United States Patent

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[54] LAYING PIPELINE IN DEEP WATER
6 Claims, 5 Drawing Figs.

[52] U.S. Cl. 61/72.3, 175/7, 175/85
[51] Int. Cl. F16l 1/00
[50] Field of Search ..... 61/72.3, 72.1; 175/5, 7, 85; 114/0.5 (D), 191

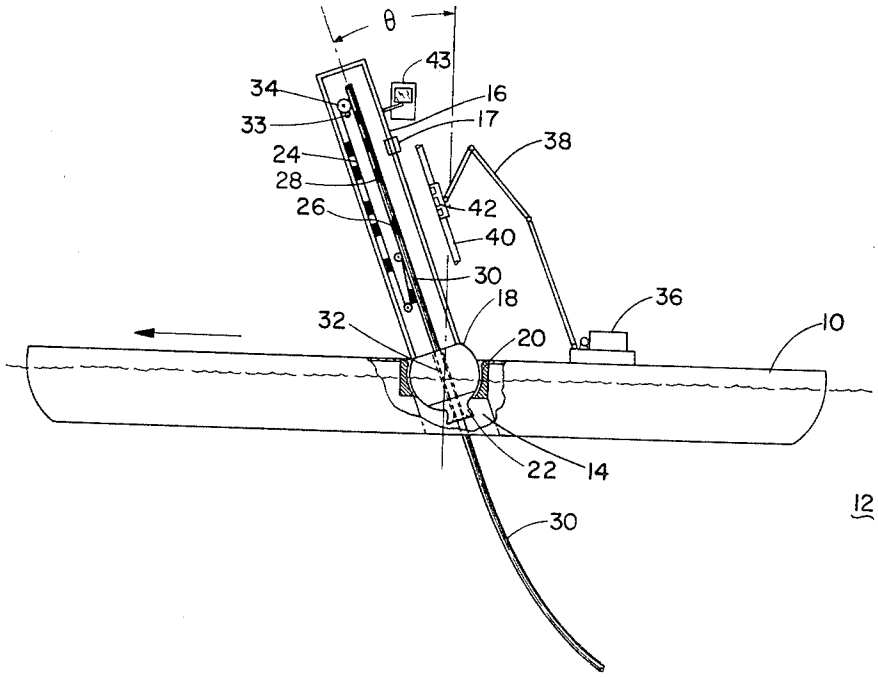
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ABSTRACT: This relates to a system of laying pipeline in deep water from a barge floating thereon. The barge has a vertical passage therethrough. A bearing means supports an elongated frame or rack above said passage and provides for pivotal movement in any direction. The elongated frame supports movable pipe gripping means, and pipe joint making means are supported on an endless belt for continuous operation. The proper restraint applied to the pipe, as the barge moves through the water, automatically provides proper catenary for the pipeline that is being laid. This pivotal system of supporting the elongated frame compensates for roll of the ship as well as pitch of the ship without having additional stress applied to the pipe, which would be the case if the pipe supporting means did not have the pivotal arrangement of this invention.



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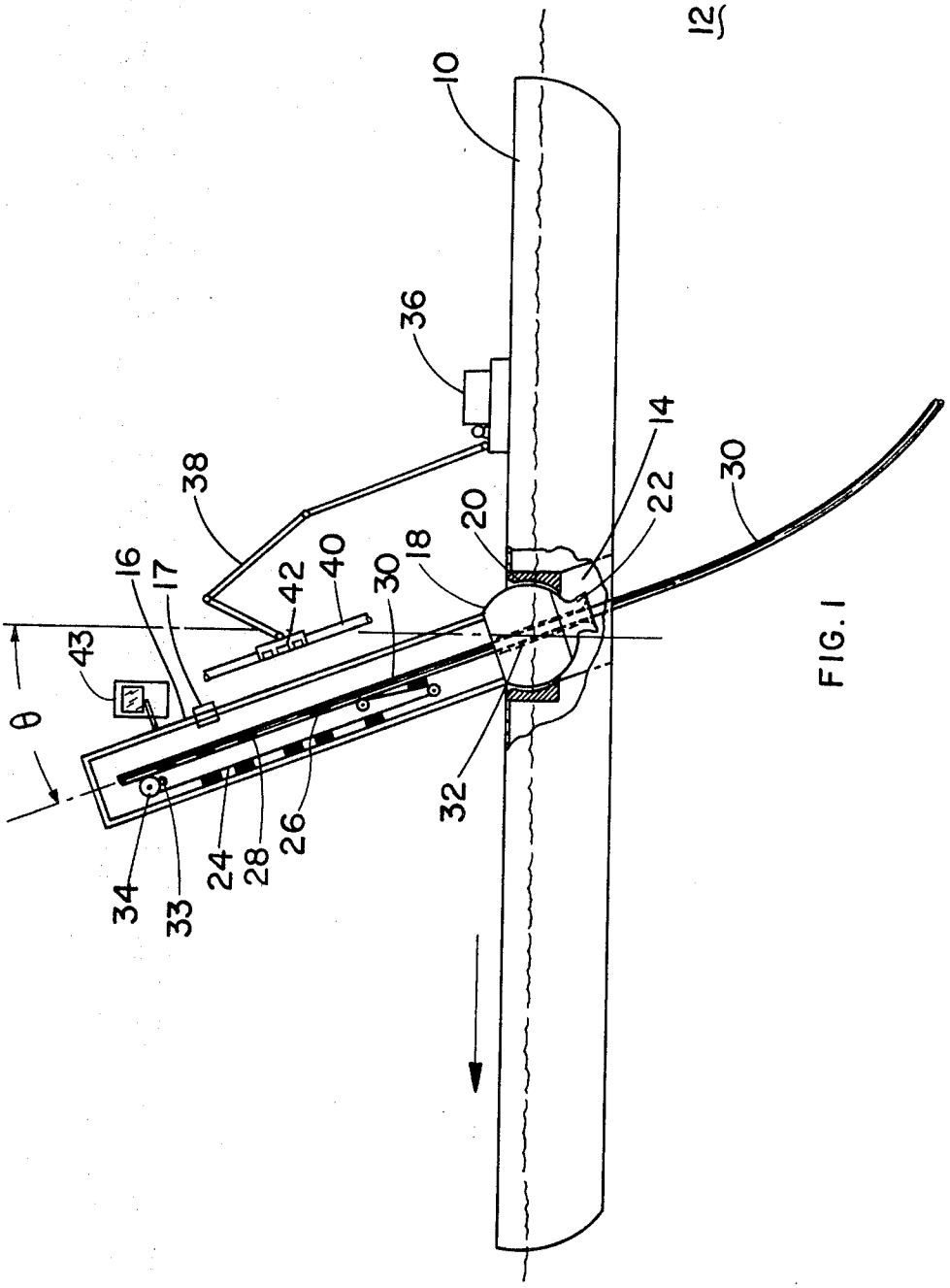


FIG. 1

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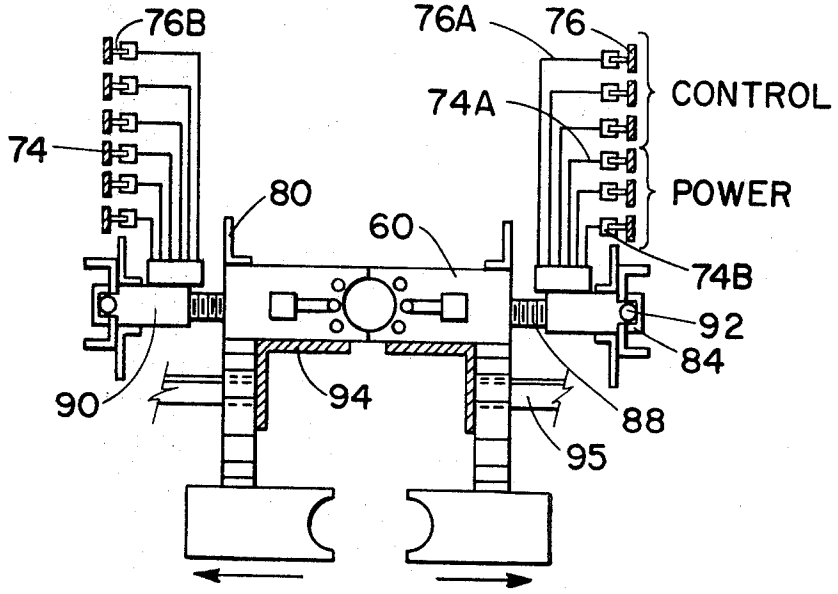


FIG. 5

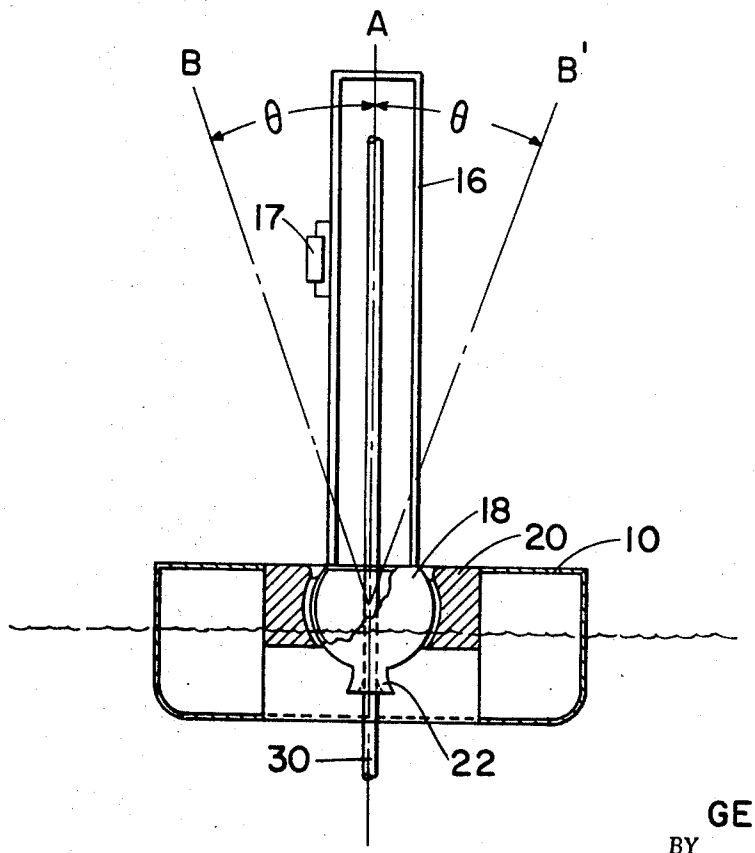


FIG. 2

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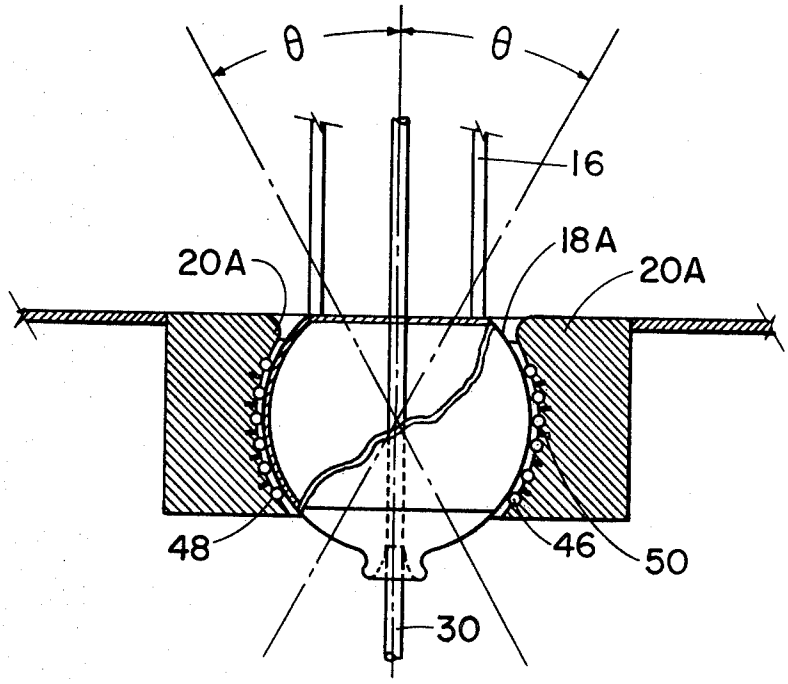


FIG. 3

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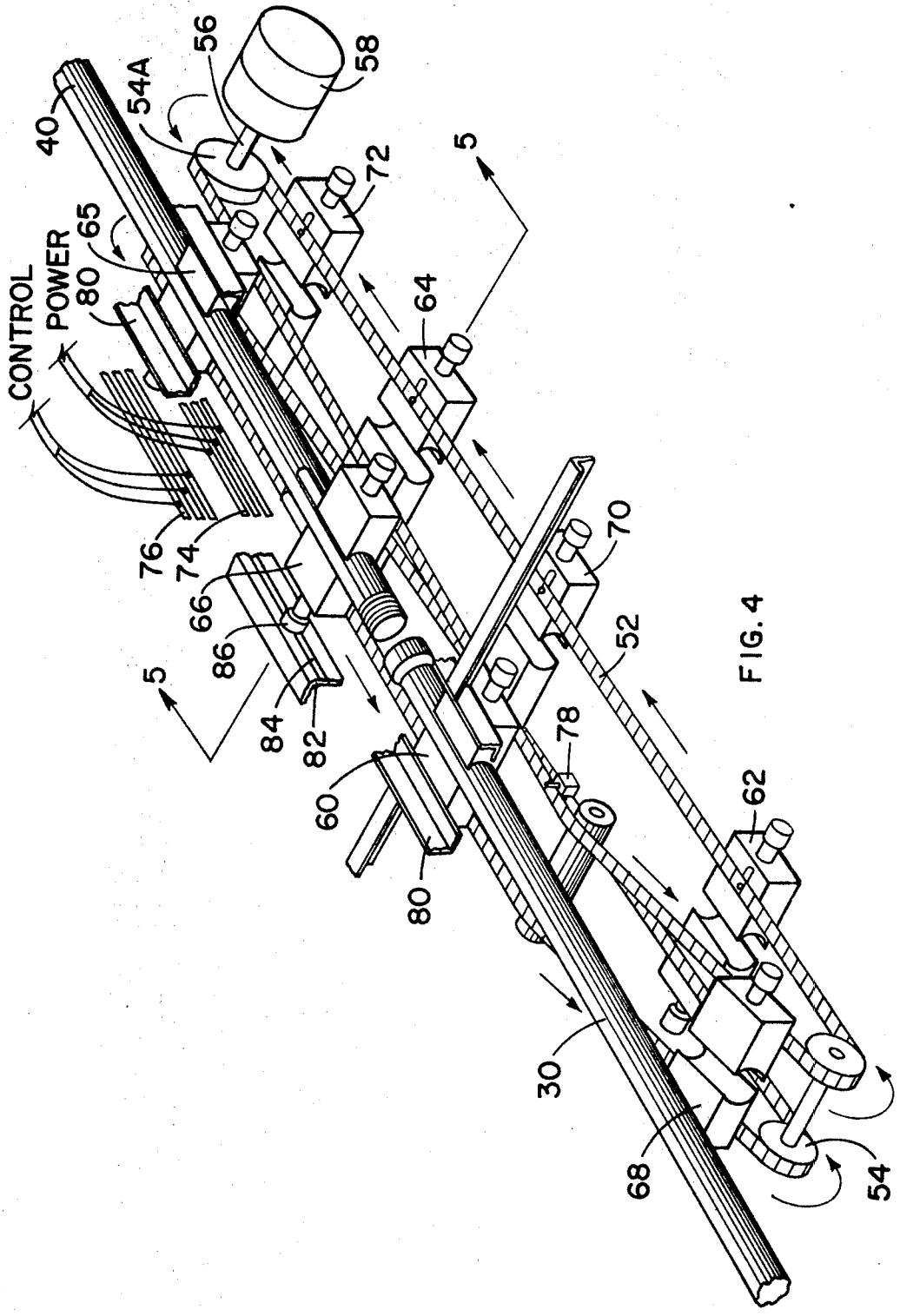


FIG. 4

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LAYING PIPELINE IN DEEP WATER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the laying of pipelines in deep water from a floating barge. It relates especially to the laying of such pipelines without the use of stingers.

2. Prior Art

In recent years the search for oil and gas has led directly to the drilling of oil and gas wells in water covered areas. Sometimes these wells are drilled as far as 50 to 100 miles or more from shore and in water from a few hundred feet up to 600 feet or more in depth. The oil and/or gas from these wells must be transported to land in order to be utilized. This is done either by oceangoing transport barges or preferably, in most cases, by the laying of pipelines. One means of laying pipeline in deep water is by the use of a barge equipped with a stinger. A stinger is merely an elongated trough extending backwardly and downwardly from the aft end of a barge. The stinger is of sufficient length and is shaped to cause the pipeline to assume a predetermined catenary curve.

As the water gets deeper the length of the stinger required becomes so great as to make the use of such stinger uneconomical. It has been suggested that a deep water pipeline can be laid without use of a stinger. For example, see the article entitled "Stiffened Catenary Calculations in Pipeline Laying Problems," by D. A. Dixon and D. R. Rutledge, published in the *Journal of Engineering for Industry*, Feb. 1968. That article discusses U.S. Pat. No. 3,266,256, "Method for Laying Marine Pipeline," issued Aug. 16, 1966. In the system discussed in the article and patent, deep water pipelines are made up in an inclined position on a lay barge and maintained under a predetermined high tensile force, while lowering the pipeline to the bottom. The axial force is chosen large enough to avoid overstressing and kinking of the pipeline near its point of tangency with the sea floor. In addition, the upper end of the pipeline must be securely clamped to the lay barge at the work level during fabrication of each successive section of pipe. If the angle at the upper end of the pipeline were arbitrary there would be a large bending moment imposed at that point. To avoid damaging the pipe laying apparatus and overstressing the pipeline, this angle should be predetermined to give zero bending moment. The Dixon-Rutledge article examines the mathematical consideration in determining this angle and the required tensile force. That article further shows that utilization of a lay barge equipped with an adjustable angle ramp and the means to provide large axial support to the pipeline allows control of the critical pipeline curvature. If the pipeline is assumed to take the shape of a natural catenary over its entire length, its natural curvature occurs with its contact with the sea floor, assuming the sea floor is horizontal. The shape of the pipeline and the required minimum tension at the lay barge are selected to minimize the curvature at the sea floor and therefore to control the maximum stress due to bending.

DESCRIPTION OF THE INVENTION

This invention concerns an apparatus for use in laying pipeline from a barge supported on a body of water. It includes a vertical passage through the barge and an elongated frame or rack supported above the vertical passage. The support means for the elongated frame includes bearing means so that the elongated frame can pivot in any direction with respect to the passage. Movable pipe-gripping means and movable pipe joint making means are provided on the elongated frame. Means are also provided for applying restraint to the movement of the pipe gripping means and to the joint-making means. The pipe trails off the barge through the vertical passage.

In an especially preferred embodiment the pipe-gripping means and the pipe joint making means are mounted on an endless belt having an elongated loop whose axis is parallel to the axis of the elongated frame. Here the means for applying restraint to the movement of the pipe-gripping means is applied to the endless belt.

Various objects and a better understanding of the invention will be had from the discussion which follows when read in conjunction with the drawings.

DRAWINGS

FIG. **1** illustrates an inclined, pivoted, elongated pipe support frame pivotally supported in a vertical passage in a pipe-laying barge.

FIG. **2** is a view taken through the vertical passage of FIG. **1** perpendicular to the elongated axis of the pipe-laying barge.

FIG. **3** is an enlarged more detailed view of the pivotal means of the elongated pipe support means mounted in the vertical passage of the lay barge.

FIG. **4** illustrates in greater detail the endless belt for supporting the pipe being laid and which is mounted from the inclined, elongated support of FIG. **1**.

FIG. **5** is a more detailed partial sectional view of the endless belt and its pipe gripping means of FIG. **4** and it is transverse to the drawing of FIG. **4**.

DESCRIPTION OF PREFERRED EMBODIMENTS

Attention is first directed to FIG. **1**. Shown thereon is a pipe-laying barge **10** supported by a body of water **12**. The barge **10** has a vertical passage **14** extending therethrough. An elongated frame or pipe support rack **16** is pivotally supported from the upper portion of vertical passage **14**. The support means include ball-type bearing **18** attached to the lower end of rack **16** and seat **20** which is rigidly mounted to barge **10** in the upper part of passage **14**. As can be seen in FIGS. **1** and **2**, bearing **18** can rotate an angle θ in any direction from the vertical. The lower end of bearing **18** has stops **22** to limit the downward inclination. This angle θ is conveniently about 20°.

Still referring to FIG. **1**, pipe support rack **16** has provided thereon an endless belt **24** which has mounted thereon a plurality of pipe gripping means **26** and pipe joint makeup means **28**. Pipe joint makeup means can be either an automatic threader or automatic welder. The pipe **30** is supported by pipe gripping means **26** and extends down through a central passage **32** in bearing **18** and down through the passage **14** into the water. The lower end of the pipe **30** is not shown but is attached to some underwater installation such as a well head or other anchor means. The endless belt **24** is provided with a brake means on roller support **34**. This brake is to provide the desired restraint to the movement of belt **24**. A power crane **36** having arm **38** is provided for adding additional joints of pipe such as shown as joint **40** held by gripping means **42** at the end of arm **38**. Rack **16** is provided with an operator's control booth **43**.

Details of the belt **24** and the bearing means **18** will be given later. A brief explanation of the operation of the device of FIG. **1** will now be given. The barge **10** is powered to move in a direction toward the left as indicated by the arrow. This movement is restrained by pipe **30** which is anchored at the lower end. This restraining force is transmitted through pipe gripping means **26** to endless belt **24** to belt support rollers **34** which are mounted on rack **16**. The force from the rack **16** is transmitted through bearing **18** and seat **20** to vessel **10**. A tension-measuring device **33** is provided to measure the tension on belt **24**. Tension may be determined by measuring the braking force required to restrain roller **34**. The amount of this restraint is calculated so that the desired stress is placed upon pipe **30** so that it will assume a desired catenary. This calculation can conveniently be made in the manner described in the article "Stiffened Catenary Calculations in Pipeline Laying Problems," supra. The pipe at bearing **18** is free to assume a slope that is tangent at this location to the catenary curve assumed by the pipe due to the downward and horizontal pull of the submarine pipe. The amount of restraint is controlled by properly applying the brake mechanism on support rollers **34** so that the force applied to pipe **30** is that force cal-

culated. When this proper force is applied, pipe **30** and elongated support rack **16** will assume a calculated angle which is a safe angle. The barge **10** is subject to both roll and pitch movement. It is most important that in accordance with my invention, rack support means **16** and pipe **30** are not affected by either. As shown in FIG. **1** the pipe and rack assume a given angle when force is applied as determined by the article "Stiffened Catenary Calculations in Pipeline Laying Problems," supra. This force is applied whether the barge has any pitch or not. As shown in FIG. **2**, if the barge has roll it still does not affect the derrick and pipe, as the pivotal support permits the rack means **16** to remain in a position aligned longitudinally with pipe being laid while the vessel **10** may roll up to an amount equal to θ. This is most important as it prohibits any bending moment being added to pipe **30** due to the roll of the barge **10**. An angle measuring device **17** is attached to rack **16** so that the angle of the pipe as it leaves the barge can be observed.

As the vessel **10** of FIG. **1** moves through the water in its prescribed direction, endless belt **24** is rotated so that pipe-gripping means **26** permits pipe **30** to be payed out. When the pipe-gripping means **26** approaches the lower end of the belt, an additional joint **40** is placed on the belt and through joint makeup means **28**. The joint makeup means can be either an automatic welding device or an automatic pipe threader. When the additional joint of pipe **40** has been made up, a second pipe-gripping means grips the upper end of the joint and the lower pipe-gripping means **26** is released so that the belt can continue to rotate. It is to be noted that the pipe-gripping means and pipe joint making means **28** are securely fastened to belt **24**.

Attention is next directed to FIG. **3** which illustrates in an enlarged view one form of the ball bearing type support of FIG. **1**. This includes a large ball bearing **18A** which may be as much as 10 feet. A plurality of individual balls **46** are placed in spherical grooves **48** within seat **20A**. A lubricating grease is inserted through groove rings **50** from a source not shown. A typical force acting on pipe **30** at the ball bearing **18A** is 150 k.p.s. When weight of pipe suspended by the rack and the weight of the rack are considered together with the size of the bearing **18A** and the seat **20A**, the force per square inch of contact area between the two is rather small. If there are 100 1-inch diameter ball bearings **46** used per square foot, then the force which each has to support is about 4,000 pounds. While ball bearings may be used, the special base of the rack **16** and its seat **20A** may be constructed as a surface to surface contact with only a lubricant between the two faces. This will effect a very low 30 p.s.i. bearing area.

Attention is next directed to FIG. **4** which shows details of the endless belt **24** of FIG. **1**. This endless belt has been shown separated from the pipe support rack **16** to help clarify the presentation. Shown thereon is pipe **30** and a new joint **40** which is to be made up with the existing pipe **30**. It includes a belt **52** which makes a loop whose axis is essentially parallel to the pipe **30**. The pipe **30** is also essentially parallel or coincides with the axis of the rack **16**. Belt **52** is supported on a plurality of rollers **54** which are supported by means not shown from the support rack **16**. One roller **54A** is connected through shaft **56** to a braking mechanism (and torque measuring) **58**. This mechanism **58** is supported from rack **16**. The function of braking-torque mechanism **58** is to apply the needed restraint to the movement of belt **16** as pipe **30** is played off barge **10** as it moves forward through the water.

Mounted on belt **52** are pipe-gripping means **60, 62, 64** and **65**. Between these pipe-gripping means there are automatic threaders **66, 68, 70** and **72**. The pipe-gripping means are securely attached to the belt.

As shown in FIG. **4**, pipe-gripping means **60** is securely gripping pipe **30** which extends out into the body of water. A second joint **40** is held in automatic threader **66** which, when actuated, threads joint **40** into pipe **30**. Other pipe joint makeup means such as automatic welders can be used if desired. However, there have recently been large advances made in the quality of threaded pipe joints. The various pipe-gripping means and automatic joint makers in FIG. **4** are indicated as being electrically operated. This is indicated in FIG. **4** by having several power bus bars **74** and control bus bar **76**. Power lead lines from this go to a power source on the barge and the lead lines from the control means go to the operator's booth **43** mounted on the rack, as shown in FIG. **1**. A switch **78** is provided. As pipe **30** pulls pipe-gripping means **60** over switch **78**, the switch causes the pipe-gripping means to be released so that it can go on and be separated from the pipe **30**. Longitudinal braces **80** are supported form the rack **16** and are used to assure that the various type gripping means and automatic threaders are aligned. Guide means **80** hold the pipe-gripping means down. Also provided, on each side and just above the endless belt, is a horizontal guide **82** which has a groove **84** therein. This groove **84** is to receive an end tongue on motor **86** of pipe threader **66**. This assures proper alignment and gives proper backup of the threading of various screws when opening or closing the pipe-gripping means or the pipe threaders.

Attention is now directed to FIG. **5** which shows a partial sectional view along the line **5–5** of FIG. **4**. Shown thereon is a pipe-gripping means **60** which opens and closes by rotation of threaded screw **88**. The pipe-gripping means **60** is held down by guide **80** and the motor **90** of the pipe-gripping means **60** is provided with a tongue **92** which extends into groove **84**. This provides proper backup for operating the motor to engage or disengage the pipe-gripping means. The power for operating the pipe-gripping means and the automatic joint makers can be provided electrically similarly as power is provided to a trolley car. For example, a plurality of power bus bars **74** are provided and a plurality of control bus bars **76** are provided. Each pipe-gripping means is provided with a plurality of power-contacting arms **74A** which have rollers **74B**, and control arms **76A** which have rollers **76B**. These rollers contact their respective bus bars. The lower side of pipe-gripping means **60** is provided with a support frame **94** which is supported from rack **16** by angle irons **95**.

The preferred embodiments above have been described in detail; however, various modifications can be made without departing from the spirit or scope of the invention.

I claim:

1. An apparatus for use in laying pipeline from a barge supported on a body of water, the improvement which comprises:

a vertical passage through said barge;

an elongated frame;

support means attached to one end of said elongated frame;

bearing means supported within said opening for receiving said support means, the combination of said support means and said bearing means providing for pivotal movement in any direction with respect to said passage;

pipe-gripping means supported by said elongated frame, said pipe-gripping means being movable with respect to said elongated frame;

means for applying restraint to the movement of said pipe-gripping means;

an endless belt means supported on said elongated frame, said pipe-gripping means mounted on said endless belt;

a second pipe-gripping means supported by said endless belt;

a joint maker supported by said endless belt between said pipe-gripping means.

2. An apparatus as defined in claim **1** in which said restraining means includes a brake-torque measuring mechanism for applying restraint to the movement of said endless belt.

3. An apparatus as defined in claim **2** including elongated guide means supported from said elongated frame for guiding and supporting said pipe engaging means and said joint maker while such engaging means is operative to engage said pipe and said pipe joint maker means when said pipe joint maker means is operative.

4. An apparatus as defined in claim **1** including means for limiting the maximum pivotal movement of said elongated frame.

5. An apparatus as defined in claim 2 including guide means supported from said elongated frame for guiding said pipe-gripping means and said joint maker during a part of the rotation of said endless belt.

6. An apparatus for use in laying pipeline from a barge supported on a body of water, the improvement which comprises:

a vertical passage through said barge;

an elongated frame;

support means attached to one end of said elongated frame;

bearing means supported within said opening for receiving said support means, the combination of said support means and said bearing means providing for pivotal movement in any direction with respect to said passage;

pipe-gripping means supported by said elongated frame, said pipe-gripping means being movable with respect to said elongated frame;

means for applying restraint to the movement of said pipe-gripping means;

means anchoring the lower end of said pipeline to the floor of said body of water.