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(54) **Title**: LASER CONTROLLED INTERNAL WELDING MACHINE FOR PIPELINES

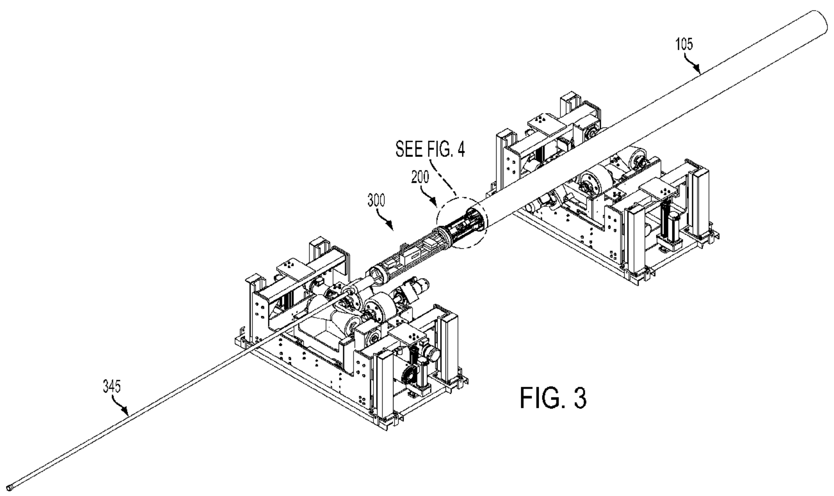

FIG. 3

(57) **Abstract**: The present invention is directed to a system for welding together segments of a pipeline. The system includes an external alignment mechanism for externally supporting and manipulating the orientation of pipe segments in order to align relative segments. The system also includes an internal welding mechanism for applying a weld to an interior face joint of the two abutted pipe segments. The internal welding mechanism including a torch for applying a weld, a laser for tracking the weld profile and guiding an articulating head of the torch, and a camera for visually inspecting the weld after the weld is applied.

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# LASER CONTROLLED INTERNAL WELDING MACHINE FOR PIPELINES

## CROSS-REFERENCE TO RELATED APPLICATIONS

**[001]** This application claims priority, under 35 U.S.C. § 119(a)-(d), to US Provisional application 61/826628, filed May 23, 2013, the contents of which are incorporated herein by reference in its entirety.

## FIELD OF THE INVENTION

**[002]** The present invention is directed to a system for aligning and connecting two pipe segments together by welding.

## BACKGROUND OF THE INVENTION

**[003]** Conventional internal welders frequently include internal alignment mechanisms that expand radially outward to contact the interior of the pipe. Alignment of the two pipe segments is accomplished from inside when extension members of a central member contact the interior of the pipe relatively close to the pipe segment joint faces on either side of the joint as shown in U.S. Patent No. 3,461,264; 3,009,048; 3,551,636; 3,612,808 and GB 1261814 (which is each incorporated herein by reference in its entirety). In order to weld the joint, the structure of the expander must allow sufficient space to accommodate a rotating torch. It would therefore be advantageous to provide internal alignment that allows sufficient space for a rotating or articulating torch or to align the pipe segments externally so as to eliminate the need for an internal expander which may create significant internal clutter.

**[004]** In addition, the conventional process of internal welding usually involves internal or external alignment and an insertion of the internal welder so that torches align with the face joint. In this process it is sometimes difficult to assess the accuracy of positioning of the internal welder in general and the torch in particular. It is even more difficult to assess the accuracy of the position of the torch as the torch traverses the inside of the pipe along its orbital path during welding. It would therefore be advantageous to provide a system of tracking the structure of or positioning of pipe edges at the pipe interface in order to control the torch by use of the tracked condition of the interface. Specifically, it would be advantageous to first track a profile of the interface with a laser before sending a signal to an electronic controller to direct the position and orientation of the welding torch relative to the tracked pipe interface profile.

**[005]** Furthermore, conventional pipeline welding systems that employ external alignment mechanisms typically support two segments on rollers and manipulate the position and orientation of the segments until alignment is satisfactory. Whether an alignment is satisfactory typically will depend, for example, on industry acceptable high-low gauges that are fairly accurate but are manually operated and positioned at discrete locations and not over the entire pipe interface. In any case, the profile or structure of the interface as observed from the inside of the pipe is not typically a consideration for quality of alignment. It would therefore be advantageous to provide an alignment system in which information about the interface profile as read by the laser is used as an input parameter during the external alignment process. Specifically, it would be advantageous to provide the information from the torch controlling laser to the controller which would utilize the information in controlling external alignment mechanisms.

**[006]** Moreover, conventional pipeline systems for welding pipe segments will typically lack a capability to visually inspect the weld applied by the torch. It therefore would be advantageous to provide a camera that followed the torch weld application and a display for showing an image of the weld in order for an operator to visually inspect the quality of the weld.

**[007]** Other advantages of the present disclosure will be apparent by review of this disclosure. Patentable advantages are not limited to those highlighted in this section.

SUMMARY OF THE INVENTION

**[008]** The present invention system for aligning and welding together the faces of two pipe segments includes an external alignment mechanism and a welding mechanism. The external alignment mechanisms may be as sophisticated as the line up modules shown in the drawings or as simple as a tipton clamp as illustrated in U.S. Patent No. 1,693,064. The mechanisms used may also be suitable for on or off shore pipeline construction. U.S. Patent No. 1,693,064 is incorporated herein by reference in its entirety. Whatever mechanism is employed, the external alignment mechanism supports and adjustably positions each segment so that the segments are substantially collinear or axially aligned along their longitudinal axes.

**[009]** The external alignment mechanism may support a pipe segment and may include powered features that allow the position and orientation of the pipe to be adjusted. Specifically, the external alignment mechanism may include rollers that allow the pipe to move longitudinally. The pipe may also be supported by rollers that allow the pipe to be rolled about the longitudinal axis and moved up and down. The position and orientation adjustments may be automatic as by motor power or hydraulic power controlled at an operator station or fed into a central controller that automatically controls an aligns the segments based on predetermined alignment parameters or feedback from an internal laser reading an interface or joint profile.

**[0010]** The welding mechanism is preferably an internal welding machine that applies a weld (e.g., a gas metal arc weld "GMAW" ) from inside the pipe segments to a face or edge joint of the segment and into a v-shaped opening formed by chamfered edges of the two pipe segments (other cross-sectional shapes other than a V may be used also). The welding mechanism includes a carriage capable of engaging the inner walls of the pipe to secure or lock itself within the pipe in a fixed position and a welding portion rotatably supported from the carriage within the pipe. Specifically, the internal welder is located within the aligned pipe and then positioned longitudinally so that a weld head or torch is in longitudinal proximity to the edge joint. The welding mechanism also includes a rotary mechanism for rotating the welding portion relative to the carriage. The weld head or torch is rotatably supported on the welding portion about the pipe longitudinal axis so that the torch may closely follow the entire interior joint interface in an orbital rotation. Specifically, during welding, the torch of the articulating head follows the edge joint around the entire interior circumference of the pipe applying weld material. In addition to circular rotation relative to the carriage, various control elements may move the weld head axially along the pipe relative to the carriage, radially toward and away from the joint, and pivotally about a point or axis (e.g., an axis parallel or perpendicular to pipe longitudinal axis A-A). A controller may direct the torches pivoting. These degrees of freedom of articulation allow the weld head to be very effective and efficient in filling in interface profiles optimally and where necessary.

**[0011]** The welding mechanism also includes a laser tracking mechanism that works in conjunction with the torch of the welding portion to sense interface joint profile or/and weld material profile to apply weld material to the edge joint in the appropriate location and amount. The laser mechanism surveys the weld and sends a signal to the controller of the articulating weld head to control movement of the head around the entire edge joint. Specifically, the torch follows the laser as the weld head control system continuously receives weld profile information from the edge joint. The information is then used to continuously adjust the torch to achieve the desired weld structure.

**[0012]** In addition to the laser tracking mechanism, the system may include a 2D camera for visual inspection of the weld. The 2D camera is mounted on the welding portion and follows the torch so that an operator can inspect the weld as soon as it is created by the torch. A visual signal is delivered to an external operator display. For example, the 2D camera may be a color camera and a change in coloration may indicate a weld defect to the operator. A perceived change in profile may also indicate a defect.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0013]** FIG. 1 illustrates a perspective view of a pipe welding system of the present invention showing two externally aligned pipe segments supported on alignment mechanisms.

**[0014]** FIG. 2 illustrates an enlarged external view of a pipe interface of two segments to be welded using the system of Figure 1.

**[0015]** FIG. 3 illustrates the system of Figure 1 showing a welding mechanism inserted into a segment according to Figure 1.

**[0016]** FIG. 4 illustrates an enlarged view of a section of Figure 3 showing the welding portion of the welding mechanism positioned for welding in a pipe segment according to Figure 1.

**[0017]** FIG. 5 illustrates a cross-sectional view of Figure 4 cut through B-B showing the arrangement of various weld portion elements.

**[0018]** FIGS. 6 and 7 illustrate side views of the welding mechanism of Figure 1.

**[0019]** FIG. 8 illustrates a perspective view of the system of Figure 1 in a configuration showing a first step of use in which a pipe segment is place on an external alignment mechanism.

**[0020]** FIG. 9 illustrates a perspective view the system of Figure 1 in a configuration showing a step subsequent to Figure 8 in which a welding mechanism is inserted into a pipe segment.

**[0021]** FIG. 10 illustrates a side view of the welding portion of the system of Figure 1.

**[0022]** FIG. 11 illustrates an enlarged perspective view of a section of the welding portion of the system of Figure 1.

**[0023]** FIG. 12 illustrates another enlarged perspective view of a section of the welding portion of the system of Figure 1.

**[0024]** FIG. 13 illustrates an enlarged perspective view of the rotary mechanism of the system of Figure 1.

**[0025]** Like reference numerals have been used to identify like elements throughout this disclosure.

## DETAILED DESCRIPTION OF THE INVENTION

**[0026]** Referring to FIGS. 1-3, the system for welding pipeline segments together is described as follows. Figure 1 shows an external alignment mechanism **10A** and **10B** which is capable of supporting, positioning, and repositioning multiple lengths of pipeline. Each mechanism **10A** and **10B** may include supports (e.g., rollers) upon which a length of pipeline may be supported. A longitudinal roller **12** moveably supports pipeline segment **105** such that segment **105** may be repositioned along its longitudinal direction defined by arrow **A**. In addition, rotational rollers **14** are rotatable about an axis parallel to axis **A-A** of support segment **105** on either side of segment **105** enabling them to rotate or adjust the angular orientation of segment **105** about axis **A-A**. External alignment mechanism **10** is able to automatically manipulate multiple segments into various positions and orientations via motors, hydraulics, etc. For example the segments may be raised, lowered, rotated, tilted, pivoted, etc.

**[0027]** As shown in Figure 1, external alignment mechanisms **10A** and **10B** support multiple segments **105**, **110** and adjust their position and orientation until segments **105**, **110** are both aligned such that their longitudinal axes **A-A** are collinear and one end of each of the segments **105**, **110** abuts at interface edges. Specifically, Figure 2 illustrates an enlarged view of detail **100** of Figure 1 in which the edges form a pipe interface **120** (known as a "fit up" joint).

**[0028]** The pipeline aligning and welding system of the present invention applies a weld to the interior of the interface **120** from inside the fitted up segments **105**, **110**. To apply a weld to the interior of joint **120**, an internal welding mechanism **300** is rolled into an end of one of the segments **105** as shown in Figure 3. A second segment **110** is then placed on external alignment mechanism **10B** and manipulated until both segments **105**, **110** are satisfactorily aligned. An external force may then be applied to a reach rod **345** of the internal welding mechanism **300** or the mechanism may include automatic self propulsion means for adjusting its axial position within the aligned segments **105**, **110**.

**[0029]** As shown in Figures 4 -7, welding mechanism **300** includes a carriage **301** and a welding portion **302**. Carriage **301** includes at least one alignment mechanism **340A, 340B** which may expand radially to engage the interior surface of segments **105** or **110**. This expansion and engagement both secures the axial/longitudinal position of welding mechanism **300** relative to segment **105**, **110** and aligns or radially centers welding mechanism **300** within segments **105**, **110**. Carriage **301** also includes a body **311** on which rotating mechanism **335** is supported. Body **311** is comprised of multiple elongated structural support members that extend between alignment mechanism **340A** and **340B**. As discussed below welding portion **302** includes a similar corresponding structure **313.**

**[0030]** Welding portion **302** is rotatably connected to carriage **301** and extends from an end of carriage **301**. The relative rotation between carriage **301** and welding portion **302** is facilitated by a rotary mechanism **335.** Rotary mechanism **335** is secured to carriage **301** and automatically (via a motor and gears) rotates welding portion **302** relative to carriage **301** about longitudinal axis A. Welding portion **302** may be cantilevered from carriage **301** or may be supported by an additional alignment mechanism **340C** located so that torch **305** is positioned between alignment mechanisms **340B** and **340C**. When alignment mechanism **340C** is provided, welding portion **302** is rotatable relative to and between both alignment mechanisms **340B** and **340C** when alignment mechanisms **340B** and **340C** expand to secure themselves to the interior of a segment. Furthermore, carriage **301** may include a reach rod **345** which can be structured as an elongated extension from carriage **301** which an operator may grasp to insert/push or retract/pull welding mechanism **300** to axially position it within a segment **105**, **110**.

**[0031]** Figure 4 shows an enlarged view of section **200** of Figure 3 in which only segment **105** is present and segment **110** is absent. As shown in Figure 4, welding portion **302** includes a welding group **303** which comprises a torch **305**, a laser sensor **310**, and a color camera **320**. Welding portion **302** further has a body **313** on which torch **305**, laser sensor **310**, and color camera **320** are supported. Laser **310** tracks an interior joint of segments **105**, **110**, and detects an interface profile to be used to position torch **305** in applying a weld to the joint interface. Body **313** extends between alignment mechanism **340B** and **340C.** Section **200** shows welding mechanism **300** located inside segment **105** with torch **305** generally pointed in a radially outward direction and positioned to apply a weld to face joint **120**. Figure 5 shows an embodiment of a general schematic cross-sectional view of welding mechanism **300** through section **B-B** which shows welding group **303** looking in the direction of insertion of welding mechanism **300**. Figure 5 also shows a direction **D** of rotation of welding group **303** when it is rotated by rotary mechanism **335**. Therefore, a welding action on a particular point along weld joint **120** will first be acted on by laser sensor **310** followed by torch **305** and finally by 2D inspection camera **320**.

**[0032]** Figures 10-12 illustrate multiple perspectives of the welding portion **302**. Figure 10 shows a wire delivery system **322**. Wire delivery system **322** includes a wire spool storage **323**, an optional wire straightener **325**, and a wire feed mechanism **330** which is automatically controlled to deliver the appropriate amount of wire to torch **305**. As rotary mechanism **335** rotates welding portion **302**, wire is fed to the torch **305** by wire delivery mechanism **322**.

**[0033]** As mentioned above, torch **305** may be positioned and oriented in multiple ways by multiple mechanisms. Torch **305** is supported on a manipulator. The manipulator includes a radial positioner, an axial positioner and a pivoter. Specifically, a radial positioner **307** (e.g., a rack and pinion) on which torch **305** is supported is capable of moving the torch radially toward and away from the interior surface of segments **105**, **110**. In other words, towards and away from the interface of segments **105**, **110** to be welded. In addition, an axial positioner **309** (e.g., a rack and pinion) may move torch **305** axially within segments **105**, **110**. The manipulator also includes a pivoter **308** that allows the torch to pivot (e.g., about an axis parallel to segment longitudinal axis **A-A**). Pivotal movement by pivoter **308** may be powered by a motor and gears **306**. For example, the motor may be a stepper motor.

**[0034]** The torch manipulator may compound the manipulative movements of the above mentioned elements by dependently supporting the elements. For example, body **313** may support the axial positioner which in turn supports the radial positioner which in turn supports the pivoter which in turn supports the torch. Similarly, the axial positioner may be supported by the radial positioner. Furthermore, any order of support may be employed.

**[0035]** The elements of the manipulator are controlled by a controller which receives as input, a series of signals including a signal from laser **310** and then processes the information before transmitting a signal to at least radial positioner **307** , axial positioner **309**, pivoter

**308**, and wire delivery system **322**. Torch **305** is then repositioned and reoriented continuously according to predetermined parameters of the controller based on signals from profile reading laser **310**.

**[0036]** The operation of the present invention internal welding system will now be described. Figures 1, 8 and 9 illustrate the process of positioning and welding segments **105** and **110** together. In operation, one or more of the following lettered steps may be executed so that: a) a pipe segment **105** is placed on alignment device/pipe stand **10A**; b) internal welding machine **300** is then inserted into pipe segment **105**; c) a second pipe segment **110** is then aligned with pipe segment **105** and welding mechanism **300** is pulled forward by reach rod **345** or automatically driven so that torch **305** generally lines up with faces joint **120** of pipe segments **105**, **110**; d) alignment mechanisms **340A, 340B** (and if necessary **340C)** are then engaged to secure welding mechanism **300** within pipe segments **105**, **110**; e) in one embodiment (optional), rotary mechanism **335** rotates weld head **305** to perform an initial scan of interface joint **120** of pipe segments **105**, **110** by laser sensor device **310** to ensure optimal fit up; f) if required, steps (c), (d) and (e) may be repeated, i.e. pipe segments **105**, **110** are realigned/rotated and rescanned by laser **310**, to improve "fit up"; g) optionally, internal alignment mechanism **340C** on the rear of the welding mechanism **300** is engaged to hold the axial position of welding mechanism **300** with respect to both pipe sections **105**, **110**; h) with welding mechanism **300** secure in pipe segments **105** and **110**, the root weld (first weld) cycle begins so that laser **310** scans pipe interface **120**, torch **305** follows laser **310**, and the output from laser **310** is used to control the position of articulated torch **305**, where the position and orientation of torch **305** with respect to the interface **120** is controlled so as to produce the best quality weld; i) in addition to a signal from laser **310**, thru the arc current monitoring can also be used in directing the torch position; j) after the completion of a 360° weld, weld head **305** is rotated back to an original position; k) the profile (using laser **310**) and the visual inspections (with 2D color camera **320**) are performed either in the previous step (j) or on a separate inspection run; l) after inspection, aligning mechanism **340A-C** are released and welding mechanism **300** is pulled or driven forward towards the open end of welded pipe **105**, **110** and with the nose of welding mechanism **300** exposed, like (b), pipe segment **110** is placed on external alignment mechanism **10B** and advanced to the next joint; m) steps (c) to (l) are then repeated for the entire production run.

**[0037]** In one embodiment, a signal from laser sensor **310** is sent to an electronic controller of external alignment mechanism **10** to automatically reposition one or both of segments **105**, **110** for a more desirable face joint **120** arrangement. Furthermore, the foregoing steps may be executed in the stated order. However, variations in the order are also contemplated.

**[0038]** In another embodiment, instead of stopping after the first 360º weld, the rotation is continued to lay another weld pass, the laser could be used to inspect & track simultaneously while the trailing 2D color camera continues inspection after the second weld.

**[0039]** In still another embodiment, instead of welding a complete 360º weld, the weld is performed in two 180º halves with the same start position. This implementation would require either multiple laser sensors for tracking or a mechanism to physically oscillate the laser and/or the torch in order to maintain the tracking sensor's lead position in both directions of rotation (i.e., rotate the torch and laser so that they switch positions).

**[0040]** While the present invention has been described in detail and with reference to specific embodiments thereof, it will be apparent to one skilled in the art that various changes and modifications can be made therein without departing from the spirit and scope thereof. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents. It is to be understood that terms such as "top", "bottom", "front", "rear", "side", "height", "length", "width", "upper", "lower", "interior", "exterior", and the like as may be used herein, merely describe points of reference and do not limit the present invention to any particular orientation or configuration.

CLAIMS

1. A system for aligning and welding together two segments of a pipe:

a welding mechanism for applying a weld to a face joint of the two segments, the welding mechanism including an articulating torch, a laser sensor for reading a profile of the face joint, and an electronic controller for receiving information signals from the laser sensor to control the position and/or orientation of the torch;

an alignment mechanism for manipulating the orientation of the longitudinal axis of at least one of the segments relative to the other; and

wherein the welding mechanism further includes a carriage for securing a position of the welding mechanism in the pipe and a welding portion capable of rotating relative to the supporting portion within the pipe; and

wherein the torch and the laser sensor are rotatably supported by the welding portion such that during welding, the torch follows the laser sensor along the face joint.

2. The system of claim 1 wherein, the weld mechanism further includes a camera for optically sensing a joint face.

3. The system of claim 1 wherein, the articulating movement of a torch head on the torch may include one of radial translation movement toward and away from the face joint, translation movement in a direction of the longitudinal axis of the segments, pivotal movement relative to the weld mechanism about an axis that is parallel to the pipe segment longitudinal axis and pivotal movement relative to the weld head about an axis that is perpendicular to the pipe segment longitudinal axis.

4. The system of claim 1 wherein, the alignment mechanism manipulates the orientation of the at least one segment by contact with an exterior of the at least one segment.

5. The system of claim 1, wherein the electronic controller receives a signal from the laser sensor to direct the alignment mechanism to adjust the relative positions of the pipe segments based on predetermined alignment parameters.

6. The system of claim 1 wherein, the weld mechanism rotates within and relative to an interior of a face joint of two segments so that the torch follows the laser sensor, the laser sensor providing continuous face joint profile data to the electronic controller which in turn continuously directs the positioning of the torch.

7. The system of claim 2 wherein, the camera follows the torch along a weld joint path, the camera sending a signal to an operation station display to allow an operator to inspect an image of a portion of the weld.

8. A method of aligning and welding together two segments of a pipe comprising the steps of:

placing a first pipe segment on an alignment device;

inserting an internal welding machine having a laser and a weld torch into the first pipe segment;

generally aligning a second pipe segment with the first pipe segment and internal welding machine;

griping an external portion of the first and second pipe segments to adjusting an axial position of the internal welding machine so as to generally line up with a face joint of the first and second pipe segments;

adjusting a relative alignment of the first and second pipe segments via the alignment device based on a signal from the internal welder;

beginning a root weld cycle in which the laser scans the face joint, the torch follows the laser, and the output from the laser is used to control the position of articulated torch, where the position and orientation of the torch with respect to the face joint is controlled to produce a quality weld;

determining a face joint profile from the laser;

releasing the alignment device and removing internal welding machine from an open pipe segment end; and

repositioning a next sequential pipe segment on the external alignment mechanism in preparation for welding of a next joint.

9. The method of claim 8, further comprising the steps of providing a rotary mechanism on which the laser and torch rotate to perform an initial scan of the face joint by laser sensor; and; generating a signal from the rotating laser to direct alignment of the first and pipe second by the alignment device before welding begins.

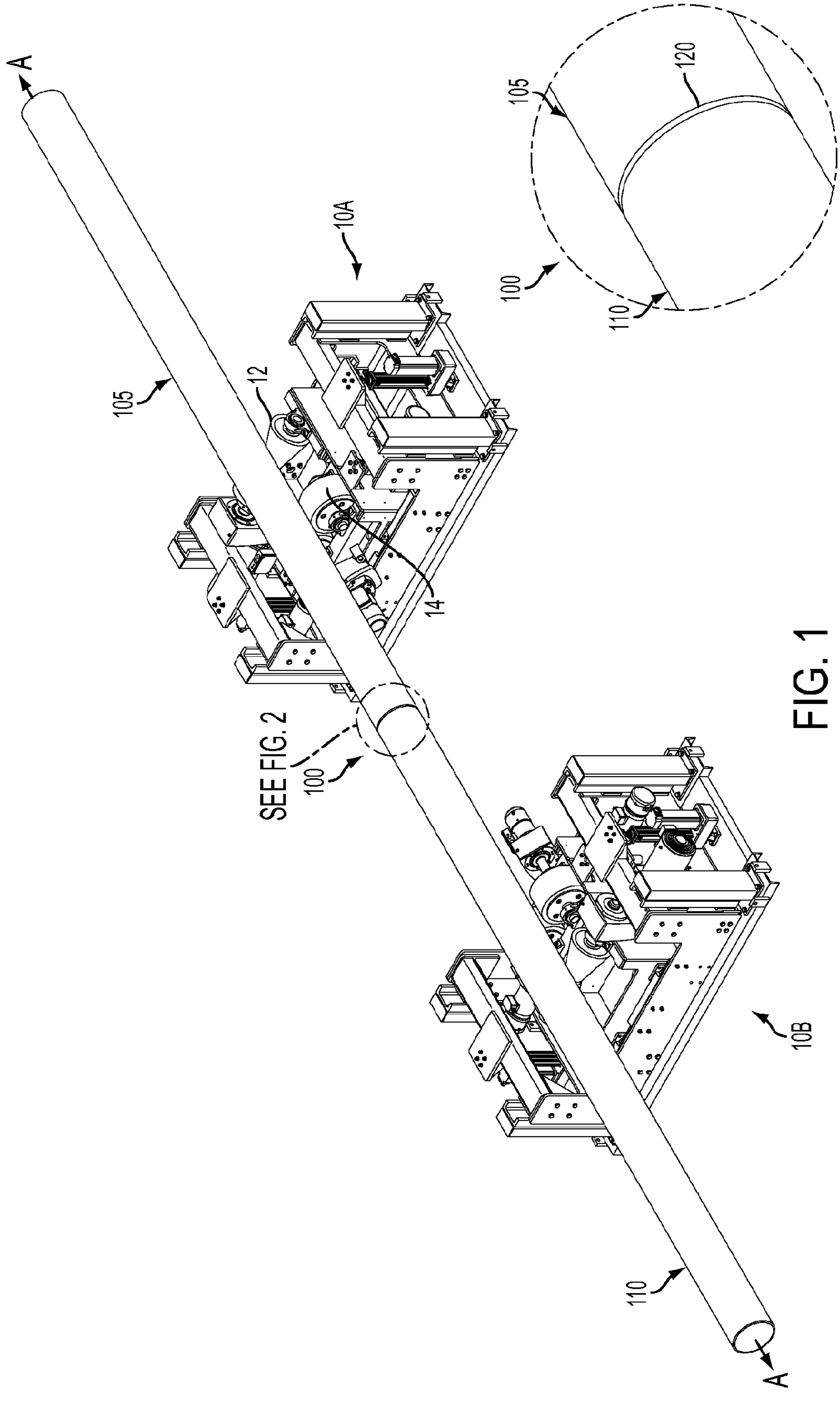



FIG. 2

FIG. 1

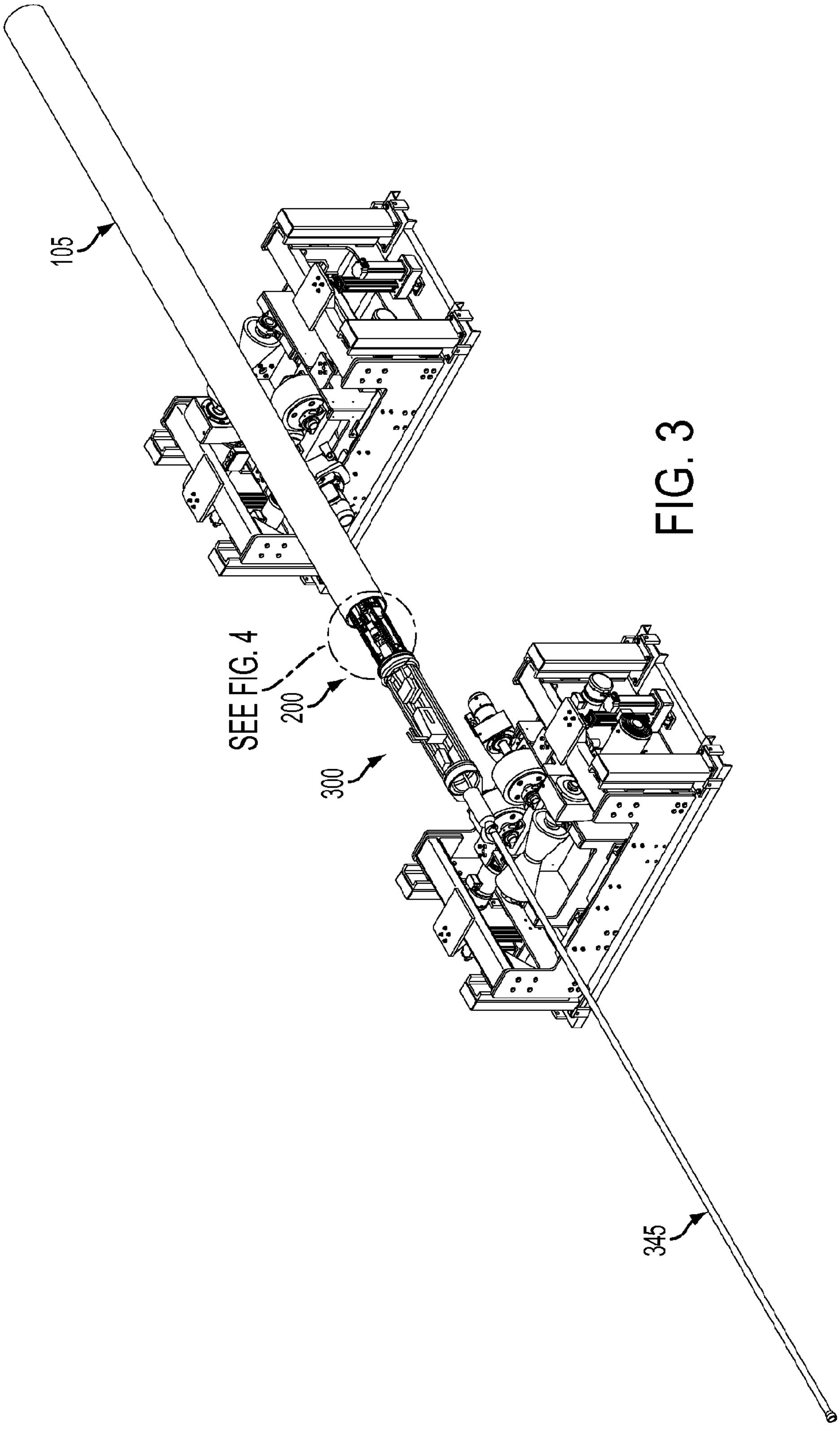



FIG. 3

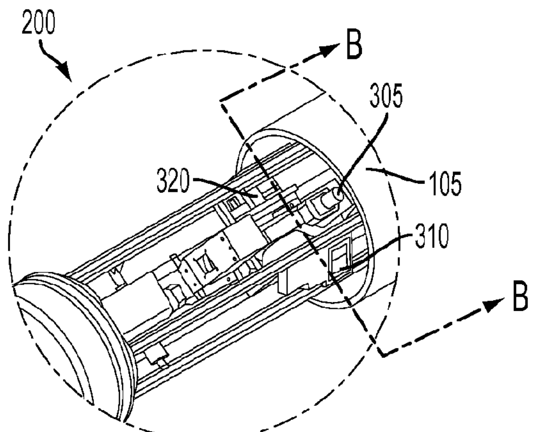



FIG. 4

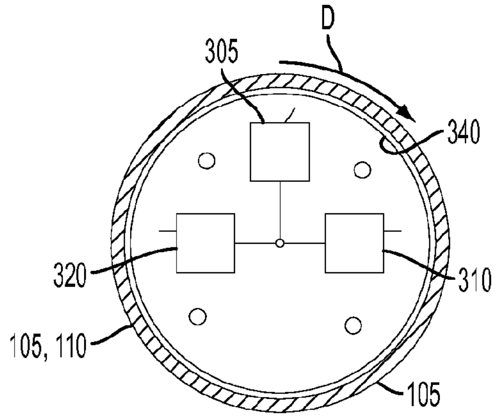
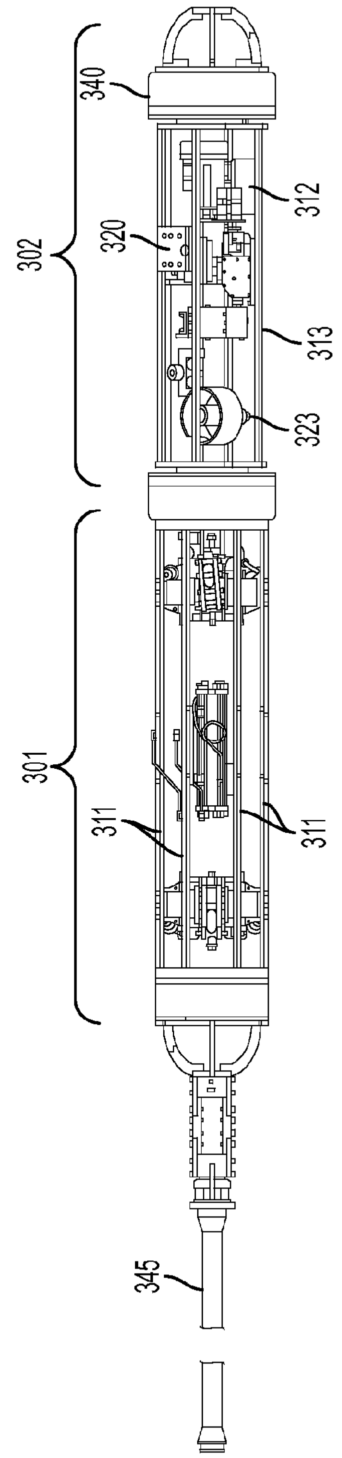



FIG. 5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323
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311
311
345

FIG. 6

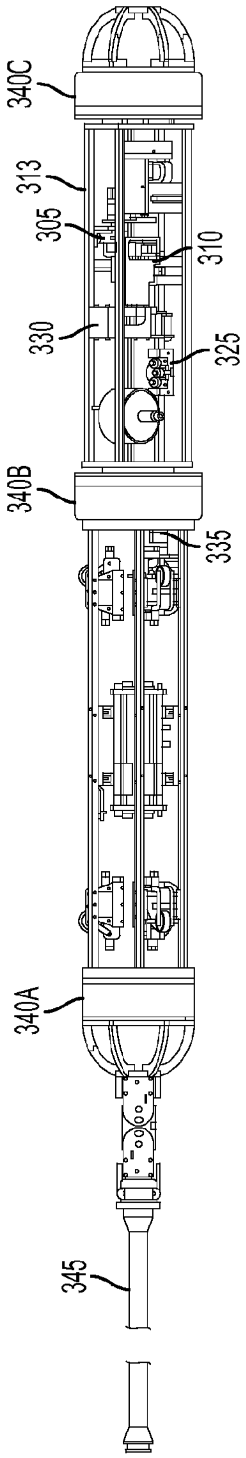
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FIG. 7

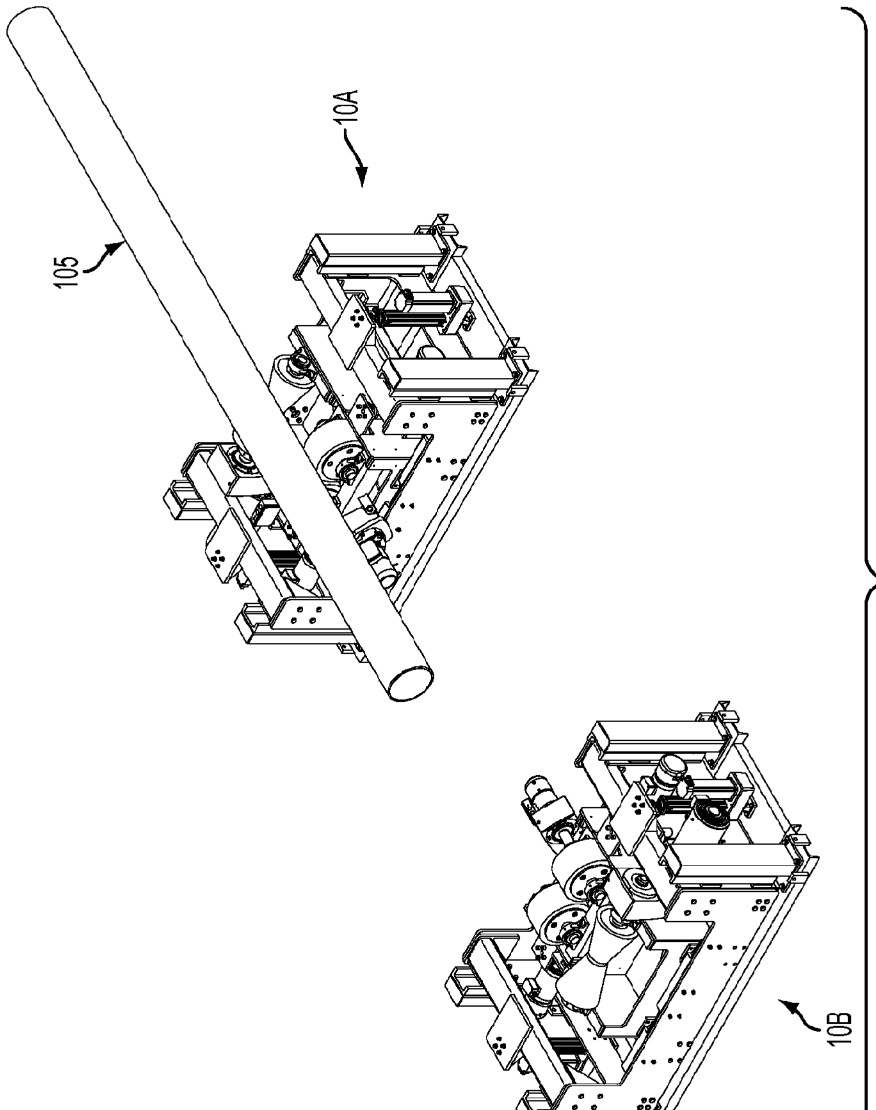


FIG. 8

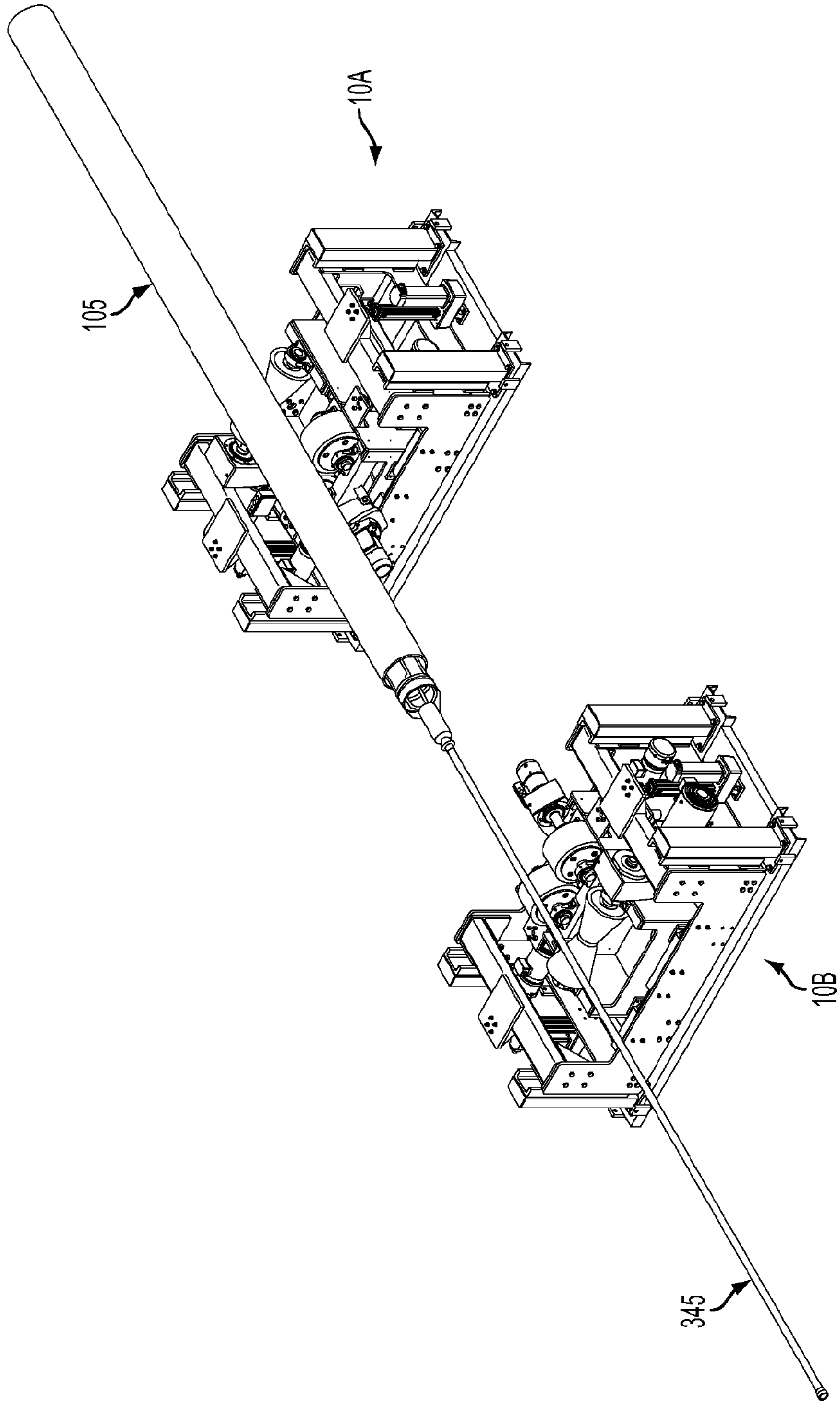


FIG. 9

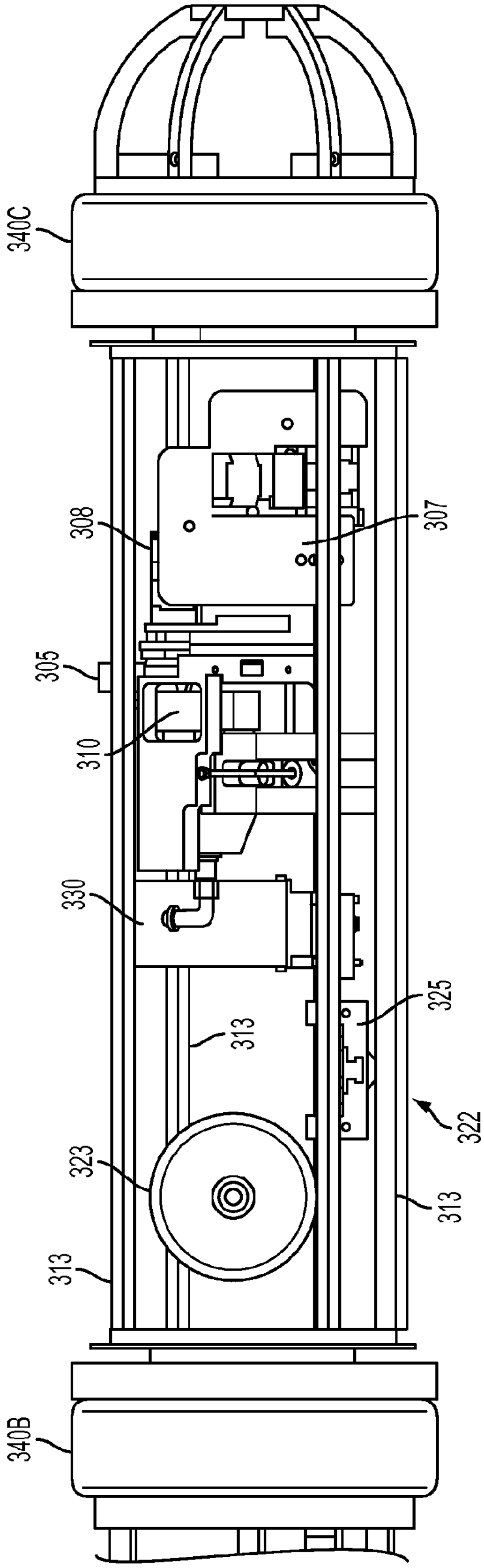


FIG. 10

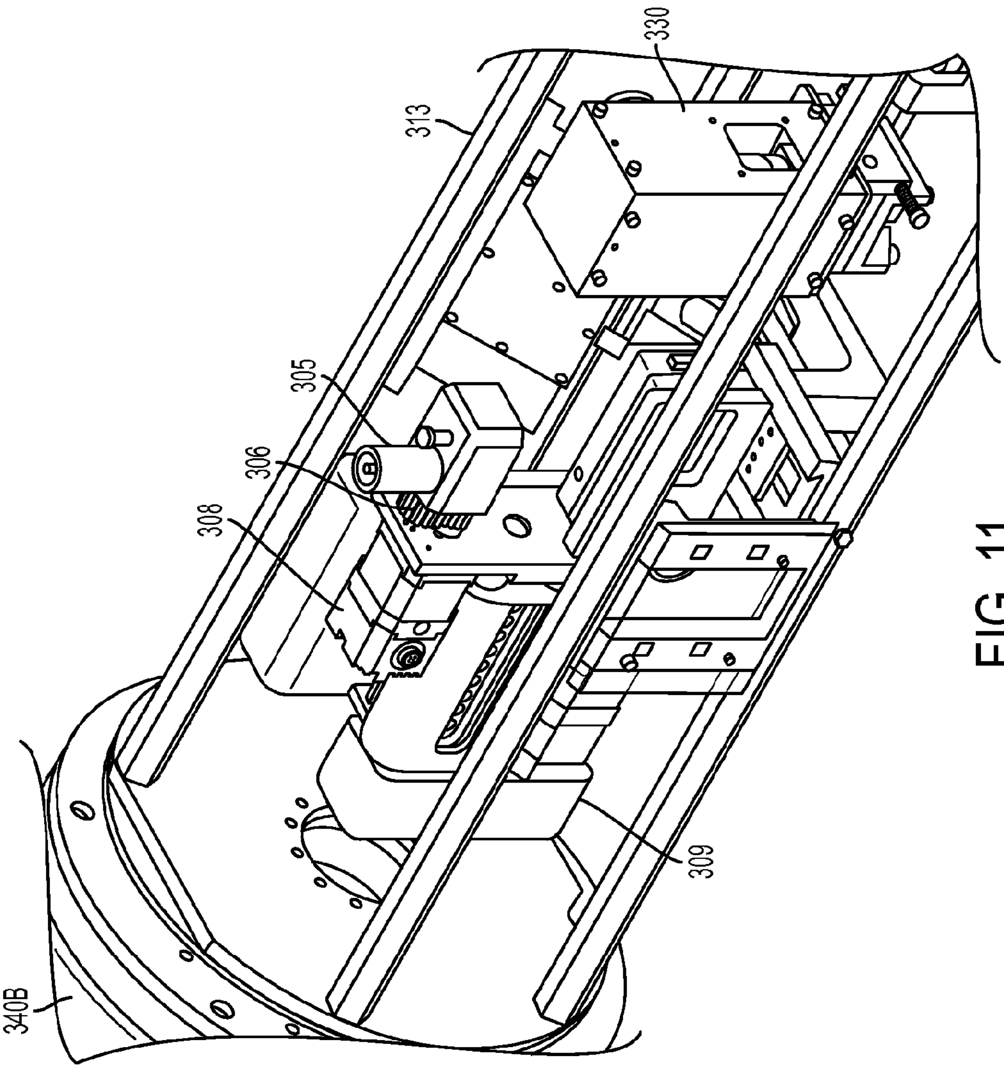


FIG. 11

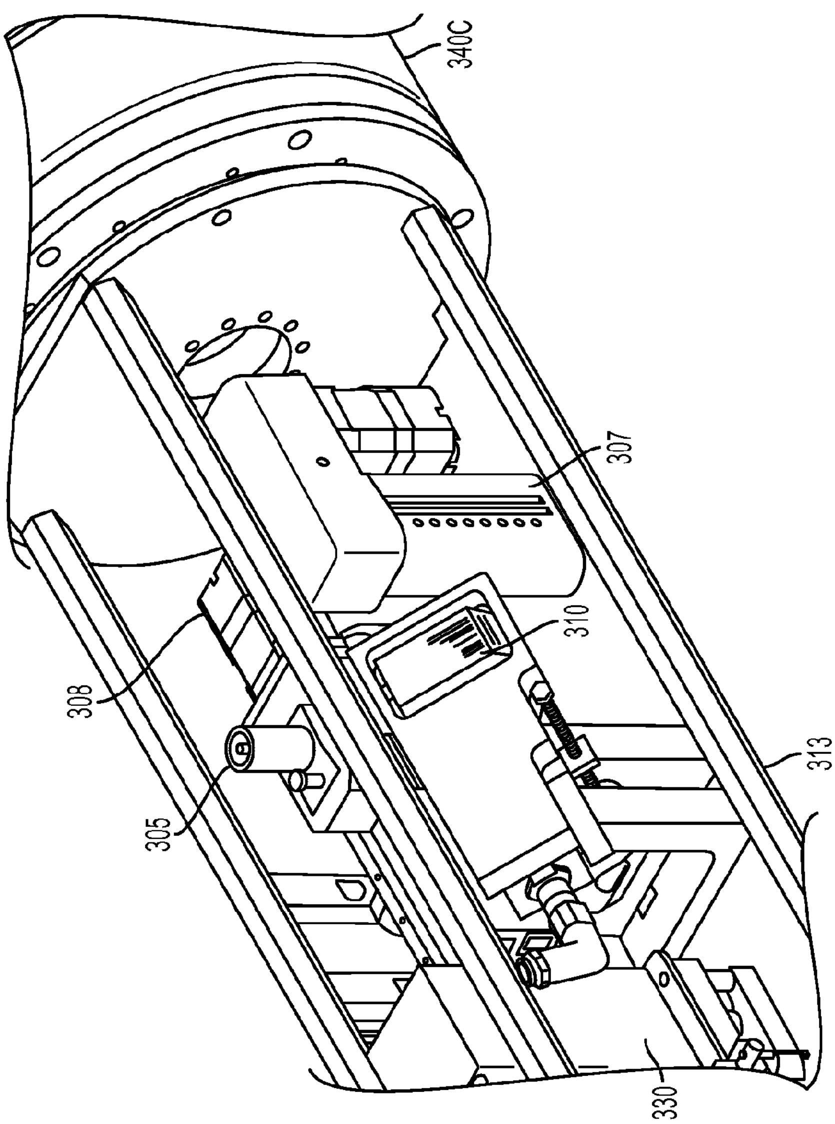


FIG. 12

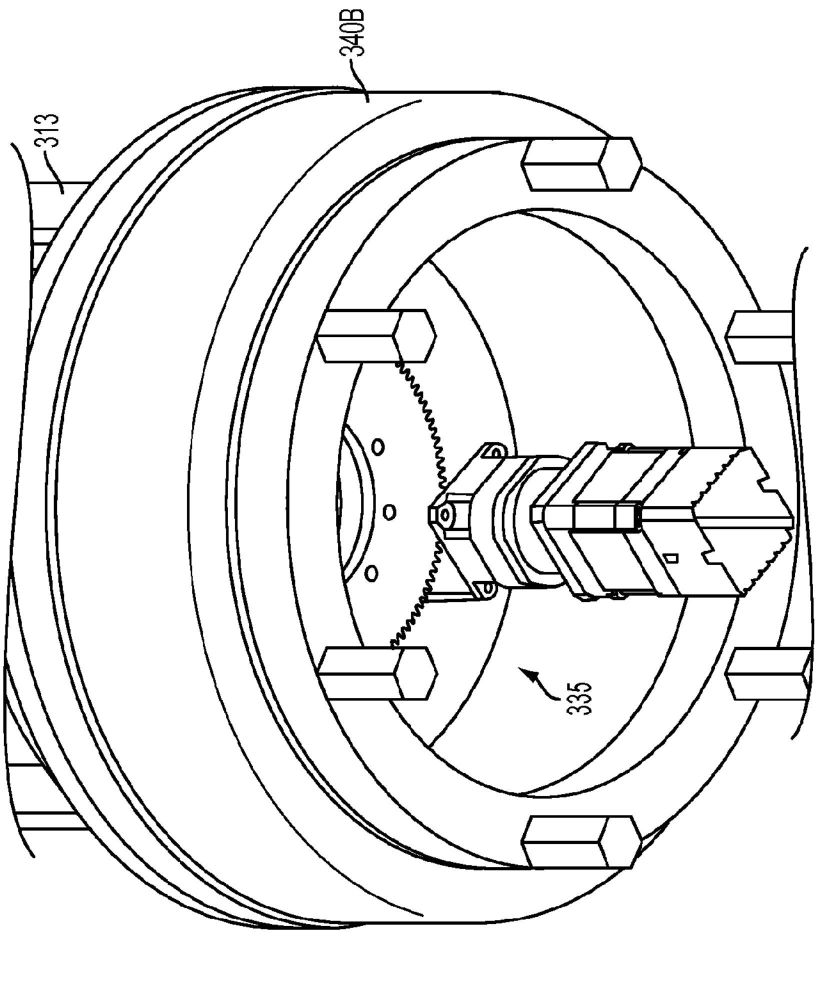


FIG. 13

## INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/39148

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B23K 37/053 (2014.01)
CPC - B23K 37/053, 9/0288, 9/10
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - B23K 37/053 (2014.01)
CPC - B23K 37/053, 9/0288, 9/10

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
MicroPatent (US Granted, US Applications, EP-A, EP-B, WO, JP, DE-G, DE-A, DE-T, DE-U, GB-A, FR-A); Google; Google Scholar; IEEE; ProQuest; IP.com; welding torch laser sensor control alignment manipulate longitudinal carriage secure position rotate

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | US 3,009,049 A (STANLEY, R.) November 14, 1961; figures 1-5, 8; column 1, lines 12-22, 30, 70-71, column 2, lines 1-5, 43-46 ,column 4, lines 1-16, 25-39, 42-51, 59-64, column 5, lines 4-13 | 1-9 |
| Y | US 6,075,220 A (ESSIEN, M. et al.) June 13, 2000; figure 1; column 3, lines 20-30 | 1-9 |
| A | US 3,764,056 A (EDWARDS, C. et al.) Octocter 09, 1973; entire patent | 1-9 |
| A | US 5,601,225 A (WOOD, J. et al.) February 11, 1997; entire patent | 1-9 |

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 4 September 2014 (04.09.2014) | 01 OCT 2014 |

| Name and mailing address of the ISA/US | Authorized officer: |
|---|---|
| Mail Stop PCT, Attn: ISA/US, Commissioner for Patents<br>P.O. Box 1450, Alexandria, Virginia 22313-1450<br>Facsimile No. 571-273-3201 | Shane Thomas<br>PCT Helpdesk: 571-272-4300<br>PCT OSP: 571-272-7774 |