ABSTRACT

An apparatus for positioning and removing an operational unit about a desired location at a vertical weld seam. A flexible connection, attached to a cage, supports a vertical track on which travels a tractor which carries an operational unit for performing a desired operation on the weld seam. The flexible connection comprises a plurality of arms pivotally connection about vertical axes. The apparatus further includes a plurality of flexible connections to accurately align the vertical track along a vertical weld seam that is not truly vertical and/or is not perpendicular to any horizontal plane.

15 Claims, 4 Drawing Figures
CAGE-TO-TRACK CONNECTION

BACKGROUND OF THE INVENTION

This invention relates generally to improvements in field construction of storage tanks and vessels, and more particularly to a new and improved apparatus for positioning a guide head, welding head, or gouging head along a vertical seam formed by the edges of generally vertical plates.

Known apparatus of this type comprise a carriage which is mounted on two wheels for movement in a direction parallel to the upper edge of the plate, and two frame members depending from the carriage one at each side of the plate. The wheels may run on the upper edge of the plate or on a rail mounted parallel thereto. An operational unit is carried by one or both of the frameworks to perform the desired work on the vertical seam. The wheels are pivotally mounted at fixed points on the carriage so that the wheels can beinclined about vertical axes to remain tangential to plates of different curvatures. Horizontally sliding bars attached at one end to the framework and pivotally connected at the other end to a vertical track, on which travels the operational unit, have been used to position the operational unit.

Such devices have been unsatisfactory in that the operator is not able to speedily, conveniently, and accurately align the vertical track, which carries the operational unit, with the vertical seams. The prior art devices are further not capable of conveniently moving the operational unit to a position so as to allow it to be transported to the next work station without subjecting the unit to possible damage. This is particularly a problem when operating on vertical seams in relatively small diameter tanks (i.e. less than 16 feet) where it is important not to bump the operational unit into the sharply curving tank wall during inside transportation of the carriage. In short, such devices lack sufficient and efficient flexibility.

SUMMARY OF THE INVENTION

This invention relates to an apparatus for performing work on vertical seams of a plate metal tank shell, and in particular relates to a flexible connector located between a cage and a vertical track which allows the operator to accurately position the track in a desired relation to a weld seam, or to bring the track into the protective confines of the cage.

Accordingly, it is an object of this invention to provide a device which quickly and conveniently positions an operational unit in a desired position relative to the center line of a vertical weld seam.

Another object is to provide a device which quickly and conveniently removes an operational unit from its position on a vertical weld seam to the inner confines of a protective cage so as to prevent damage to the intricate parts of the operational unit when it is moved to the next vertical weld seam.

A further object of the invention is to provide means to accurately align a vertical track, on which an operational unit travels, so as to permit the unit to accurately follow a weld seam which is not truly vertical and/or which is leaning either inwardly or outwardly, so as not to be perpendicular to any horizontal plane.

Other objects and advantages of the invention will be apparent from the drawings, specification, and claims.

Briefly stated, the invention includes a flexible connection which operates from a conventional vertical welding cage, of the type that travels by rolling horizontally to the vertical seams on a field erected storage tank, and then stops to allow a desired vertical operation on the seam. The flexible connections can be conveniently attached to one of the conventional vertical structure members of the cage. From this vertical member the invention provides a flexible connection to a vertical track on which travels a tractor which carries a welding head, grinding head, gouging head, or any device for performing a desired operation on the weld seam. The novel flexible connection comprises a plurality of arms pivotally connected about vertical axes and thereby allows the operator to accurately and quickly position the track in the desired relation to the weld seam, or to bring the track into the protective confines of the cage. By using a plurality of flexible connections the operator can accurately align the vertical track along a vertical weld seam that is either not truly vertical or is leaning inwardly or outwardly.

DESCRIPTION OF THE DRAWING

Other objects and advantages of the invention will hereinafter become more fully apparent from the following description of the annexed drawings, which illustrates a preferred embodiment, and wherein:

FIG. 1 is a front elevation of a tank under construction by apparatus in accordance with this invention.

FIG. 2 is a plan view of the apparatus of FIG. 1, with the operational unit omitted for clarity, showing in dotted lines the position of the flexible connection when the operational unit is located within the inner confines of the cage.

FIG. 3 is a plan view on an enlarged scale of the flexible connection of the invention.

FIG. 4 is a front elevation of the flexible connection as shown in FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, it will be seen that cage 10 comprises a horizontally moveable carriage 20 and a plurality of vertically depending support columns 30. Carriage 20 is steerable mounted on two wheels 22 for travel along the upper edges of curved plates 11 and 12 which are being welded to each other.

Guide wheels 24 enable the cage 10 to smoothly and accurately travel in a horizontal direction about plates 11 and 12. Thus, cage 10 is able to traverse the upper edges of plates 11 and 12, stopping at a particular vertical weld seam, and then 35 after the desired operations are performed on that weld seam moving on to the next vertical weld seam.

Attached to one of the vertical columns 30 are flexible segmented connections 40 and 40' which support vertical track 50 upon which travels a tractor 59 which carries operational unit 60. Operational unit 60 may be a single operation unit such as a welder, grinder, cutter, etc. or a multi-operation unit that performs many operations on the weld seam simultaneously. The term “operation unit”, as used hereinafter, is intended to embrace all such devices that perform work on a weld seam. The accurate positioning of vertical track 50 is critical, as it along determines the path which the tractor will follow thus determining the course which the operational unit will take. The novel flexible connections 40 and 40', which will be described in detail below, are the key elements in positioning the vertical track 50 upon which the tractor 59 travels.

Flexible connections 40 and 40' must be able to accurately and quickly locate the vertical track 50 in a desired position with a center line of a vertical seam that is not truly vertical or one which is leaning either inwardly or outwardly. It further must be able to remove the vertical track 50 from its position at the vertical weld seam to a position within the confines of the cage to allow the cage to travel about a sharply curving shell structure without damage to the operational unit 60.

Flexible connections 40 and 40' are substantially identical and, therefore, only flexible connection 40 will be described in detail. Referring to FIGS. 3 and 4, flexible connection 40 is composed of a first arm 41, a second arm 44, and a third arm 47. First arm 41, having first and second ends 42 and 43 respectively; second arm 44 having first and second ends 45 and 46 respectively; and a third arm 47, having first and second ends 48 and 49 respectively.

As can be seen in FIG. 4, the second end 43 of first arm 41 has a pair of spaced ears 71 and 72, having apertures therein, extending horizontally therefrom, and the first end 45 of second arm 44 also has a pair of spaced ears 73 and 74, having apertures therein, extending horizontally therefrom. Ears 71–74 are vertically spaced so as to permit ear 73 to rest upon ear 71 and ear 74 to rest upon ear 72 with vertical alignment of the respective apertures. Pin 80 having a head 85, larger in
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diameter than the ear apertures, extends upwardly through said apertures in ear 72, 74, 71 and 73 respectively. The upper portion of pin 80 is threaded so as to receive locking nut 88 and thereby permits locking of first arm 41 and second arm 44 in a fixed angular relationship.

As can be seen in FIG. 4, second end 46 of second arm 44 is pivotally connected to first end 48 of third arm 47 by passing pin 82 upwardly through ears 76, 74, 75, and 77 respectively is a similar manner as described immediately above. Locking nut 86 receives pin 82 locking second arm 44 in a fixed angular relationship to third arm 47.

Second end 49 of third arm 47 is rigidly attached to channel 90 by bolts 91 and 92. Channel 90 is adapted to be secured to vertical track 50 upon which the tractor 59, which carries operational unit 60, travels in a conventional manner.

First arm 41 is attached to column 30 by horizontal sleeve 100 and vertical sleeve 110. Sleeve 100, which slidably received first arm 41, is attached to sleeve 110, which is slidably received about column 30. Sleeve 110 may have a slippery coating on the interior thereof to facilitate the sliding of sleeve 110 on column 30. A set bolt 114 passing through an opening in sleeve 110 holds sleeve 110, and thus the flexible connection 40, at any desired elevation. First plate 120 attached to sleeve 100 threadedly receives one end of a threaded rod 122. The other end of rod 122, having a control knob 125 attached thereto, passes through an upper aperture in second plate 130. First end 42 of first arm 41 is attached to plate 130 through a lower aperture in plate 130 and thereby upon rotation of rod 122, first arm 41 slides horizontally or parallel to the floor of the cage.

In operation, carriage 20 travels along the upper edges of plates 11 and 12 to a vertical seam 13. During this period, vertical track 50, and therefore operational unit 60, is located within the inner confines of cage 10 (as seen in broken lines in FIG. 2) so as to prevent damage to operational unit 60. This should be contrasted to prior apparatus which due to the lack of sufficient flexibility were not able to position the operational unit into the protective confines of the cage and thereby protect same from bumping into the plates during travel between vertical seams.

Locking nuts 86, 88, 86' and 88' are loosened to permit vertical track 50 to be swung towards the vertical seam by pivot- ings 44, 47, 44' and 47' about pins 80, 82, 80' and 82' (as seen in solid lines in FIG. 2). Vertical track 50 is positioned parallel to plates 11 and in contact therewith. Locking nuts 86, 88, 86' and 88' are then tightened to securely lock flexible connections 40 and 40' in position.

Control knobs 125 and 125' are adjusted to position track 50 parallel to the vertical seam by sliding first arm 41 and 41' horizontally within sleeves 100 and 100' respectively. The vertical track 50 is now positioned to allow operational unit 60 to accurately follow a weld seam even though not perpendicular to any horizontal plane. Operational unit 60 is carried by trac- tor 59 which travels up vertical track 50 in a conventional manner (i.e. a rack and pinion drive) and performs a desired operation on the vertical seam.

After completion of the work operation on this vertical seam the locking nuts 88 and 88' are loosened and the vertical track 50 is positioned within the inner confines of cage 10, and the carriage 20 is ready to be moved to the next vertical seam.

It can readily be seen that the above disclosed apparatus provides a novel flexible connection which allows an operator to accurately position a vertical track, which carries an operational head, along a vertical seam that is not perpendicular to any horizontal plane. This increased alignment accuracy of the vertical track with respect to the seam is particularly criti- cal when the operational unit is a conventional grinder. Due to the accurate positioning of the grinder on the seam, only one pass of the grinder is required where previously several passes were necessary because the grinding head was not in constant contact with the seam during the initial pass.

Alignment accuracy is even more important when the operational unit is a welding device. If fact for welding opera-
tions additional rigidity of contact between channel 90 (on which track 50 is secured) and the tank shell, may be provided by vacuum cups 51 which press tightly against the tank shell and are also rigidly and mechanically attached to the channel 90 by bolts 52. The vacuum cups are a commercial stock item available from the Weld Tooling Corporation in Pittsburgh, Pennsylvania, as "No. ARV – 1100 vacuum rail attachment," as seen in FIG. 1.

It will be understood that while the form of the invention herein shown and described constitutes a preferred embodi- ment, it is not intended herein to illustrate all the equivalent forms or ramifications thereof. It will also be understood that the words used are words of description rather than of limita- tion, and that various changes may be made without departing from the spirit and scope of the invention herein disclosed, and it is aimed in the appended claims to cover all such changes as fall within the true spirit of the invention.

We claim:

1. Apparatus for use in performing operations on the vertical edges of substantially vertical plates to form a curved shell structure comprising:

a. a carriage;

b. means to enable said carriage to move along the upper edges of said plates;

c. an operational unit;

d. a vertical track on which travels said operational unit;

e. a framework suspended from said carriage; and

f. laterally-movable flexible connection means connecting said vertical track to said framework so as to permit in- ward movement of said operational unit within the confi- nes of the framework and thereby prevent damage to said operational unit when said carriage is moved around a sharply curved shell structure and means to lock the connecting means in a fixed relationship to permit posi- tive positioning of the vertical track.

2. An apparatus as claimed in claim 1, wherein said flexible connection means comprises a plurality of arms pivotally connected about substantially vertical axes.

3. An apparatus as claimed in claim 2, wherein:

a. said framework includes a substantially vertical column; and

b. said flexible connection means is slidably attached to said vertical column so as to permit vertical adjustment of said flexible connection means.

4. An apparatus as claimed in claim 3, wherein a plurality of flexible connection means are slidably attached to said vertical column and rigidly attached to said vertical track.

5. An apparatus as claimed in claim 2, wherein at least one of said arms is adjustable with respect to said framework so as to permit horizontal adjustment of said vertical track with respect to said framework.

6. Apparatus for use in performing operations on the vertical edges of substantially vertical plates to form a curved shell structure comprising:

a. a carriage;

b. means to enable said carriage to move along the upper edges of said plates;

c. an operational unit;

d. a vertical track on which travels said operational unit;

e. a framework suspended from said carriage; and

f. flexible connection means connecting said vertical track to said framework so as to permit inward movement of said operational unit and thereby prevent damage to said operational unit when said carriage is moved around a sharply curved shell structure, said connecting means comprising:

1. a first arm having first and second ends, a second arm having first and second ends, and a third arm having first and second ends;

2. said first arm being slidably attached to said framework at its first end so as to permit vertical adjustment of said flexible connection means relative to said framework;
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5. said vertical track being connected to the second end of said third arm.

7. An apparatus as in claim 6 wherein said operational unit is mounted on a tractor means which vertically traverses said vertical track means.

8. Apparatus for use in welding, grinding, and cutting vertical edges of substantially vertical plates to form a curved tank shell structure comprising:
   a. a carriage movable along the top edge of said plates;
   b. an operational unit to perform welding, grinding, and cutting operations on said vertical edges;
   c. vertical track means adapted to support said operational unit and allow same to vertically traverse said vertical plates;
   d. a framework, including at least one substantially vertical column, suspended from said carriage; and
   e. first flexible connection means connecting said vertical track to said vertical column so as to allow movement of said operational unit away from said tank shell and thereby prevent damage to said operational unit when said carriage is moved around a sharply curved tank shell, said first connecting means comprising
      1. a first arm having first and second ends, a second arm having first and second ends, and a third arm having first and second ends;
      2. said first end of said first arm being slidably connected to said framework;
      3. said second end of said first arm being pivotally connected to said first end of said second arm for movement about a vertical axis; and
      4. said second end of said second arm being pivotally connected to said first end of said third arm for movement about a vertical axis; and
   5. said second end of said third arm being connected to said vertical track.

9. An apparatus as claimed in claim 8, wherein said pivotal connections include means to lock said arms in a fixed angular relationship to permit positive positioning of said vertical track.

10. An apparatus as claimed in claim 8, wherein a second flexible connection means, spaced from and substantially identical to said first flexible connection means, connects said vertical track to said framework so as to permit tilting of said vertical track when said first and second flexible connection means are not in vertical alignment.

11. An apparatus as claimed in claim 10, wherein said first ends of said first arms of said first and said second flexible connection means being adjustably clamped to said vertical column so as to allow vertical movement of said flexible connections means relative to said vertical column.

12. An apparatus as claimed in claim 11, wherein said first ends of said first arms of said first and said second flexible connection means is also attached to said vertical column by mounting means so as to permit horizontal adjustment of said first arms.

13. Apparatus for use in welding, grinding, and cutting vertical edges of substantially vertical plates to form a curved tank shell structure comprising:
   a. a carriage movable along the top edge of said plates;
   b. an operational unit to perform welding, grinding, and cutting operations on said vertical edges;
   c. vertical track means adapted to receive said operational unit and allow same to vertically traverse said vertical plates;
   d. a framework suspended from said carriage, said framework including at least one substantially vertical column;
   e. two, spaced apart and substantially identical, flexible connection means connecting said vertical track to said vertical column.

14. An apparatus as in claim 13 wherein said operational unit is mounted on a tractor means which vertically traverses said vertical track means.

15. Apparatus for use in performing operations on the vertical edges of substantially vertical plates comprising:
   a. a carriage;
   b. means to enable said carriage to move along the upper edge of said plates;
   c. an operational unit;
   d. a vertical track on which travels said operational unit;
   e. a framework including at least one substantially vertical column suspended from said carriage; and
   f. a plurality of flexible connection means connecting said vertical track to said vertical column so as to allow alignment of said vertical parallel to plate edges that are not perpendicular to any horizontal plane, said flexible connection means comprising
      1. a first arm having first and second ends, a second arm having first and second ends, and a third arm having first and second ends;
      2. said first arm being slidably attached to said framework at its first end so as to permit vertical adjustment of said flexible connection means relative to said framework;
      3. said second arm being pivotally attached at its first end to the second end of said first arm for movement about a vertical axis;
      4. said third arm being pivotally attached at its first end to the second end of said second arm for movement about a vertical axis; and
      5. said vertical track being connected to the second end of said third arm.