

APPARATUS AND METHOD FOR FLANGE-PIPE ALIGNMENT

TECHNICAL FIELD

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The present invention relates to an apparatus and method for alignment of a flange to a pipe and in particular, the present invention relates to an apparatus and method for aligning flange to pipe for welding the flange to a correct position of a pipe.

10 BACKGROUND

15 Welding flanges onto pipes is a typical process for pipeline construction. To ensure that quality standards are met, alignment of flange with the pipe is required prior to welding. Flanges and pipes are manufactured by separate processes and each having their own dimensional tolerances. While under ideal situation that flange has an inner diameter the same as the outer diameter of a pipe, in reality and due to manufacturing errors, flanges with a slightly larger inner diameter are used for welding to pipes. There is therefore a need to make proper alignment for the flange and pipe prior to welding.

20 Current alignment process for flanges and pipes are manually operated. Alignment is done by the sight of the operator. Labor has been used to lift pipes into place, following that, flanges will be brought in line with the pipes. This alignment method has several drawbacks. Firstly, as flanges have an inner diameter larger than the external diameter of a pipe, flanges will have to be held without resting on any part of the pipe, i.e. in a spaced relationship with a pipe. Holding flanges in this manner is therefore unstable. This is particularly cases for flanges used in heavy industries. Secondly, line of sight is vulnerable to human error, hence it is deemed not appropriate in the long run and not reliable, due to inconsistency in judgments among different operators. Welding performed based on incorrect flange-pipe alignment will result in unacceptable parts fabricated and reworks on the pipe flanges become necessary during which, flange removal and further hot work may damage the intended pipe and flange, rendering them unfit for use in addition to the extra time, efforts and costs needed for the rework.

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It is therefore a need to provide a solution for accurate and reliable alignment between flanges and pipes to meet the pipeline construction requirements.

5 SUMMARY OF THE INVENTION

Embodiments of the present invention provide an apparatus and a method for aligning a flange to a pipe. The apparatus includes a base, a jig moveably supported on the base and a detector attached to the base and disposed adjacent to the jig. A flange is mounted to the jig and rotates following the rotation of the jig by which, a profile of an inner surface of the flange is measured by the detector. A flange position reference is determined based on the measurement. The jig then moves relative to the base, according to the flange position reference, to align the flange to the pipe at a correction for welding.

15 Other aspects and advantages of the present invention will become apparent from the following detailed description, illustrating by way of example the inventive concept of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the present invention will be described in detail with reference to the accompanying drawings, in which:

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Fig. 1 is an exaggerated perspective view showing a flange to be welded to a pipe;

Fig. 2 is a front view of Fig. 1;

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Fig. 3 is a perspective view of an apparatus for aligning flanges to pipes for welding according to one embodiment of the present invention;

Fig. 4 is a perspective view showing the apparatus of Fig. 3 when carrying out flange-pipe alignment;

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Fig. 5 is an enlarged partial view of Fig. 4;

Fig. 6 is a schematic diagram showing an inner surface profile of a flange and data sampling lines used for profile measurement of the flange by the apparatus of Fig. 3;

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Fig. 7 is a perspective view of an apparatus for aligning flanges to pipes for welding according to another embodiment of the present invention;

Fig. 8 is a schematic diagram showing an inner surface profile of a flange, an external surface profile of a pipe and data sampling lines used for profile measurement of the flange and the pipe by the apparatus of Fig. 7;

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Fig. 9 is a perspective view showing the apparatus of Fig. 3 and Fig. 8 when the flange and the pipe are aligned and brought together for welding.

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Fig. 10 is a flow chart showing a method for flange-pipe alignment according to one embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Figs. 1 and 2 show a flange 10 to be aligned and welded to a pipe 20. Due to manufacturing errors, the external surface 24 of pipe 20 and the inner surface 14 of flange 10 may have imprecise dimensions and/or irregular shapes. Under such situation, when flange 20 is rested on pipe 10, the position reference points, e.g. an alignment center 12 of flange 10 becomes misaligned from the alignment center 22 of pipe 20. Method and apparatus according to embodiments of the present invention are provided for alignment of flange 10 to pipe 20 for welding, as illustrated in detail below.

As shown in Fig. 3, according to one embodiment of the present invention, an apparatus 100 for aligning a flange to a pipe includes a base 110, a first supporting plate 120 and a second supporting plate 130 mounted to base 110. Sliding tracks 112, 122 are provided on base 110 and first supporting plate 120, respectively. First supporting plate 120 is slidable relative to base 110 along Z direction, and second supporting plate 130 is slidable relative to first supporting plate 120, along Y direction. A jig, e.g. a chuck 140 is mounted to second supporting plate 130, and rotatable relative to second supporting plate 130 about the axis of rotation 142 of chuck 140. In this way, chuck 140 is movable relative base 110 along Y and Z directions. In addition, chuck 140 is rotatable relative to base 110 about axis 142.

A detection device 150 is supported on base 110. Detection device 150 has a detector, e.g. camera head 152 mounted thereon and disposed adjacent to chuck 140. As shown in Figs. 4 and 5, in use, a flange 10 is mounted onto chuck 140, e.g. by jaws 144 of chuck 140. Following the rotation of chuck 140, flange 10 rotates relative to camera head 152 and a profile of the inner surface or bore 14 of flange 10 can be measured by camera head 152. Depending on the alignment accuracy requirements, e.g. the dimensional and positional tolerances of the flange and the pipe, the measurement may be carried out and data obtained along one or more predetermined data sampling lines 16, as shown in Fig. 6. Based on the orientation and the length of chords 16a (only one is indicated in Fig. 6 for

illustration) along each data sampling line 16, the alignment position reference point 12 of flange 10 can be determined.

In the present embodiment, alignment is carried out in a situation where a position reference point 22 of pipe 20 is known, e.g. with reference to the given diameter of the pipe, the positions of the support racks 170 and its positional relationship with respect to base 110 of the apparatus 100. Upon determination of the position reference point 12 of flange 10, the distance and orientation between position reference point 12 of flange 10 and position reference point 22 of pipe 20 can be derived and thereafter, chuck 140 is moved, through the movement of first supporting plate 120 and/or second supporting plate 130, along Z and/or Y direction(s) by the determined distance and along the direction to bring the flange 10 into alignment with the pipe 20. Welding can then be carried out to fix the flange to the pipe to complete the fabrication work.

Referring again to Fig. 3, first and second supporting plates 120, 130 may be driven by a respective step motor (not shown), and apparatus 100 may include a controller 102 coupled to detection device 150 and the step motors of first supporting plate 120 and second supporting plate 130. Measurement results from data sampling lines 16 may be transmitted to controller 102 and processed to determine alignment position reference point 12 of flange 10. Controller 102 then controls the movement of first and second supporting plates 120, 130, based on the position reference point 12 of flange 10 and through the step motors, to move chuck 140 along Z and/or Y direction(s), to bring flange 10 into alignment with pipe 20.

In another embodiment, as shown in Fig. 7, an apparatus 200 includes a base 210, first and second supporting plates 220, 230 and a chuck 240 configured in a manner similar to the previous embodiment. Apparatus 200 further includes racks 270 for supporting a pipe thereon for determining a pipe position reference for alignment and welding with a flange. A detection device 250 is mounted to base 210. Detection device 250 has a camera head 252 which is movably attached thereto. Position of camera head 252 is therefore adjustable to measure, in addition to the inner surface profile of flange 10, the external surface profile of a pipe 20'. Apparatus according to the present embodiment

may be used in situations where the position reference point, e.g. alignment center of pipe 20' is unknown. In such situation, camera head 254 is positioned facing the pipe 20' and with the rotation of pipe 20' relative to racks 270, e.g., with the assistance of rollers 272 mounted to racks 270, an external surface 24' of pipe 20' is measured and data obtained along predetermined data sampling lines 26 together with the measurements made to the inner surface 14 of flange 10', as shown in Fig. 8. Based on the orientation of each data sampling line 26, the length of chords 26a of inner surface 14 of flange 10', the length of chords 26b of the external surface of pipe 20' along each data sampling line 26 as well as the difference 26c between chords 26a and 26b, the alignment position reference point 12' of flange 10' and the alignment position reference point 22' of pipe 20' can be determined.

Based on the alignment position reference point 12' of flange 10', the alignment position reference point 22' of pipe 20', the positional relationship between the flange 10, 10' and pipe 20 or 20' is determined. The chuck 240 can then be moved accordingly to bring the flange into alignment with the pipe. When flange 10 is in correct alignment with pipe 20 (Fig. 3), and flange 10' is in correct alignment with pipe 20' (Fig. 7), the flange 10, 10' and pipe 20 or 20' can be moved together, e.g. along X direction, to enable welding of the flange to the pipe at correct alignment position, as shown in Fig. 9.

In a flange-pipe alignment method 500 as shown in Fig. 10, a flange is mounted to a jig (block 510). A profile of an inner surface of the flange is measured (block 520). According to the measured inner surface profile, a flange position reference can be determined (block 530). The jig is then moved based on the flange position reference to bring the flange into alignment with the pipe.

Although embodiments of the present invention have been illustrated in conjunction with the accompanying drawings and described in the foregoing detailed description, it should be appreciated that the present invention is not limited to the embodiments disclosed. Therefore, the present invention should be understood to be capable of numerous rearrangements, modifications, alternatives and substitutions without departing from the spirit of the invention as set forth and recited by the following claims.

CLAIMS

1. An apparatus for aligning a flange to a pipe, the apparatus comprising:
 - a base;
 - 5 a jig movably supported on the base, wherein the jig is to mount the flange thereon;
 - a rack for supporting the pipe;
 - a detector attached to the base and disposed adjacent to the jig, wherein the detector is to determine a flange position reference;
 - 10 wherein the jig is to move the flange based on the flange position reference to align the flange to the pipe.
2. The apparatus of claim 1, further comprising a first supporting plate slidably mounted to the base and a second supporting plate slidably mounted to the first supporting plate, wherein the jig is rotatably mounted to the second supporting plate.
- 15 3. The apparatus of claim 2, wherein the jig is rotatable relative to the detector by which the detector measures a profile of an inner surface of the flange to determine the flange position reference.
- 20 4. The apparatus of claim 2, wherein the detector is movable relative to the base to measure a profile of an outer surface of the pipe to determine a pipe position reference.
- 25 5. The apparatus of claim 4, wherein the rack is to rotatably support the pipe by which the pipe is rotatable relative to the detector for the measurement of the outer surface of the pipe to determine the pipe position reference.
- 30 6. The apparatus of claim 2, further comprising a controller coupled to the detection device and the first and second supporting plates, wherein the controller is to move the jig based on the flange position reference to align the flange to the pipe.

7. A method for aligning a flange to a pipe, the method comprising:
 - mounting the flange to a jig;
 - measuring an inner surface profile of the flange;
 - 5 determining a flange position reference according to the inner surface profile;
 - moving the jig based on the flange position reference to align the flange to the pipe.
8. The method of claim 7, wherein measuring an inner surface profile of the flange
 - 10 including positioning a detector adjacent to the jig, rotating the jig with respect to the detector and capturing chord lengths of the inner surface of the flange along predetermined data sampling lines.
9. The method of claim 7, further comprising measuring an external surface profile of the pipe, determining a pipe position reference according to the external surface
 - 15 profile, and moving the jig based on the flange position reference and the pipe position reference to align the flange to the pipe.
10. The method of claim 9, wherein measuring an external surface profile of the pipe
 - 20 including positioning a detector adjacent to the pipe, rotating the pipe with respect to the detector and capturing chord lengths of the external surface of the pipe along predetermined data sampling lines.