64** formed along a top of the body of the beam. As shown, the third channel **64** is an upwardly facing open channel provided to receive a ceiling seal. Similarly, the body **52** of the lower portion of the beam **50** further includes the third channel **66** formed along a bottom of the body of the beam. As shown, the third channel **66** is a downwardly facing open channel provided to receive a cabinet seal. The third channels **64**, **66** each define a slot that is designed and configured to receive its respective seal thereby creating an airtight seal to contain air within the air-containment system.

[0060] The body **52** of the upper portion of the beam **50** further includes the fourth channel **68** formed along a top of the body of the beam. As shown, the fourth channel **68** is located next to its respective third channel **64**, with the fourth channel **68** being narrower than the third channel **64**. The fourth channel **68** is an open channel provided to receive a ceiling support. Similarly, the body **52** of the lower portion of the beam **50** further includes the fourth channel **70** formed along a bottom of the body of the beam. As shown, the fourth channel **70** is located next to its respective third channel **66**, with the fourth channel **70** being narrower than the third channel **66**. The fourth channel **70** is an open channel provided to receive a cabinet support. The fourth channels **68**, **70** each define a slot that is designed and configured to receive its respective support thereby providing support to the ceiling and cabinet.

[0061] As noted above with reference to the beam connector **28** used with beam **10**, for each first channel **56**, **58**, a beam connector can be configured to include a body having a cross section that is sized and shaped to fit within the opening formed by the first channel **56**, **58**. The arrangement is such that the body of the beam connector can move axially within the opening of the first channel **56**, **58**, while preventing lateral movement of the beam connector with respect to the beam. The beam connector can be configured to connect and secure beams that are co-axial with respect to one another or perpendicular with respect to one another to form corners of the air-containment system.

[0062] Referring to FIG. **5**, a mounting rail connector is generally indicated at **72**. As shown, the mounting rail connector **72** is shaped to fit within each of the second channels **60**, **62** of the body **52** of the beam **50**. The mounting rail connector **72** includes a flange portion **74** that is shaped and sized to fit within each of the second channels **60**, **62** and a support portion **76** integrally formed with the flange portion. Specifically, the flange portion **74** of the mounting rail connector **72** has a cross section that is shaped and sized to fit within each of the second channels **60**, **62** of the body **52** of the beam **50**. The support portion **76** of the mounting rail connector **72** is configured to support components of the air-containment system. For each second channel **60**, **62**, the arrangement is such that the flange portion **74** can move axially within the second channel, while preventing lateral movement of the mounting rail connector **72** with respect to the body **52** of the

beam **50**.
[0063] For example, referring additionally to FIGS. **6** and **7**, the mounting rail connector **72** is configured to support a ceiling seal (FIG. **6**), generally indicated at **78**, and a cabinet seal (FIG. **7**), generally indicated at **80**. As shown, the ceiling seal **78** includes a support structure **82** that is configured to engage and releasably connect to the mounting rail connector **72** on the third channel **64** and a seal **84** that is connected to the support structure. The seal **84** forms an inverted U-shape seal that is designed to engage and seal the beam **50** to a ceiling. Similarly, the cabinet seal **80** includes a support structure **86** that is configured to engage and releasably connect to the mounting rail connector **72** on the third channel **66** and a seal **88** that is connected to the support structure. The seal **88** forms a sheet or barrier for the air-containment system.
[0064] Referring to FIGS. **8**-**10**, components of a panel connector assembly are shown. Specifically, FIG. **8** shows a multi-wall panel is indicated at **90**, FIG. **9** shows a panel connector indicated at **92**, and FIG. **10** shows a mounting rail indicated at **94**. The multi-wall panel **90** can be used to form sides and the ceiling of the air-containment system. With reference to FIGS. **3** and **4**, the panel connector **92** is configured to be releasably secured to the second channel **60** of the body **52** of the beam **50** and to the mounting rail **94**. The purpose of the panel connector **92** is to secure the mounting rail **94** to the beam. Once secured, the mounting rail **94** is configured to releasably secure the multi-wall panel **90** at an edge of the multi-wall panel. In the shown embodiment, the multi-wall panel **90** is disposed horizontally; however, the beam **50** can be oriented in a manner in which the multi-wall panel is disposed vertically.
[0065] Referring to FIGS. **11** and **12**, components of a lighting fixture assembly are shown. Specifically, FIG. **11** shows a lighting mounting rail indicated at **96** and FIG. **12** shows a light emitting diode (LED) module indicated at **98**. With reference to FIG. **4**, the lighting mounting rail **96** is configured to be releasably secured to the second channel **62** of the body **52** of the beam **50** and to the LED module **98** (lighting fixture). The LED module **98** is provided to illuminate an interior of the air-containment system, and may be connected to a suitable power source and to a switch to activate the LED module.
[0066] Referring to FIGS. **13** and **14**, angled corner brackets or connectors **100**, **102** are used to secure adjacent beams, e.g., beams **50**, at a corner of the air-containment system. As shown, the air-containment system at a corner of the air-containment system includes a first type of L-shaped bracket **100** configured to engage an upper horizontal surfaces of the beams **50** forming the corner. The air-containment system at the corner further includes a second type of L-shaped bracket **102** configured to engage horizontal inner surfaces of the beams **50** forming the corner and configured to engage vertical and horizontal inner surfaces of the beams forming the corner. Screw fasteners, each indicated at **104**, are used to secure the brackets **100**, **102** to the beams **50**. In one embodiment, the screw fastener **104** is a self-tapping screw.
[0067] Referring to FIG. **15**, several connectors, each indicated at **106**, are used to connect butt ends of adjacently placed beams **50**. As shown, the butt ends of the beams **50** are spaced apart from one another, with each straight connector **106** being seated within a channel, each indicated at **108**, formed in an outer surface of the beam. The arrangement is that the butt ends of the beams **50** are moved toward one another so as to engage one another, with the connectors **106** being secured to the beams by screw fasteners, such as self-tapping screws.
[0068] Referring to FIG. **16**, a tool, such as Allen wrench **110**, can be used to secure the brackets in place. Specifically, the Allen wrench **110** can be used to secure the screw fasteners used for the brackets **100**, **102** and for the connector **106**.
[0069] In some embodiments, a method of fabricating an air-containment system beam may include forming a first channel in an extruded body, the first channel being configured to receive a beam connector, forming a second channel in the body, the second channel being configured to receive an air-containment panel, forming two third channels in the body, the third channels being configured to receive a cabinet seal and a ceiling seal, and forming two fourth channels in the body,

the fourth channels being configured to receive a cabinet support and a ceiling panel support. In one embodiment, the method further includes forming a fifth channel in the body, the fifth channel being configured to receive at least one lighting support fixture. The method can include an extrusion process of plastic material, such as PVC material.

[0070] In another embodiment, a method of fabricating an air-containment system beam may include forming a main channel in an extruded body, forming two first channels in the body, the first channels each being configured to receive a beam connector, forming two second channels in the body, the second channels being configured to receive an air-containment panel and a lighting support fixture, forming two third channels in the body, the third channels being configured to receive a cabinet seal and a ceiling seal, and forming two fourth channels in the body, the fourth channels being configured to receive a cabinet support and a ceiling panel support. As with the aforementioned method, the method can include an extrusion process of plastic material, such as PVC material.

[0071] A data center can be configured to have rows of equipment racks, with aisles being disposed between the rows of equipment racks. In one embodiment, a row of equipment racks is positioned so that the fronts of the equipment racks face outwardly and a second row of equipment racks may be positioned on an opposite side of the aisle so that the fronts of the equipment racks face outwardly and the backs of the equipment racks face the backs of the row of equipment racks. In certain embodiments, one or more equipment racks may be replaced by a cooling rack to provide cooling to the aisle.

[0072] In one embodiment, the rows of equipment racks can be arranged so that hot air is exhausted through the backs of the equipment racks into the aisle. Conversely, the rows of equipment racks can be arranged so that cold air is deposited into the aisle through one or more air duct systems. In another embodiment, air can be directed to escape the aisle above the equipment racks. As is well known, warm air rises, thus creating a situation in which the ceiling of the data center may become too warm. This situation may negatively affect the climate control within the data center. An air-containment system of an embodiment of the present disclosure is designed to control the flow of warm air within the data center, and within the space between the equipment racks. The air-containment system is further configured to efficiently accommodate cooling, electrical and communication/networking equipment.

[0073] In some embodiments, an air-containment system includes a frame structure having beams, such as beams **10**, **50**, which provide the main structural components of the air-containment system. As described, the air-containment system further includes connectors, closures, wall and ceiling panels and other accessories used to complete the air-containment system. Embodiments of the air-containment system enable equipment racks and other floor standing, rolling or otherwise transportable equipment to be rolled, inserted, or otherwise moved and removed into and out of the frame structure of the air-containment system, without being encumbered by piping, ductwork, raceways containing wires, cables, and other means of conveyance of electricity, thermal energy, data, and other transferable media, which shall be supported by the frame structure. In certain embodiments, the air-containment system can include means of conveyance that are specific to data center architecture, include electrical conduits, fire suppression pipes, chilled water pipes, “supply” and/or “return” air ducts and other similar guides, channels, or raceways, are intended to attached to the frame structure instead of the overhead structure of the building. For example, the frame structure may be modified to support chilled water pipes.

[0074] Referring to FIGS. **17**-**22**, exemplary configurations of air-containment systems are shown. For example, FIG. **17** shows a low profile air-containment system **112** disposed over an aisle between two rows of equipment racks. FIG. **18** shows a higher profile air-containment system **114** disposed over an aisle between two rows of equipment racks. FIG. **19** shows a low profile air-containment system **116** disposed over an aisle between one row of equipment racks and a wall. FIG. **20** shows a high profile air-containment system **118** disposed over an aisle between one row

of equipment racks and a wall. FIG. **21** shows a high profile air-containment system **120** supported by a structure configured to elevate the air-containment system. FIG. **22** shows another high profile air-containment system **122** supported by another type of structure configured to elevate the air-containment system. During installation, the beams are assembled with one another to create the desired configuration.

[0075] Having thus described at least one embodiment of the present disclosure, various alternations, modifications and improvements will readily occur to those skilled in the art. Such alterations, modifications and improvements are intended to be within the scope and spirit of the disclosure. Accordingly, the foregoing description is by way of example only and is not intended to be limiting. The disclosure's limit is defined only in the following claims and equivalents thereto.

Claims

1. An air-containment system beam, comprising: a body including a first channel configured to receive a beam connector, a second channel configured to receive an air-containment panel, a third channel configured to receive at least one of a cabinet seal or a ceiling seal, and a fourth channel configured to receive at least one of a cabinet support or a ceiling panel support.

2. The air-containment system beam of claim 1, further comprising a fifth channel configured to receive at least one lighting support.

3. The air-containment system beam of claim 2, wherein the fifth channel is an open channel positioned at a corner of the body.

4. The air-containment system beam of claim 1, wherein the first channel is a closed channel positioned within a middle of the body.

5. The air-containment system beam of claim 1, wherein the second channel is an open channel positioned at a side of the body.

6. The air-containment system beam of claim 1, wherein the third channel is an open channel positioned at a top or a bottom of the body.

7. The air-containment system beam of claim 1, wherein the fourth channel is an open channel positioned at a top or a bottom of the body.

8. The air-containment system beam of claim 1, wherein the third channel includes at least one of an upwardly facing channel formed in the body and a downwardly facing channel formed in the body.

9. The air-containment system beam of claim 1, wherein the fourth channel includes at least one of an upwardly facing channel formed in the body and a downwardly facing channel formed in the body.

10. The air-containment system beam of claim 1, wherein the beam is fabricated from extruded PVC material.

11. The air-containment system beam of claim 1, further comprising a connector configured to secure a first beam to a second beam.

12. The air-containment system beam of claim 11, wherein the connector includes a straight connector configured to connect mating ends of the first beam and the second beam along a common axis.

13. The air-containment system beam of claim 11, wherein the connector includes an angled connector configured to connect mating ends of the first beam and the second beam, the second beam being perpendicular to the first beam.

14. An air-containment structure comprising the air-containment system beam of claim 1.

15. A method of fabricating an air-containment system beam, the method comprising: forming a first channel in an extruded body, the first channel being configured to receive a beam connector; forming a second channel in the body, the second channel being configured to receive an air-containment panel; forming a third channel in the body, the third channel being configured to

receive at least one of a cabinet seal or a ceiling seal; and forming a fourth channel in the body, the fourth channel being configured to receive at least one of a cabinet support or a ceiling panel support.

16. The method of claim 15, wherein the first channel is a closed channel positioned within a middle of the body, the second channel is an open channel positioned at a side of the body, the third channel is an open channel positioned at a top or a bottom of the body, and the fourth channel is an open channel positioned at a top or a bottom of the body.

17. The method of claim 15, further comprising forming a fifth channel in the body, the fifth channel being configured to receive at least one lighting support.

18. The method of claim 17, wherein the fifth channel is an open channel positioned at a corner of the body.

19. The method of claim 15, further comprising securing a connector to a first beam and to a second beam.

20. The method of claim 19, wherein the connector includes at least one of a straight connector configured to connect mating ends of the first beam and the second beam along a common axis and an angled connector configured to connect mating ends of the first beam and the second beam, the second beam being perpendicular to the first beam.