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 an angle bracket.

FIGS. 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 optional turnbuckles 40, a plurality of optional knuckles 50, a plurality of angle brackets 60, a plurality of shelves 70, a plurality of optional shoe assemblies 80 and a plurality of fasteners 95. Modular stanchions 20 and stanchion brace 30 connect to table apertures 11. Stanchion shaft 21 has a length ranging from fasteners 95. Modular stanchions 20 and stanchion brace 30 form multiple groupings, each grouping made up of four shelving 70 support shoe assemblies 80. Fasteners 95 connect knuckles 50 and angle brackets 60 to modular stanchions 20. Shelves 70 support shoe assemblies 80. Fasteners 95 connect knuckles 50 and angle brackets 60 to modular shelving 70 to shoe assemblies 80. Stanchion brace 30 provide additional reinforcement against forces exerted on 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 shaft 21 is a vertical shaft with a rectangular cross-section fixedly mounted to stanchion foot 22. Stanchion shaft 21 has a length ranging from approximately 1 foot to approximately 50 feet. Stanchion foot 22 connects to at least one table aperture 11 to adjustably position modular stanchion 20 on table 10. In the exemplary embodiment, both stanchion shaft 21 and fixed angle support 26 mount to the same stanchion foot 22. In other embodiments, stanchion shaft 21 and fixed angle support 26 each mount to their own stanchion foot 22.

Stanchion shaft 21 also includes stanchion attachment apertures 23 on at least one side. In the exemplary embodiment, stanchion attachment apertures 23 are located on all four sides and the upper surface of stanchion shaft 21. In the exemplary embodiment, stanchion attachment apertures 23 form multiple groupings, each grouping made up of four stanchion attachment apertures 23 arranged in a substantially square pattern. The spacing of these groupings accommodates complementary apertures in knuckles 50 and angle brackets 60. Other components may also attach to stanchion shaft 21 using stanchion attachment apertures 23.

In the exemplary embodiment, stanchion shaft 21 also includes stanchion tracker 24, a laser tracker hole located on the upper surface of stanchion shaft 21. When moving modular stanchion 20 into position on table 10, stanchion tracker 24 allows a user to determine when modular stanchion 20 reaches the correct position. All modular stanchions 20 within MSS 100 have stanchion trackers 24 in the same location to ensure uniform positioning. In the exemplary embodiment, stanchion shaft 21 also includes stanchion dowel apertures 25. Stanchion dowel apertures 25 receive dowels that peg to complementary apertures in angle brackets 60 to accurately locate angle bracket 60 during attachment.

Fixed angle support 26 is an angled shaft fixed between stanchion shaft 21 and stanchion foot 22. When stanchion shaft 21 experiences angled or horizontal forces, fixed angle support 26 provides reinforcement. Fixed angle support 26 has a rectangular, square or round cross-section and forms an angle with stanchion foot 22 ranging from approximately 15 degrees to approximately 90 degrees.

Stanchion cap 29 is an aluminum block with an upper surface that supports workpieces 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.

FIG. 2c illustrates a side view of an exemplary embodiment of modular stanchion 20 with optional adjustable angle support 27. In this embodiment, modular stanchion 20 includes a stanchion shaft 21, two stanchion feet 22a and 22b, 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.

In this embodiment, stanchion shaft 21 is a vertical shaft with a rectangular cross-section rotatably connected to stanchion foot 22a and adjustable angle support 27. In this embodiment, stanchion shaft 21 and adjustable angle support 27 each rotatably connect to their own stanchion foot 22a and 22b, respectively. Stanchion feet 22a and 22b connect to table aperture 11 to adjustably position modular stanchion 20 on table 10. The 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.

FIG. 2d illustrates a perspective view of an exemplary embodiment of stanchion extension 28. Stanchion extension 28 is a vertical shaft with a rectangular cross-section removably mounted to the upper surface of stanchion shaft 21 using stanchion attachment apertures 23. A user increases the overall height of stanchion shaft 21 by removably connecting at least one stanchion extension 28. In cases where additional height increase is necessary, one or more additional stanchion extensions 28 may connect to the first stanchion extension 28. The cross-section of stanchion extension 28 matches that of stanchion shaft 21. Each stanchion extension 28 has a height ranging from approximately 1 foot to approximately 50 feet.

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 and lower surfaces of stanchion extension 28. In the exemplary embodiment, stanchion attachment apertures 23 form multiple groupings, each grouping made up of four stanchion attachment apertures 23 arranged in a square pattern. The spacing of these groupings accommodates complementary apertures in stanchion attachment apertures 23. In the exemplary embodiment, stanchion extension 28 matches that of stanchion shaft 21. Each stanchion extension 28 has a height ranging from approximately 1 foot to approximately 50 feet.

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 and lower surfaces of stanchion extension 28. In the exemplary embodiment, stanchion attachment apertures 23 form multiple groupings, each grouping made up of four stanchion attachment apertures 23 arranged in a square pattern. The spacing of these groupings accommodates complementary apertures in stanchion extension 28. In other stanchion extensions 28, knuckles 50 and angle brackets 60.

FIG. 3 illustrates a perspective view of an exemplary embodiment of turnbuckle 40. Turnbuckle 40 provides optional added stabilization between various elements of MSS 100. By way of non-limiting example, fixing turnbuckle 40 between two modular stanchions 20 provides resistance to lateral relative movement in modular stanchions 20.

Turnbuckle 40 includes a turnbuckle adjustment frame 41, two turnbuckle nuts 42a and 42b, and two turnbuckle eyebolts 43a and 43b. Turnbuckle adjustment frame 41 is a hollow cylinder having turnbuckle nuts 42a and 42b connected to each end. The threaded shank of each turnbuckle eyebolt 43a and 43b rotatably connects to turnbuckle nuts.
fasteners inserted through stanchion attachment apertures removably connects to stanchion shaft by means of a knuckle base, a plurality of knuckle attachment apertures, a knuckle swivel, a plurality of knuckle clevis pin apertures, a knuckle clevis pin and a knuckle clevis pin lock. Knuckle base removably connects to stanchion shaft by means of a knuckle clevis pin in place, preventing accidental dislodgement in 45-degree increments in a substantially circular pattern, allowing orientation and positioning of a knuckle in 45-degree increments relative to stanchion shaft.

Knuckle swivel rotates through 360 degrees. Knuckle clevis receives turnbuckle eyebolt or between knuckle clevis pin apertures. Insertion of a knuckle clevis pin through eyebolt or as, but not limited to a hand tool, drill or motor.

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

Shoe platform is a removable separator between shoe frame and shelf having a substantially wedge-shaped configuration. When used, shoe platform supports and rounds the work piece, allowing for fine adjustment of the overall radius of MSS. Shoe assembly translates manufacturing leads placed on work pieces into MSS while maintaining dimensional tolerances during fabrication. Shoe assembly includes an optional shoe platform, a shoe frame, two optional shoe grooves and an optional shoe backplate, two optional shoe set screws, a plurality of optional shoe attachment apertures, a threaded rod aperture and an optional shoe set screw.

Shoe backplate can close off the rear of shoe frame. Shoe backplate can slideably connect to shoe frame through shoe grooves and an inner lateral sides of shoe frame for additional guidance during use. Shoe backplate can close off the rear of shoe frame. Shoe backplate connects across the rear of shoe frame, with shoe set screws extending through shoe backplate and into shoe frame. In the exemplary embodiment, fasteners extend through shoe attachment apertures to removably connect shoe frame to shelf. In other embodiments, shoe assembly is an integrated part of shelf.

The front end of threaded rod extends within shoe, allowing shoe to extend from and retract into shoe frame by movement of threaded rod. In the exemplary embodiment, the configuration of the back end of threaded rod can be, but is not limited to, a substantially recessed, square, pentagonal or hexagonal cross-section. This allows removable connection to manual or powered drivers, such as, but not limited to a hand tool, drill or motor.

In the exemplary embodiment, threaded rod extends through threaded rod aperture in shoe backplate. Threaded rod aperture has an internal threading that substantially corresponds to the external threading of threaded rod, allowing guided extension and retraction of threaded rod through threaded rod aperture. In the exemplary embodiment, rod set screw holds threaded rod.
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 bracket attachment apertures and said plurality of shelf 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 angle brackets, 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.