The modular fixturing system of the present invention is modular, reusable and capable of significant customization, both in terms of system radius and system height, allowing it to be arranged and rearranged in numerous unique configurations. The system includes multiple modular stanchions having stanchion shafts and stanchion feet that removably attach to apertures in a table. Angle brackets attached to the modular stanchions support shelves. These shelves in turn provide support to work pieces during fabrication processes such as welding.

20 Claims, 12 Drawing Sheets
MODULAR FIXTURING SYSTEM

CROSS-REFERENCES TO RELATED APPLICATIONS

The invention described herein was made by an employee of the United States Government and may be manufactured and used by the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefore.

BACKGROUND OF THE INVENTION

1. Field of Invention
This invention relates to the field of metal fabrication and more specifically to a fixturing system capable of holding components in place for large-scale fabrication projects.

2. Description of Related Art
NASA and the aerospace industry require highly specialized equipment for the fabrication of rockets and other aerospace vehicles. These projects require assembly and manipulation of large components with very low error tolerance. For example, in 2014, NASA developed a specialized Vertical Assembly Center to construct the 200-foot-tall core stage for a massive rocket designed for extended manned missions.

Welding and fabrication processes require the use of frameworks to secure rocket components in place during fabrication. Currently, large-scale fixturing systems known in the art are constructed from stationary pipes and rods, which are joined to form a framework. Movable components referred to as shoes extend from the pipes and rods to provide for precise positional adjustments. When fabrication is complete, this framework must be disassembled or stored using large amounts of storage space.

Reusable fixturing systems known in the art cannot withstand the heavy loads or meet stress requirements necessary for rocket fabrication. The use of easily disassembled modular components introduces unacceptable error to the assembly process due to deformation and misalignment of components during assembly. Misalignment may not be visible during fabrication, but can render a finished object unusable.

There is an unmet need in the art for a modular fixturing system capable of accommodating large-scale fabrication projects, such as rockets and other spacecraft.

SUMMARY OF THE INVENTION

The present invention is a novel modular stanchion system constructed using a plurality of stanchions, shelves and brackets in place of pipes and rods. Each modular stanchion includes a stanchion shaft connected to at least one stanchion foot. This stanchion foot connects to an aperture in a table. The stanchion shaft has apertures used to connect objects to the stanchion and to connect the stanchion to other objects. Angle brackets connect to the modular stanchions, and shelves connect to the angle brackets. Each of the angle brackets includes a bracket platform component and an upright component. The bracket platform and upright components include apertures. The shelves have a substantially planar configuration. Each of the shelves includes apertures. Fasteners extend through the stanchion, bracket and shelf apertures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1a-1c illustrate perspective views of first and second configurations and a partial side view of the second configuration, respectively, of an exemplary embodiment of a modular stanchion system (MSS).

FIGS. 2a and 2b illustrate side and partial top views, respectively, of an exemplary embodiment of a modular stanchion with an optional fixed angle support.

FIG. 2c illustrates a side view of an exemplary embodiment of a modular stanchion with an optional adjustable angle support.

FIG. 2d illustrates a perspective view of an exemplary embodiment of a stanchion extension.

FIG. 3 illustrates a perspective view of an exemplary embodiment of a turnbuckle.

FIGS. 4a and 4b illustrate top and perspective views, respectively, of an exemplary embodiment of a knuckle.

FIGS. 5a-5c illustrate front, side and perspective views, respectively, of an exemplary embodiment of an angle bracket.

FIGS. 6a-6c illustrate top, front and perspective views, respectively, of an exemplary embodiment of a shelf, while FIG. 6d illustrates a front view of an exemplary embodiment of the shelf mounted to angle brackets.

FIGS. 7a-7c illustrate perspective, exploded and top views, respectively, of an exemplary embodiment of a shoe assembly.

TERMS OF ART

As used herein, the term “angle bracket” means a substantially right-angled support attached to and projecting from a surface having a vertical component.

As used herein, the term “brace” means an optional support attachment.

As used herein, the term “cap” means a component connected to a stanchion shaft and contacting a component being fabricated.

As used herein, the term “clevis” means a substantially U-shaped connector within which another part can be fastened by means of a pin passing through apertures in the connector.

As used herein, the term “foot” means a component capable of connecting to a stanchion shaft and a table.

As used herein, the term “knuckle” means a joint capable of rotation in at least one direction.

As used herein, the term “modular” means capable of being selectively attached, removed or changed.

As used herein, the term “rotatably” means capable of revolving around an axis.

As used herein, the term “shaft” means the primary portion of a stanchion that extends at least partially vertically.

As used herein, the term “stanchion” means a bar or post assembly extending at least partially vertically.

As used herein, the term “table” means a component or base to which one or more modular stanchions are secured.

As used herein, the term “turnbuckle” means a coupling using a threaded connection to adjust the tension or distance between two points.

DETAILED DESCRIPTION

FIGS. 1a-1c illustrate perspective views of first and second configurations and a partial side view of the second configuration, respectively, of an exemplary embodiment of MSS 100. MSS 100 mounts to a table 10 having a plurality of table apertures 11. In the exemplary embodiment, table 10 is a fixed rectangular table, fixed round table or rectangular
In the exemplary embodiment, table apertures 11 are elongated slots. In other embodiments, table apertures 11 are round, square or rectangular apertures.

MSS 100 includes a plurality of modular stanchions 20, a plurality of optional stanchion brace 30, a plurality of stanchion attachment apertures 23, a plurality of optional stanchion dowel apertures 25, a plurality of turnbuckles 40, a plurality of optional turnbuckle nuts 42, a plurality of knuckles 50, a plurality of angle brackets 60, a plurality of shelf 70, a plurality of shoe assemblies 80 and a plurality of turnbuckle nuts 42.

Modular stanchions 20 and stanchion braces 30 connect to table apertures 11. Stanchion extension 28 also includes a plurality of modular stanchions 20, a plurality of stanchion attachment apertures 23, a plurality of optional turnbuckle nuts 42, a plurality of optional knuckles 50, a plurality of angle brackets 60, a plurality of shelves 70, a plurality of shoe assemblies 80 and a plurality of turnbuckle nuts 42.

Stanchion tracker 24 on table 10 allows for gross adjustment of the overall radius of MSS 100. FIGS. 2a and 2b illustrate side and partial top views, respectively, of an exemplary embodiment of modular stanchion 20 with optional fixed angle support 26. Modular stanchions 20 provide significant load-bearing capabilities to MSS 100 and serve to interconnect other components of MSS 100 with table 10. Repositioning modular stanchions 20 on table 10 allows for gross adjustment of the overall radius of MSS 100.

In this embodiment, modular stanchion 20 includes a stanchion shaft 21, at least one stanchion foot 22, a plurality of stanchion attachment apertures 23, at least one optional stanchion tracker 24, a plurality of optional stanchion dowel apertures 25, a fixed angle support 26 and an optional stanchion cap 29. Stanchion cap 29 is an aluminum block with an upper surface that supports work pieces during assembly and fabrication. This upper surface may be stepped, angled or flat. Stanchion cap 29 removably connects to the upper surface of stanchion shaft 21.

In this embodiment, modular stanchion 20 includes a stanchion shaft 21, two stanchion feet 22a and 22b, a plurality of optional stanchion attachment apertures 23 and an adjustable angle support 27. The structure and function of stanchion attachment apertures 23 is substantially identical to those of the embodiment of FIGS. 2a and 2b above.

Stanchion extension 28 is a vertical shaft with a rectangular cross-section fixedly mounted to stanchion feet 22a and 22b. Stanchion extension 28 also includes a plurality of stanchion attachment apertures 23, at least one optional stanchion tracker 24 in a vertical shaft with a rectangular cross-section fixedly mounted to stanchion foot 22. Stanchion extension 28 is a vertical shaft with a rectangular cross-section fixedly mounted to stanchion foot 22. When modular stanchion 20 connects to table apertures 11, stanchion extension 28 connects to at least one table aperture 11 to adjustably position modular stanchion 20 on table 10. Distance between stanchion foot 22a and 22b determines the relative angle between stanchion shaft 21 and adjustable angle support 27, as well as the angulation of stanchion shaft 21. Stanchion shaft 21 forms an angle with stanchion foot 22 ranging from approximately 15 degrees to approximately 90 degrees.

Stanchion extension 28 also includes a plurality of stanchion attachment apertures 23. In the exemplary embodiment, stanchion attachment apertures 23 are located on all four sides and the upper surface of stanchion shaft 21. The spacing of these groupings accommodates complementary apertures in stanchion attachment apertures 23 arranged in a substantially square pattern. The spacing of these groupings accommodates complementary apertures in stanchion attachment apertures 23 arranged in a square pattern. The spacing of these groupings accommodates complementary apertures in stanchion attachment apertures 23 arranged in a square pattern. The spacing of these groupings accommodates complementary apertures in stanchion attachment apertures 23 arranged in a square pattern. The spacing of these groupings accommodates complementary apertures in stanchion attachment apertures 23 arranged in a square pattern. The spacing of these groupings accommodates complementary apertures in stanchion attachment apertures 23 arranged in a square pattern.
fasteners 95 inserted through stanchion attachment apertures removably connects to stanchion shaft 21 by means of configuration of shelves 70 allows incremental alterations to disposition of knuckle 50. In the exemplary embodiment, knuckle base 51 includes eight knuckle attachment apertures 52, a knuckle swivel 53, a knuckle clevis 54, a plurality of knuckle clevis pin apertures 55, a knuckle clevis pin 56 and a knuckle clevis pin lock 57. Knuckle base 51 removably connects to stanchion shaft 21 by means of fasteners 95 inserted through stanchion attachment apertures 23 and knuckle attachment apertures 52. In the exemplary embodiment, knuckle base 51 includes eight knuckle attachment apertures 52 arranged at 45-degree increments in a substantially circular pattern, allowing orientation and positioning of knuckle 50 in 45-degree increments relative to stanchion shaft 21.

Knuckle swivel 53 rotatably connects knuckle base 51 to knuckle clevis 54. Knuckle swivel 53 can rotate through 360 degrees. Knuckle clevis 54 receives turnbuckle eyebolt 43a or 43b between knuckle clevis pin apertures 55. Insertion of knuckle clevis pin 56 through eyebolt 43a or 43b and knuckle clevis pin apertures 55 removably connects turnbuckle 40 and knuckle 50. Insertion of knuckle clevis pin lock 57 through knuckle clevis pin 56 removably locks knuckle clevis pin 56 in place, preventing accidental dislodgment.

FIGS. 5a-5c illustrate front, side and perspective views, respectively, of an exemplary embodiment of angle bracket 60. Angle bracket 60 removably connects shelf 70 to modular stanchion 20. Angle bracket 60 has a substantially upside-down L-shaped configuration. Angle bracket 60 includes a bracket platform 61, a bracket upright 62, a bracket support 63, a plurality of bracket attachment apertures 64 and a plurality of bracket dowel apertures 65. Bracket platform 61 removably connects to shelf 70, while bracket upright 62 removably connects to modular stanchion 20. In the exemplary embodiment, bracket platform 61 supports lateral sides of two different shelves 70. Bracket support 63 extends between bracket platform 61 and bracket upright 62 to provide additional support to bracket platform 61.

In the exemplary embodiment, bracket attachment apertures 64 are located in both bracket platform 61 and bracket upright 62. In the exemplary embodiment, bracket attachment apertures 64 in bracket upright 62 have an elongated configuration. This configuration allows highly adjustable positioning of angle bracket 60 with respect to modular stanchion 20. In the exemplary embodiment, bracket dowel apertures 65 are located in bracket upright 62. Bracket dowel apertures 65 receive dowels that peg to complementary stanchion dowel apertures 25 to accurately locate angle bracket 60 during attachment to modular stanchion 20.

FIGS. 6a-6c illustrate top, front and perspective views, respectively, of an exemplary embodiment of shelf 70. Shelf 70 has a substantially planar configuration and is manufactured from metallic materials such as, but not limited to, aluminum. In the exemplary embodiment, shelf 70 has a planar, partially curved rectangular configuration. The configuration of shelves 70 allows incremental alterations to MSS 100 diameter.

Shelf 70 supports shoe assembly 80 and connects shoe assembly 80 to modular stanchion 20. Shelf 70 includes a plurality of shelf attachment apertures 71 and at least one optional shelf tracker 72. Bracket platform 61 removably connects to a lower surface of shelf 70 through shelf attachment apertures 71. In the exemplary embodiment, two bracket platforms 61 support each shelf 70 through shelf attachment apertures 71 located on lateral sides of shelf 70. Other embodiments add one or more additional bracket platforms 61 to support each shelf 70 depending on the overall length of and support required for each shelf 70.

In the exemplary embodiment, shelf trackers 72 are laser tracker holes located on the upper surface of shelf 70 and the front surface of shelf 70. When connecting shelf 70 to modular stanchion 20, shelf trackers 72 allow a user to determine when shelf 70 reaches the correct height on modular stanchion 20 and position above table 10. In other embodiments, shelf 70 includes only a single shelf tracker 72.

Shoe platform 81 is a removable separator between shoe frame 82 and shelf 70 having a substantially wedge-shaped configuration. When used, shoe platform 81 angles shoe frame 82 relative to shelf 70. This angulation may range from approximately one degree to approximately 45 degrees. Shoe frame 82 has a U-shaped cross-section. Shoe 83 has a box-shaped configuration with a rounded front surface. In the exemplary embodiment, shoe frame 82 has a radius of approximately 0.25 inches. Other embodiments may have a radius of up to one inch. In the exemplary embodiment, shoe 83 is made from aluminum. Optionally, shoe 83 can be made from brass or copper. Shoe 83 can be made from wood or plastic as well. In the exemplary embodiment, the front end of shelf 70 is a rectangular configuration. When used, shoe platform 81 and shelf 70 support each shelf 70 through shelf attachment apertures 71 located on lateral sides of shelf 70. Shoe platform 81 removably connects to a lower surface of shelf 70 through shelf attachment apertures 71. In the exemplary embodiment, two bracket platforms 61 support each shelf 70 through shelf attachment apertures 71 located on lateral sides of shelf 70. Other embodiments add one or more additional bracket platforms 61 to support each shelf 70 depending on the overall length of and support required for each shelf 70.

In the exemplary embodiment, shelf trackers 72 are laser tracker holes located on the upper surface of shelf 70 and the front surface of shelf 70. When connecting shelf 70 to modular stanchion 20, shelf trackers 72 allow a user to determine when shelf 70 reaches the correct height on modular stanchion 20 and position above table 10. In other embodiments, shelf 70 includes only a single shelf tracker 72.

Shoe platform 81 is a removable separator between shoe frame 82 and shelf 70 having a substantially wedge-shaped configuration. When used, shoe platform 81 angles shoe frame 82 relative to shelf 70. This angulation may range from approximately one degree to approximately 45 degrees. Shoe frame 82 has a U-shaped cross-section. Shoe 83 has a box-shaped configuration with a rounded front surface. In the exemplary embodiment, shoe frame 82 has a radius of approximately 0.25 inches. Other embodiments may have a radius of up to one inch. In the exemplary embodiment, shoe 83 is made from aluminum. Optionally, shoe 83 can be made from brass or copper. Shoe 83 can be made from wood or plastic as well. In the exemplary embodiment, the front end of shelf 70 is a rectangular configuration. When used, shoe platform 81 and shelf 70 support each shelf 70 through shelf attachment apertures 71 located on lateral sides of shelf 70. Shoe platform 81 removably connects to a lower surface of shelf 70 through shelf attachment apertures 71. In the exemplary embodiment, two bracket platforms 61 support each shelf 70 through shelf attachment apertures 71 located on lateral sides of shelf 70. Other embodiments add one or more additional bracket platforms 61 to support each shelf 70 depending on the overall length of and support required for each shelf 70.

In the exemplary embodiment, shelf trackers 72 are laser tracker holes located on the upper surface of shelf 70 and the front surface of shelf 70. When connecting shelf 70 to modular stanchion 20, shelf trackers 72 allow a user to determine when shelf 70 reaches the correct height on modular stanchion 20 and position above table 10. In other embodiments, shelf 70 includes only a single shelf tracker 72.
Fasteners 95 are standardized bolts having identical gauge and thread density (threads per inch). In the exemplary embodiment, fasteners 95 are bolts with a diameter of approximately 0.5 inches and a thread density of approximately 13.

It will be understood that many additional changes in the details, materials, procedures and arrangement of parts, which have been herein described and illustrated to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

It should be further understood that the drawings are not necessarily to scale; instead, emphasis has been placed upon illustrating the principles of the invention. Moreover, the terms “substantially” or “approximately” as used herein may be applied to modify any quantitative representation that could permissibly vary without resulting in a change in the basic function to which it is related.

What is claimed is:

1. A modular stanchion system, comprising:
   a table supporting a plurality of modular stanchions, wherein each of said plurality of modular stanchions comprises at least one stanchion foot and a stanchion shaft, wherein said stanchion foot is connected to at least one table aperture in said table, wherein said stanchion shaft has a plurality of stanchion attachment apertures;
   a plurality of angle brackets connected to said plurality of modular stanchions, wherein each of said plurality of angle brackets comprises a bracket platform and a bracket upright, wherein said bracket platform comprises a plurality of bracket attachment apertures, wherein said bracket upright comprises a plurality of bracket attachment apertures;
   a plurality of variably positioned shelves removably connected to said plurality of angle brackets to allow incremental alterations to a diameter of said system, wherein each of said plurality of shelves has a substantially planar configuration, wherein each of said plurality of shelves comprises a plurality of shelf attachment apertures;
   a plurality of shoe frames removably connected to said variably positioned shelves, wherein each of said plurality of shoe frames is slidably connected to a shoe, wherein said shoe may extend from said shoe frame; and
   a plurality of fasteners extending through said plurality of stanchion attachment apertures, said plurality of shelf attachment apertures, and said plurality of shoe attachment apertures.

2. The system of claim 1, wherein said plurality of stanchion attachment apertures form multiple groupings, wherein each grouping is made up of four stanchion attachment apertures arranged in a substantially square pattern.

3. The system of claim 1, wherein each of said plurality of modular stanchions further comprises a plurality of shoe frame dowel apertures, wherein each of said plurality of angle brackets further comprises a plurality of bracket dowel apertures.

4. The system of claim 1, wherein each of said plurality of modular stanchions further comprises at least one stanchion tracker located on an upper surface of each of said plurality of modular stanchions.

5. The system of claim 1, wherein each of said plurality of modular stanchions further comprises a fixed angle support extending between said stanchion shaft and said at least one stanchion foot.

6. The system of claim 1, wherein said at least one stanchion foot comprises a first stanchion foot and a second stanchion foot, wherein each of said plurality of modular stanchions further comprises an adjustable angle support extending between said first stanchion foot and said stanchion shaft, wherein said adjustable angle support is rotatably connected to said first stanchion foot and said stanchion shaft, wherein said stanchion shaft is rotatably connected to said second stanchion foot.

7. The system of claim 1, further comprising at least one stanchion extension removably connected to an upper surface of said stanchion shaft.

8. The system of claim 1, further comprising at least one stanchion cap removably connected to an upper surface of said stanchion shaft.

9. The system of claim 1, further comprising at least one stanchion brace extending between said stanchion shaft and at least one table aperture.

10. The system of claim 1, wherein each of said plurality of angle brackets further comprises a bracket support extending between said bracket upright and said bracket platform.

11. The system of claim 1, wherein each of said plurality of shelves is supported along a first lateral edge by one of said plurality of angle brackets and along a second lateral edge by another of said plurality of angle brackets.

12. The system of claim 1, wherein each of said plurality of shelves further comprises at least one shelf tracker located on at least one of an upper surface of each of said plurality of shelves or a front surface of each of said plurality of shelves.

13. The system of claim 1, wherein each of said plurality of fasteners comprises a bolt having a diameter of approximately 0.5 inches and a thread density of approximately 13 threads per inch.

14. The system of claim 1, wherein each of said plurality of shoe frames includes a threaded rod extending through each of said plurality of said shoe frames and into said shoe.

15. The system of claim 14, further comprising at least one shoe platform removably located between at least one of said plurality of shelves and at least one of said plurality of shoe frames, said at least one shoe platform having a substantially wedge-shaped configuration.

16. The system of claim 14, further comprising a shoe backplate connected to each of said plurality of shoe frames by a plurality of shoe set screws, said shoe backplate having a threaded rod aperture, said threaded rod extending through said threaded rod aperture.

17. The system of claim 14, wherein a front surface of said shoe has a radius of up to one inch.

18. The system of claim 14, wherein a back end of said threaded rod has a cross-section selected from the group consisting of: substantially recessed, square, pentagonal or hexagonal cross-sections.

19. The system of claim 1, further comprising:
   a plurality of knuckles connected to said plurality of modular stanchions, wherein each of said plurality of knuckles comprises a knuckle base having a plurality of attachment apertures, a knuckle swivel rotatably interconnecting said knuckle base and a knuckle clevis, and a knuckle clevis pin removably extending through a plurality of knuckle clevis pin apertures in said knuckle clevis; and
a plurality of turnbuckles connected to said plurality of knuckles, wherein each of said plurality of turnbuckles comprises a plurality of turnbuckle eyebolts rotatably connected to a turnbuckle adjustment frame through a plurality of turnbuckle nuts.

20. The system of claim 19, wherein said plurality of knuckle attachment apertures comprise eight knuckle attachment apertures arranged at 45-degree increments in a substantially circular pattern on said knuckle base.