

[54] SYSTEM FOR ALIGNING TWO PIPELINES

[72] Inventor: Bruce Calvin Gilman, Annandale, Va.

[73] Assignee: Ocean Systems, Inc., New York, N.Y.

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[52] U.S. Cl. ....228/4, 29/200 P, 61/69 R, 228/44, 269/37, 285/24

[51] Int. Cl. ....B23k 37/04, B63c 11/00

[58] Field of Search.....29/200 P, 200 J; 61/69, 72.3; 166/6; 228/4, 44, 49; 269/37, 55, 58; 285/24, 27

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Primary Examiner—Theron E. Condon

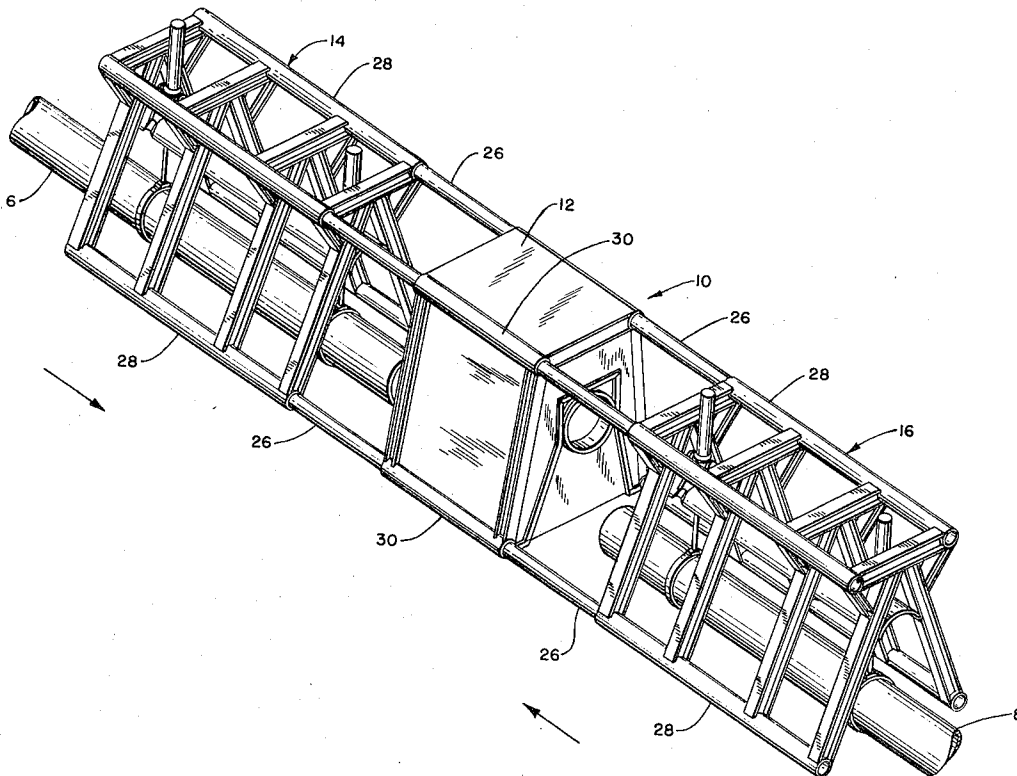
Assistant Examiner—Neil Abrams

Attorney—Paul A. Rose, Harrie M. Humphreys, Dominic J. Terminello and Eugene Lieberstein

[57] ABSTRACT

A pipe alignment system including a central chamber and a fixture at each opposite end thereof along the longitudinal axis of the system. Each fixture includes pivotal support means for rigidly holding and axially aligning a pipe string. Pressure-actuated cylinders couple the end fixtures to the central chamber for controllably moving the fixtures relative to the chamber.

10 Claims, 11 Drawing Figures



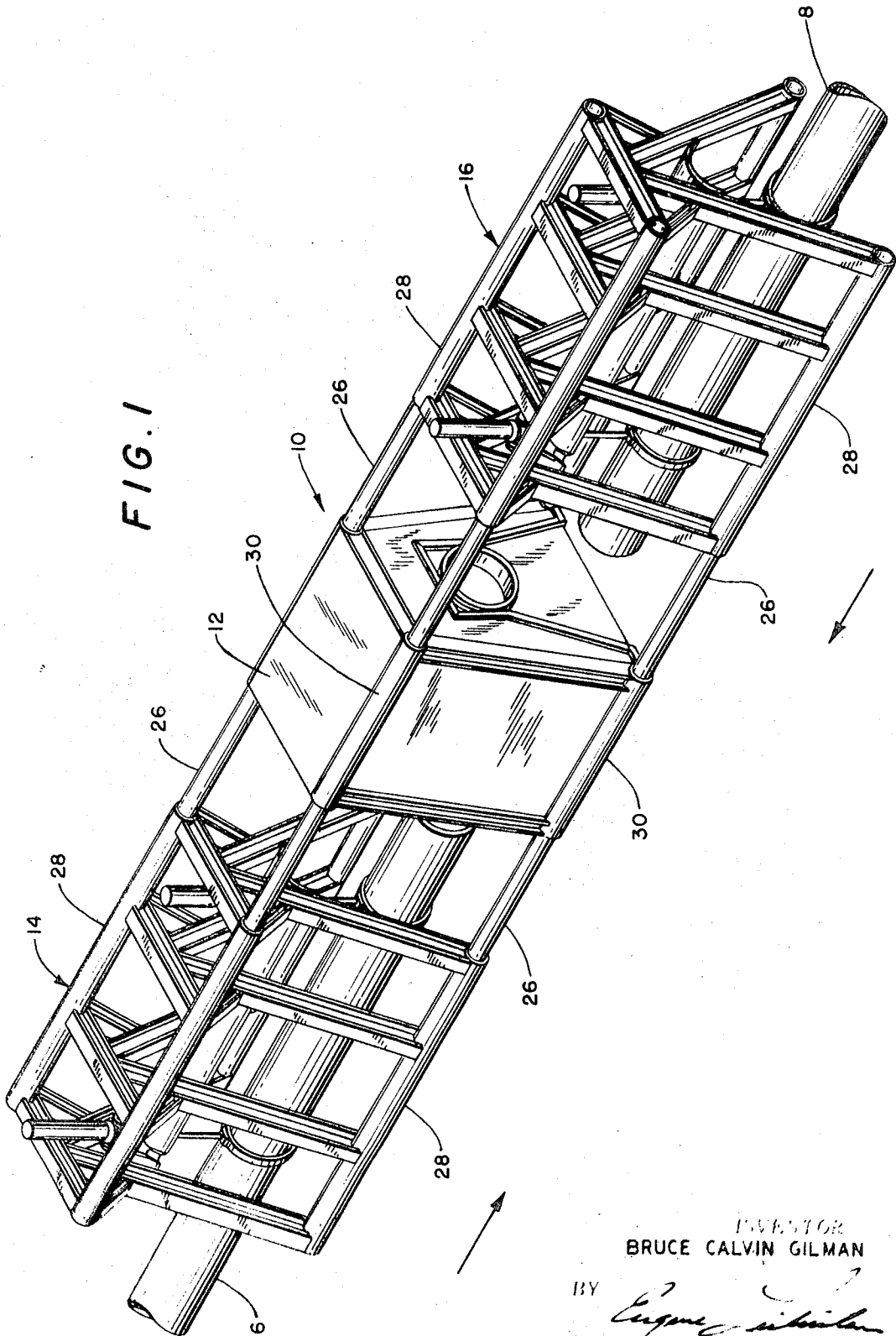


FIG. 1

INVENTOR  
BRUCE CALVIN GILMAN

BY

*Eugene J. ...*  
ATTORNEY

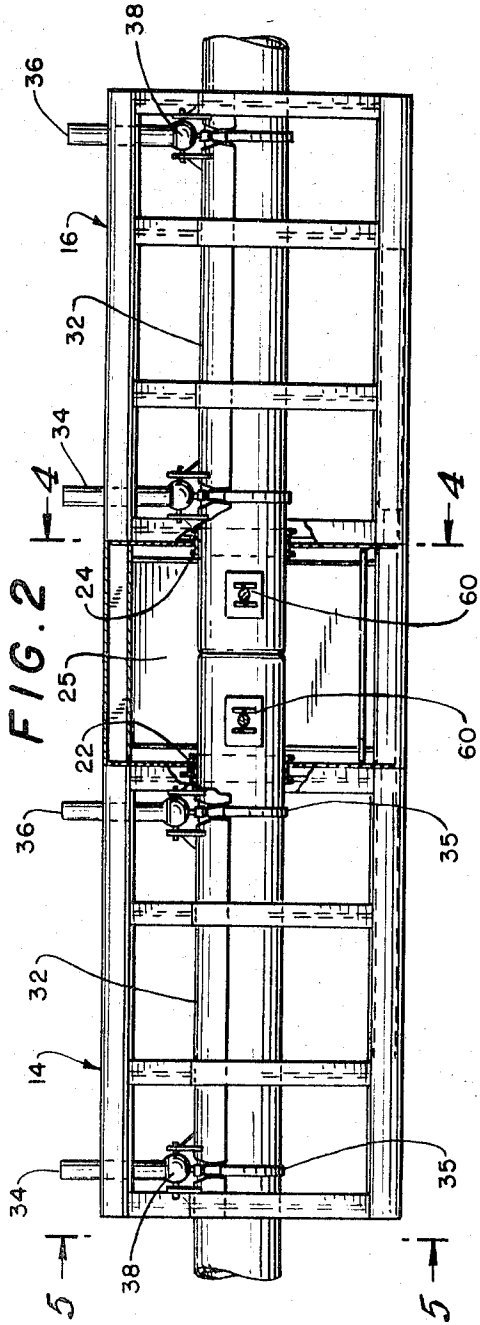
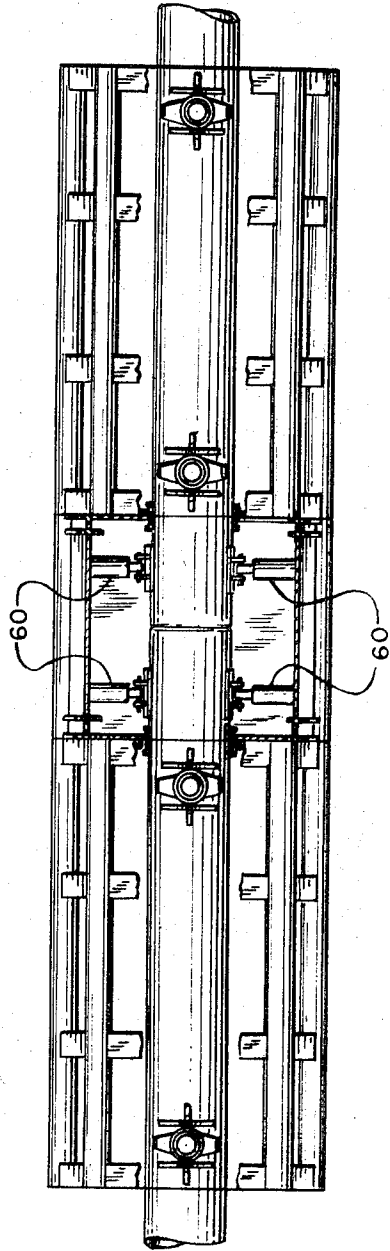


FIG. 3



INVENTOR.  
BRUCE CALVIN GILMAN

BY

*Eugene J. ...*  
ATTORNEY

FIG. 5

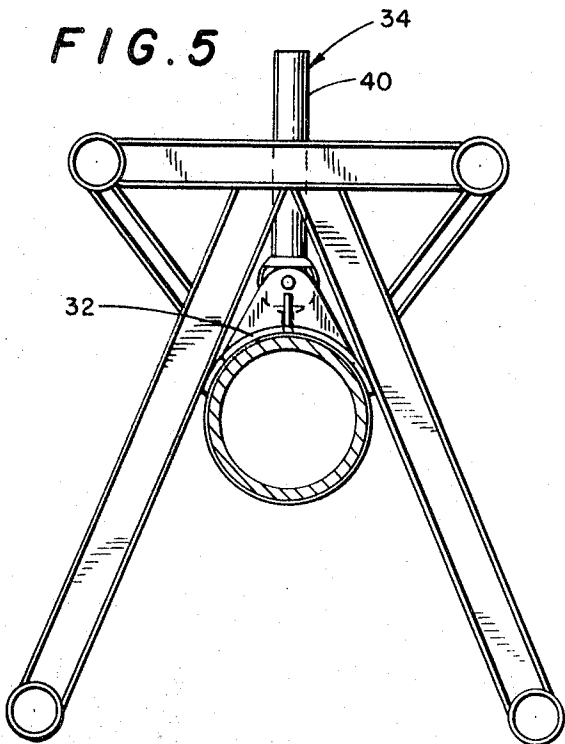


FIG. 2a

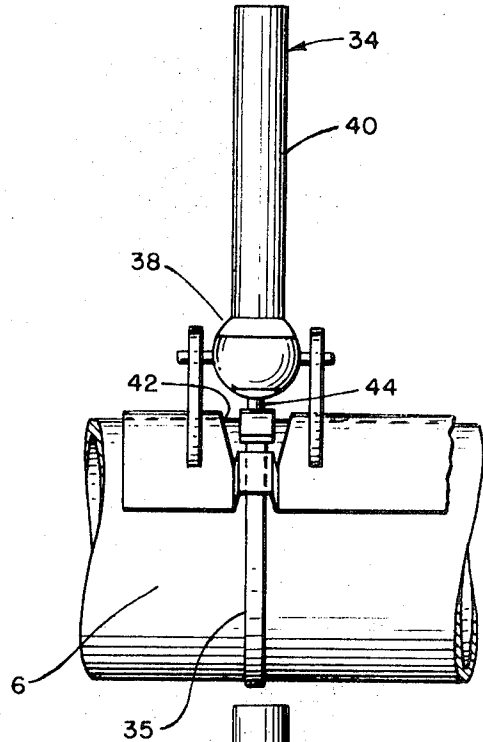


FIG. 4

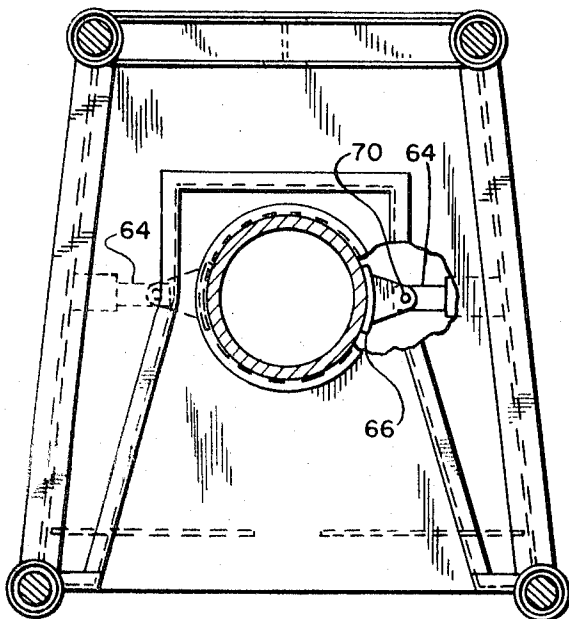
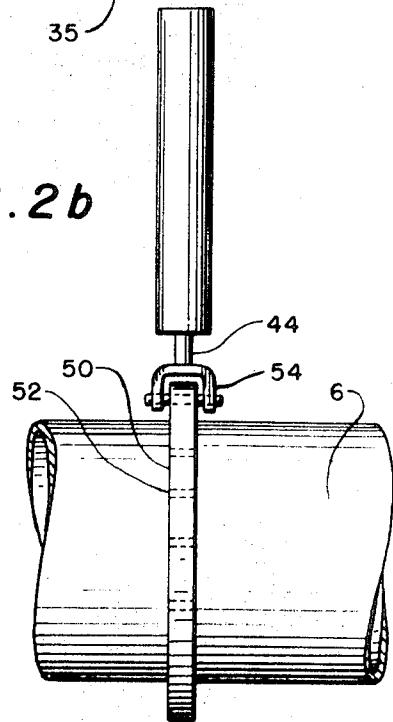


FIG. 2b



INVENTOR,  
BRUCE CALVIN GILMAN

BY *Engene ...*  
ATTORNEY

FIG. 6 b

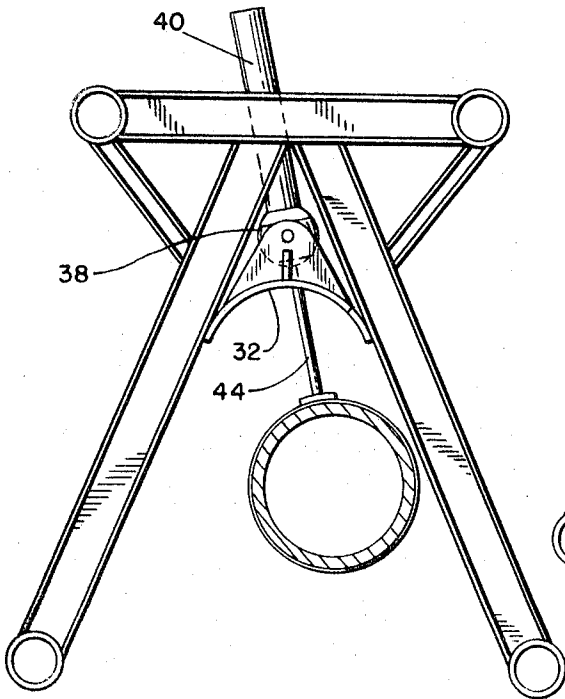


FIG. 6 a

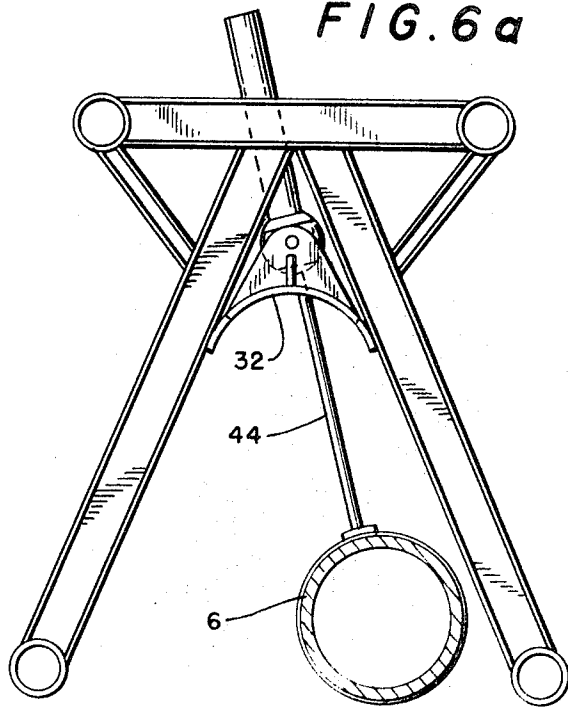


FIG. 6 c

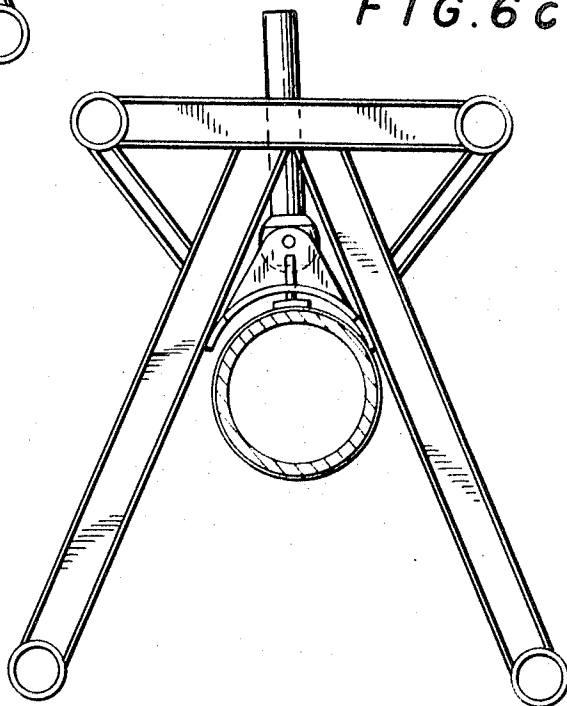
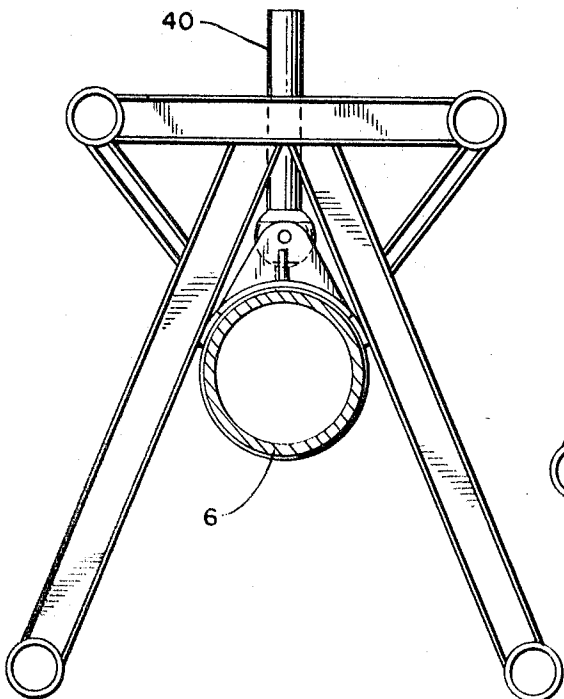


FIG. 6 d



INVENTOR,  
BRUCE CALVIN GILMAN

BY

*Eugene Schuch*  
ATTORNEY

## SYSTEM FOR ALIGNING TWO PIPELINES

This invention relates to apparatus for automatically mating the ends of two strings of pipeline and more particularly to apparatus for remotely aligning two strings of pipeline in a welding chamber.

Marine pipeline construction requires precision welding. Heretofore, the pipeline was fabricated from long sections or strings of pipe welded together on the surface and then lowered to the sea bottom following a complicated procedure to avoid pipe stress and buckling. A system which would permit precision welding insitu along the sea bottom would not only be far more economical but would require fewer field joints and permit the installation of larger diameter pipe in relatively deep water. Such a system would also be useful on the surface when pipe alignment and welding are rendered difficult because of inclement weather.

It is therefore the primary object of the present invention to provide a system for remotely aligning two sections of pipeline in a welding chamber.

It is a further object of the present invention to provide a system for suspending two sections of submerged pipeline along a common axis and thereafter remotely advancing the sections relative to one another until the ends of such sections are in abutting relationship thereby forming a substantially perfectly aligned joint for welding.

It is yet another object of the present invention to align the ends of two sections of submerged pipeline in an underwater hyperbaric welding chamber such that the ends may be joined together in a dry atmosphere.

According to the invention a novel system is provided for aligning and rigidly holding two sections of pipeline in abutting relationship to be thereafter joined by a welding operation comprising:

a welding chamber having two opposite sides each side being adapted to receive an end of the pipeline sections to be welded; a support fixture located at each of the opposite sides of such welding chamber for suspending and rigidly holding the pipeline sections in substantial alignment with respect to one another; and means for advancing at least one support fixture relative to said welding chamber along the longitudinal axis of the chamber such that the ends of the pipeline sections are brought together in said welding chamber to form a substantially perfectly aligned joint for welding.

In the accompanying drawings forming a part of the present description;

FIG. 1 is a perspective view of the system of the present invention;

FIG. 2 is a front elevation of the system of FIG. 1 illustrating the actuator mechanisms for holding two pipeline sections in abutting relationship;

FIG. 2a is an enlarged detailed showing of one of the actuator mechanisms of FIG. 2;

FIG. 2b is an alternative showing of a connection between the actuator mechanism of FIG. 2a and a pipeline section;

FIG. 3 is a plan view of the system of FIG. 1 with the cover of the chamber removed to illustrate the horizontal actuator mechanisms;

FIG. 4 is an end elevation of the welding chamber of FIG. 2 taken along the lines 4-4; a portion being broken away to expose the pivotal connection between the clamping shoes and the horizontal actuators of FIG. 3;

FIG. 5 is an end elevation of the system taken along the lines 5-5 of FIG. 2 showing a pipeline section in biased position against the guide rail;

FIG. 6(a-d) is a diagrammatical illustration of the sequence of operation of the system of FIG. 1 for suspending and aligning the pipeline sections along the longitudinal axis of the central chamber.

Referring to FIGS. 1-5 inclusive in which is shown in detail the alignment system 10 of the invention, the system includes a chamber 12 located intermediate a pair of end support fixtures 14 and 16, respectively. The free ends of two sections of pipeline 6 and 8, respectively, are brought into the chamber

12 for joining; preferably by a dry welding operation as specifically taught in U.S. Pat. No. 3,508,410, filed on Oct. 30, 1968. In following the procedure taught in the above-identified patent application the chamber 12 would be characteristic of a hyperbaric chamber having an inverted open bottom cup configuration. At sea bottom the interior of the chamber 12 would be purged by injecting the gas therein until the water is complete displaced. The pressure in the chamber would be maintained at the system ambient sea pressure. Auxiliary breathing equipment and accessories would be provided within the chamber for a diver to weld the two pipe ends together.

To perform a proper welding operation the pipe sections must be in substantially perfect alignment with respect to one another and the open ends in abutting relationship. As in any welding operation the ends of the pipe to be welded will be prepared in accordance with the type of operation to be performed. Hence, for purposes of the present disclosure the phrase "abutting relationship" has been employed only to impress upon the reader that the pipe ends must be adequately juxtaposed relative to one another to permit the desired joint to be prepared for the type of welding operation involved.

Chamber 12 has a pair of apertures 22 and 24, respectively, located on opposite sides of the chamber and coaxial with the longitudinal axis thereof. The apertures 22 and 24 are selected to be of a diameter slightly greater than the pipe diameter and can be changed for different pipe diameters. Each aperture 22 and 24 is adapted to receive a free end of a pipe string and represents a guide for advancing such pipe string into the interior 25 of chamber 12. A seal is then made circumferentially between the pipe and the aperture 22 and 24 so that the interior of the chamber can be purged.

The end support fixtures 14 and 16, respectively, are substantially identical to one another and are coupled to the chamber 12, on opposite sides thereof, facing the apertures 22 and 24, respectively, by means of a plurality of actuators 26, 26. The actuators 26, 26 are mounted in cylindrical support members 28, 28 of each of the end support fixtures 14 and 16, respectively. The support members 28, 28 and actuators 26, 26 preferably represent in combination conventional type pressure-actuated pistons and cylinders, where the actuators 26, 26 represent piston rods and the support members 28, 28 associated cylinders. In such instance each piston would be coupled at one end thereof in a conventional manner to each cylinder. The opposite ends of actuators 26, 26 would be affixed internally within cylindrical members 30, 30 of chamber 12. Cylindrical members 30, 30 of chamber 12 may in addition represent exterior structural support beams for chamber 12.

Actuator mechanism combination 26, 28 is a linear reciprocating device which can be hydraulically or pneumatically controlled and remotely if need be. As is apparent from FIG. 1, when the device is energized actuator cylinders 28, 28 will be drawn telescopically toward cylinders 30, 30 thereby moving the end fixtures 14 and 16, relative to the chamber 12 along its longitudinal axis. It should be understood that although two end fixtures are shown and described the invention may be carried out with only one end fixture or alternatively using both end fixtures where each is operated independent of the other in any preferred operating sequence. Moreover each end fixture need not be a duplicate of the other.

Affixed to each end fixture 14 and 16, respectively, is a guide rail 32 having an arcuate contour, to match the pipe diameter, and which may be changed to match different pipe diameter the focal line of which coincides with the longitudinal axis of chamber 12. Mounted on each guide rail 32 is a pair of linear actuator mechanisms 34 and 36 laterally spaced from each other in a direction parallel to the longitudinal axis of the chamber 12. The linear actuator mechanisms 34 and 36, respectively, are representative of conventional type pressure-actuated pistons and cylinders. Cylindrical portion 40 of linear actuator 34 when in the de-energized mode is held in a

freely suspended state. This is preferably accomplished by seating cylinder 40 in a ball and socket joint 38 which may in turn either be supported by the end fixture 14 and 16 or directly mounted on guide rail 32 as shown in FIG. 2a. The cylinders can also be suspended from a ball joint. The ball joints 38 permit each of the linear actuator mechanisms 34 and 36, respectively, to move with substantial freedom in any geometric plane. Although ball joints are preferred it should be apparent that other means may be used to pivotally support the actuator mechanisms 34 and 36 on the end fixtures 14 and 16, respectively.

The guide rail 32 has a cut-away portion 42 located directly beneath each ball joint 38. The area around the cut-away portion 42 is shaped to receive the strap 35 or collar 50. Piston 44 of linear actuator 34 extends downwardly from the cylinder portion 40 through the cut-away portion 42 of guide rail 32 and is adapted to be connected by any flexible means such as a strap 35 to the pipe string 6 to be welded. An alternative connection, preferred for constructing submerged pipeline, would involve mounting one or more collars 50 with indexed holes 52 as shown in FIG. 2b about the circumference of each pipe string 6 and 8, respectively, before lowering the pipe strings to the sea bottom. Piston 44, for example, would then be connected to the collar 50 in a predetermined hole 52 by means of a pin and bracket mount 54. The collars 50 may also be mounted to the pipe on the sea bottom, in which case the collars 50 would be of hinged section construction and be mechanically clamped to the pipe.

Once the pipe strings 6 and 8 are brought through apertures 22 and 24, respectively, of chamber 12 each pipe is adjusted for precise axial alignment with respect to one another by a pair of linear actuator mechanisms 60, 60 mounted on opposite sides of the chamber 12 in a horizontal plane transverse to the longitudinal axis. Actuator mechanisms 60, 60 represent conventional pistons and cylinders. Each piston rod 64 is pivotally coupled at the end thereof adjacent the pipe to a clamp 66 by means of pivot pin and eye bracket assembly 70. The exposed side of each clamp 66 is curved to mate intimately with the pipe.

In operation, two strings of pipeline are lowered from a barge (not shown) to the sea bottom or separately pulled off shore from a beach location. The pipelines must be contiguous to one another although they may be completely misaligned. The alignment system 10 will then be lowered to the bottom and the actuator mechanisms 34, 36 of end fixtures 14 and 16 secured to the pipelines 6 and 8, respectively. The actuators 34 and 36 may then be energized in any desired sequence. The piston rods of the actuator mechanisms will be drawn up into their associated cylinders until the pipelines 6 and 8 are urged firmly against guide rail 32 as shown in FIG. 2 with the longitudinal axis of the pipe strings substantially in alignment with the longitudinal axis of chamber 12. The sequence for axially suspending the pipelines is shown in detail in FIG. 6(a-d). In FIG. 6a piston rod 44 is shown flexibly connected to the pipe 6. FIGS. 6b and c show how the piston 44 is drawn up into cylinder 40 while the cylinder 40 simultaneously rotates within ball joint 38. The process continues until as shown in FIG. 6d the pipe string 6 is firmly biased into proper position against the guide rail 32. The same procedure may simultaneously be followed in fixture 16 for suspending pipe string 8.

Immediately following the rough axial alignment of pipe strings 6 and 8, actuator mechanisms 28, 28 are energized drawing in the end fixtures 14 and 16 relative to chamber 12, thereby pulling the free ends of pipe strings 6 and 8 into the center welding chamber 12 of the system 10. Additional alignment adjustment in a horizontal plane is possible by energizing actuator mechanisms 60, 60. Actuator mechanisms 60, 60 may also be used in concert with actuator mechanisms 34, 36, respectively, for incremental fine positioning along two orthogonal planes. The above operations may be remotely controlled if so desired.

While the invention has been described in connection with the specific apparatus shown and described, it is apparent that

many modifications to such apparatus may be made by those skilled in the art without departing from the underlying scope of the invention. It is therefore intended that the appended claims cover all such modifications which fall within the spirit and scope of the present invention.

I claim:

1. A system for aligning and rigidly holding two sections of pipeline in a contiguous relationship to be joined by a welding operation comprising:

a welding chamber having two opposite sides each side being adapted to receive an end of said pipeline sections to be welded;

a pipeline support fixture located at each of said opposite sides of said welding chamber, each support fixture including means for suspending and rigidly gripping said pipeline sections and at least one pressure-actuated cylinder and piston combination, coupled to such means, for adjusting the pipeline sections into substantial alignment with respect to one another; and

means comprising at least another pressure-actuated piston and cylinder integrally coupled between said welding chamber and at least one of said support fixtures for axially drawing said pipeline sections toward one another.

2. A system for aligning and rigidly holding two sections of submerged pipeline in abutting relationship for joining in an underwater welding operation comprising:

a welding chamber having two opposite sides each side being adapted to receive an end of said pipeline sections to be welded;

a pipeline support fixture located at each of said opposite sides of said welding chamber, each support fixture including means for suspending and rigidly gripping said pipeline sections and at least one pressure-actuated cylinder and piston combination, coupled to such means, for adjusting the pipeline sections into substantial alignment with respect to one another; and

means comprising a plurality of pressure-actuated piston and cylinder integrally coupled for linear reciprocation between said welding chamber and at least one support fixture for moving said support fixture along the longitudinal axis of said chamber until the ends of said pipeline sections are brought within said welding chamber.

3. Apparatus as defined in claim 2 wherein said support fixture further comprises:

a rigid frame;

a curved guide rail connected to said frame; and

wherein said pressure-actuated cylinder is pivotally supported above said guide rail such that said cylinder may move in any geometric plane with a relatively substantial degree of freedom and wherein said piston extends from said cylinder below said guide rail being connected at the free end thereof to a pipeline section, whereby upon actuating said cylinder said piston is drawn into said cylinder raising the pipeline section until the pipeline is firmly biased against said guide rail.

4. Apparatus as defined in claim 3 wherein the focal line of said curved guide rail coincides with the longitudinal axis of the welding chamber.

5. Apparatus as defined in claim 4 wherein two pressure-actuated cylinders are pivotally supported above the guide rail and are laterally separated from one another along the longitudinal axis of the chamber.

6. Apparatus as defined in claim 5 further comprising a ball and socket joint mounted upon said guide rail in which said cylinder is seated and wherein said guide rail has an opening directly below and in line with said joint through which said piston extends.

7. Apparatus as defined in claim 6 wherein said pipeline section is securely held by strap means connected to said piston.

8. Apparatus as defined in claim 6 wherein said piston is connected to an indexed collar mounted about the circumference of the pipeline to be welded.

9. Apparatus as defined in claim 5 further comprising a pair of pressure-actuated cylinders and pistons mounted on op-

posite sides of said welding chamber in a horizontal plane transverse to the longitudinal axis of the chamber for providing additional alignment adjustment to the pipeline to be welded.

10. Apparatus as defined in claim 9 wherein said pistons are pivotally connected to clamp means for intimate engagement with the pipeline to be welded.

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