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(54) **ORBITAL WELDING APPARATUS**

(76) Inventor: **Paul John Berbakov**, Coconut Creek, FL (US)

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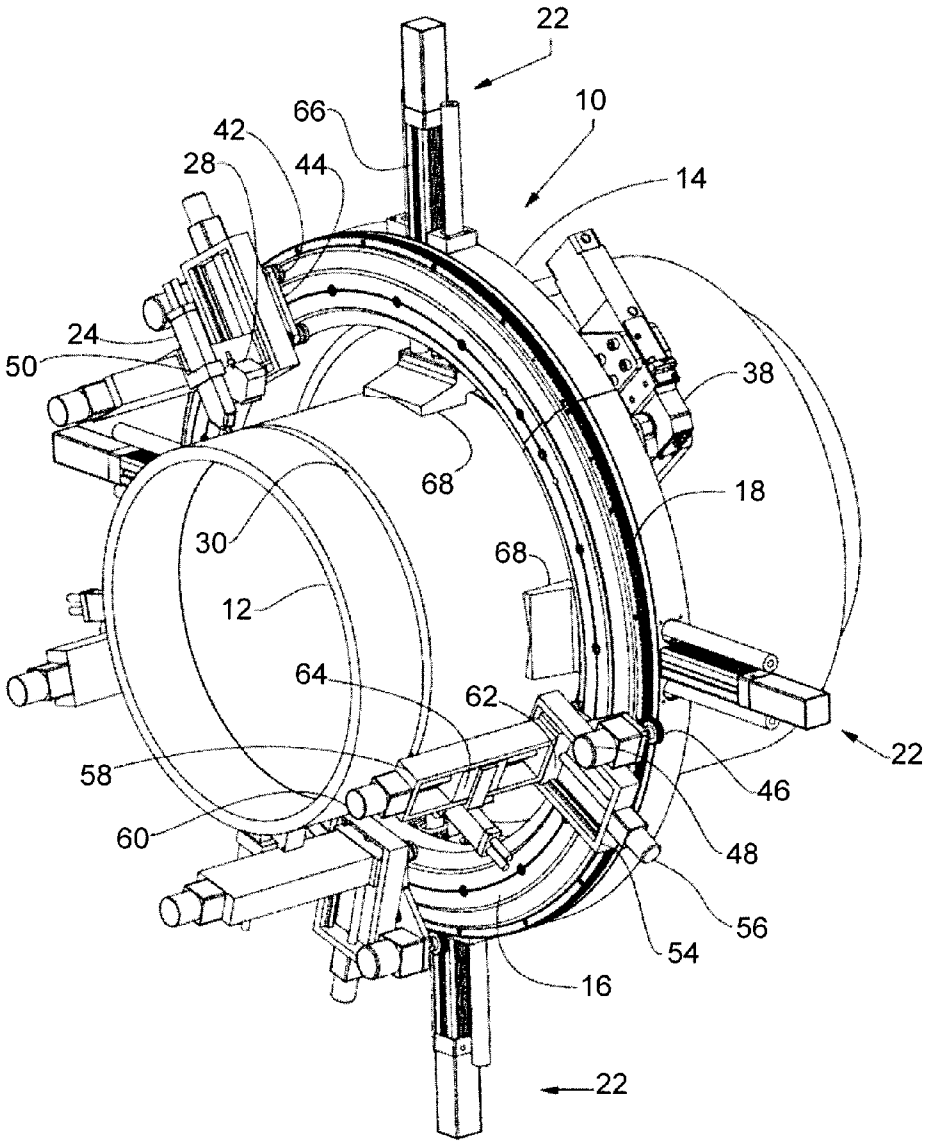
(57) **ABSTRACT**

A pipe welding arrangement that allows for real-time independent control of all carriages, torches, and ancillary components by design. The invention uses a split-ring race that is mounted on a backing ring of similar design. Numerous welding heads are mounted on carriages that are distributed at set intervals along the circumference of the race. The left and right side race and backing ring assemblies are split at the twelve o'clock and six o'clock positions. They can be decoupled and spread apart horizontally to facilitate installation and for clearing obstacles. Alignment tools (tapered pins) facilitate assembly. Locking devices located near each split interface, coupled with the alignment pins, assure that the race acts as a continuous unit during the welding operation. Linear actuators mounted on the backing rings maintain concentricity between the race and the welded tube and act as a positive clamping system.



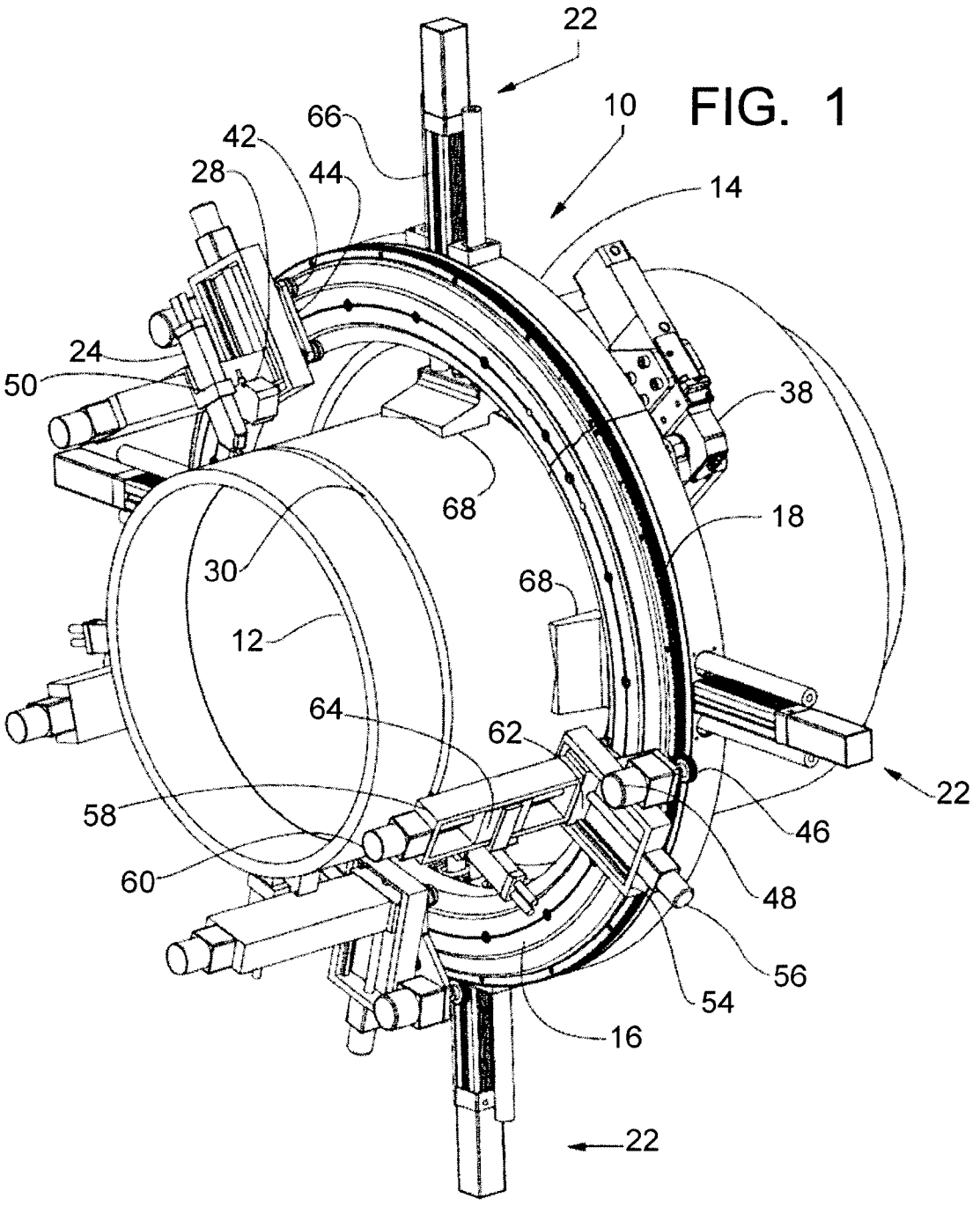

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FIG. 1

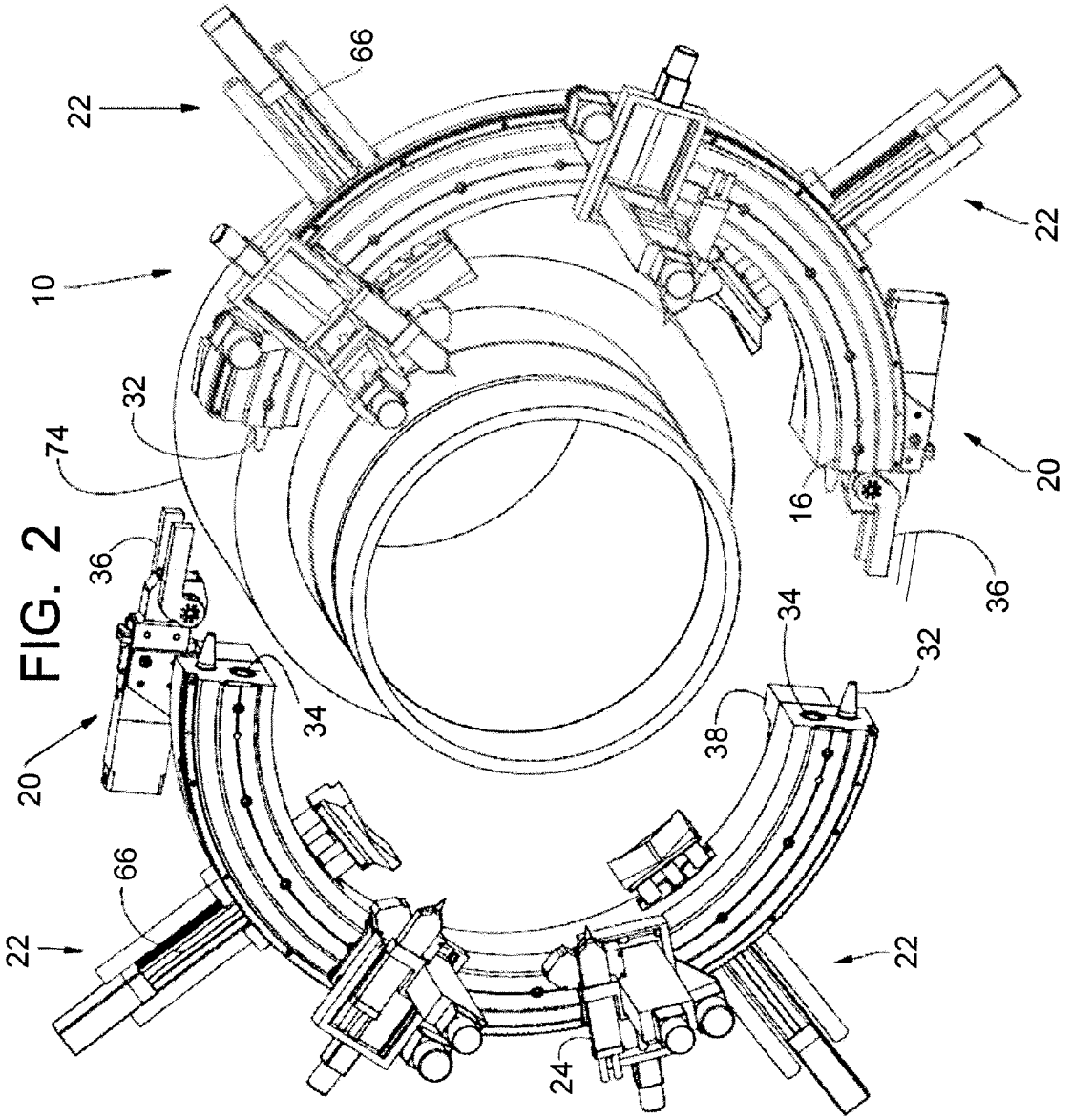
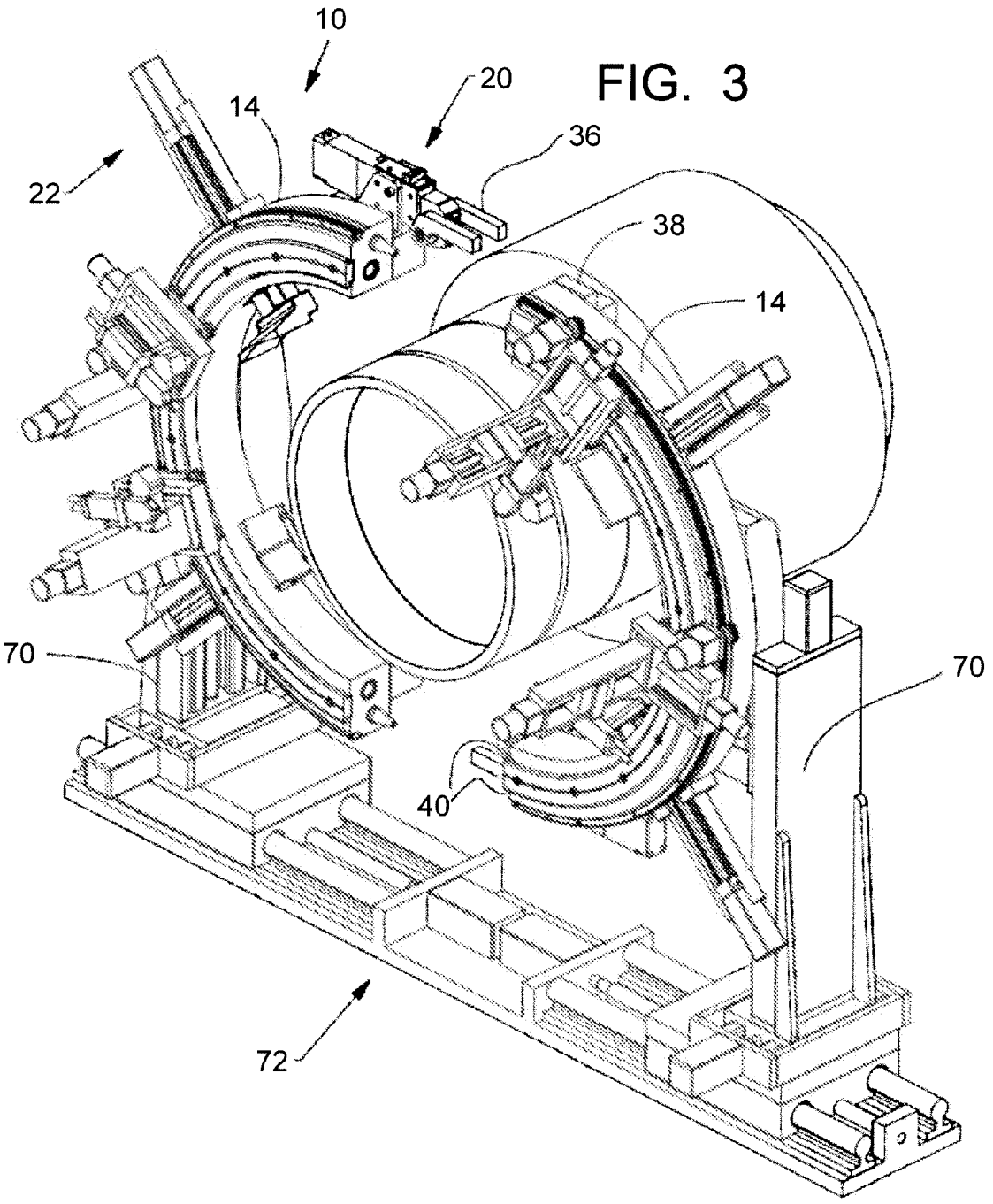


FIG. 2

FIG. 3



ORBITAL WELDING APPARATUS

FIELD AND BACKGROUND OF INVENTION

[0001] The invention is generally related to the automatic pipe welding process and, more particularly, to the simultaneous and independent control of multi-carriage/multi-torch arrangements.

[0002] Pipeline welding has evolved over the years from manual welding to single head semi-automatic orbital welding, to multiple-head automatic welding. Each new method came with improvements in quality and productivity. However, the latest approach was not able to achieve its theoretical maximum potential because of its inability to control all parameters of each welding head independently, particularly velocity and acceleration. Also, these machines lack the ability to provide the clearances that nozzles and other large attachments require.

[0003] Automatic welding systems generally consist of one or more welding torches, a circular race concentric to the pipes to be joined, and a motorized carriage (normally referred to as a "bug") that carries the weld heads and some ancillary equipment along a weld seam. The circular race has a clamshell design that is hinged at one end and installed manually over the tubes. This is the most common method for orbital welding of pipelines. Its drawbacks are long set-up times and single carriage operation.

[0004] Another approach is to use one or two continuous races supported on a stationary frame that has multiple welding heads mounted at fixed intervals. Here the carriage is a complete or partial ring where two or more welding heads are mounted. This approach allows for multi-torch simultaneous operation, but it does not allow for independent velocity/acceleration control of each weld head.

SUMMARY OF INVENTION

[0005] The present invention is drawn to an arrangement that allows for real-time independent control of all carriages, torches, and ancillary components by design. The invention uses a split-ring race that is mounted on a backing ring of similar design. Numerous welding heads are mounted on carriages that are distributed at set intervals along the circumference of the race. The left and right side race and backing ring assemblies are split at the twelve o'clock and six o'clock positions. They can be decoupled and spread apart horizontally to facilitate installation and for clearing obstacles. Alignment tools (tapered pins) facilitate assembly. Locking devices located near each split interface, coupled with the alignment pins, assure that the race acts as a continuous unit during the welding operation. Linear actuators mounted on the backing rings maintain concentricity between the race and the welded tube and act as a positive clamping system. They also maintain perpendicularity between the axis of the pipe and the plane of the split race.

[0006] The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming part of this disclosure. For a better understanding of the present invention, and the operating advantages attained by its use, reference is made to the accompanying drawings and descriptive matter, forming a part of this disclosure, in which a preferred embodiment of the invention is illustrated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] In the accompanying drawings, forming a part of this specification, and in which reference numerals shown in the drawings designate like or corresponding parts throughout the same:

[0008] FIG. **1** is a perspective view of the invention in the closed position.

[0009] FIG. **2** is a perspective view of the invention in the open position.

[0010] FIG. **3** is a perspective view of the invention in the open position and mounted on a manipulator structure.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0011] As seen in FIGS. **2** and **3**, the invention is an orbital pipe welding apparatus **10** that is split into two halves designed to be attached together around a pipe segment **12** as seen in FIG. **1**. The orbital welding apparatus **10** is generally comprised of two separate backing rings **14**, circular race **16**, circular gear rack **18**, locking means **20** for locking the two backing rings together, means **22** for securing the apparatus **10** in welding position to and around work pieces to be welded together (a pipe segment **12**), welding torches **24**, means **26** for holding and moving the welding torches **24**, and scanning means **28** for scanning and tracking the weld area **30**.

[0012] As seen in FIGS. **2** and **3**, each backing ring **14** is semi-circular and provided with alignment means such as tapered pins **32** and bores **34** to receive the pins **32**. This insures correct alignment of both halves when they are engaged as illustrated in FIG. **1**.

[0013] Each half is provided with locking means **20** (attached to the backing rings **14**) which is comprised of one portion with a prong **36** and a second portion with a receptacle **38** for receiving the prong **36**. Prong **36** is received in receptacle **38** and rotated to lock the two halves of the welding apparatus **10** together.

[0014] Circular race **16** is provided with grooves **40**, best seen in FIG. **3**, for receiving rollers **42** on welding carriages **44**. Welding carriages **44** are selectively caused to move along the circumference of the welding apparatus **10** by the use of a pinion gear **46** and drive motor **48** attached to the carriages **44**.

[0015] Also attached to each welding carriage **44** are a welding torch holder **50**, a welding torch **52**, a vertical slide **54**, a vertical slide drive motor **56**, a horizontal/axial slide **58**, and a horizontal/axial slide drive motor **60**. The vertical and axial slides **54** and **58** each use a screw drive to move a plate on the screw in a manner that is generally known.

[0016] The axial slide **58** is attached to the movable plate **62** of the vertical slide **54** (best seen in FIG. **1**). The welding torch holder **50** and scanning means **28** are attached to the movable plate **64** (best seen in FIG. **1**) of the axial slide **58**.

[0017] Means **22** for securing the welding apparatus **10** in position to and around a pipe **12** for welding operations is provided in the form of a plurality of linear actuators **66** and linear actuator feet **68** spaced around each backing ring **14**.

[0018] In operation, each half of the welding apparatus **10** is preferably mounted on left and right side manipulators **70** of a lateral base slide **72**. The manipulators **70** are mounted on the base slide **72** so as to allow selective motion of the manipulators **70** to move the welding apparatus **10** between open and closed positions. The manipulators **70** are posi-

tioned so as to have the welding apparatus **10** in the open position as seen in FIGS. **2** and **3**.

[0019] A section of pipe, which may or may not have a coating **74** applied, is positioned so as to preferably be coaxial with the two halves of welding apparatus **10** and a section of pipe **12** to be added is also placed in position as seen in FIG. **3** such that one end is in contact and aligned with the first section of pipe. The manipulators **70** are moved along the base **72** to cause both halves of welding apparatus **10** to engage. Tapered pins **32** are received in bores **34** to insure alignment and form a continuous circle with backing rings **14**, race **16**, and gear rack **18**. Locking means **20** is used to lock both backing rings **14** together. Linear actuators **66** move actuator feet **68** into contact with the pipe to maintain the pipe in coaxial alignment with the welding apparatus **10**. They also maintain perpendicularity between the axis of the pipe **12** and the plane of the split race **16**.

[0020] Weld area scanning means **28** and vertical and axial slides **54**, **58** are used in conjunction to scan the weld seam area and position and move the welding torches **24** vertically and axially to weld the two pipe sections together while they are rotated around the pipe by pinion gears **46** and drive motors **48**.

[0021] The invention provides several advantages.

[0022] Set up times are reduced by having the welding apparatus split into two halves that are designed to be aligned and form a continuous circle when brought together.

[0023] The two halves of the apparatus allow it to be opened to facilitate installation of the pipe and for clearing obstacles on the pipe.

[0024] Multiple welding heads are provided for simultaneous operation.

[0025] The multiple welding heads are capable of independent control for velocity and acceleration.

[0026] While specific embodiments and/or details of the invention have been shown and described above to illustrate the application of the principles of the invention, it is understood that this invention may be embodied as more fully described in the claims, or as otherwise known by those skilled in the art (including any and all equivalents), without departing from such principles.

What is claimed as invention is:

1. An orbital welding apparatus, comprising:

a. two separate semi-circular backing rings;

b. alignment means for joining the backing rings to form a continuous circle; and

c. at least one welding torch received on each backing ring for independent movement of each welding torch around the circumference of the backing rings during welding operations.

2. The orbital welding apparatus of claim **1**, further comprising means for selectively moving the welding torches on two linear axes relative to the weld area.

3. The orbital welding apparatus of claim **1**, further comprising means for scanning and tracking the weld area.

4. The orbital welding apparatus of claim **1**, further comprising means for locking the two backing rings together in a continuous circle.

5. The orbital welding apparatus of claim **1**, further comprising means mounted on the backing rings for securing the backing rings in position to and around work pieces to be welded together.

6. An orbital welding apparatus, comprising:

a. two separate semi-circular backing rings;

b. alignment means for joining the backing rings to form a continuous circle;

c. at least one welding torch received on each backing ring for independent movement of each welding torch around the circumference of the backing rings during welding operations;

d. means for selectively moving the welding torches on two linear axes relative to the weld area; and

e. means for scanning and tracking the weld area.

7. The orbital welding apparatus of claim **6**, further comprising means for locking the two backing rings together in a continuous circle.

8. The orbital welding apparatus of claim **6**, further comprising means mounted on the backing rings for securing the backing rings in position to and around work pieces to be welded together.

9. An orbital welding apparatus, comprising:

a. two separate semi-circular backing rings;

b. alignment means for joining the backing rings to form a continuous circle;

c. at least one welding torch received on each backing ring for independent movement of each welding torch around the circumference of the backing rings during welding operations;

d. means for selectively moving the welding torches on two linear axes relative to the weld area;

e. means for scanning and tracking the weld area; and

f. means for locking the two backing rings together in a continuous circle.

10. The orbital welding apparatus of claim **9**, further comprising means mounted on the backing rings for securing the backing rings in position to and around work pieces to be welded together.

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