United States Patent [19]

Menard

[11] **3,765,184**

[45] **Oct. 16, 1973**

[54] **DEVICE AND METHOD FOR THE ATTACHMENT OF PIPELINES TO AN UNDERWATER SURFACE**

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[73] Assignee: **Compagnie Francaise Des Petroles and Techniques Louis Menard,** both of Paris, France

[22] Filed: **Sept. 27, 1971**

[21] Appl. No.: **183,919**

[30] **Foreign Application Priority Data**

Mar. 8, 1971 France 7107866

[52] **U.S. Cl.** **61/72.3,** 61/53.5, 61/63, 114/206, 294/66

[51] **Int. Cl.** **F16l 1/00,** B63b 21/26

[58] **Field of Search** 61/72.3, 72.1, 46, 61/53.5, 63; 114/206; 294/66

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Primary Examiner—Jacob Shapiro

Attorney—Sughrue, Rothwell, Mion, Zinn and Macpeak

[57] **ABSTRACT**

An apparatus and a method of securing an underwater pipeline to the bed of a body of water is provided. A buoyant boom is attached to a floating line to be guided down to the pipeline. The floating line is secured to the pipeline by a clip that can utilize compressed air to penetrate the underwater bed. The buoyancy of the boom can be controlled to regulate both ascent and descent. A sled like base member is attached to the boom by a cardan joint and carries both a source of compressed air and a control panel. A television system can be utilized to monitor the control panel and the actual sinking of inverted L-shaped piles by a vibro-piledriver.

21 Claims, 17 Drawing Figures

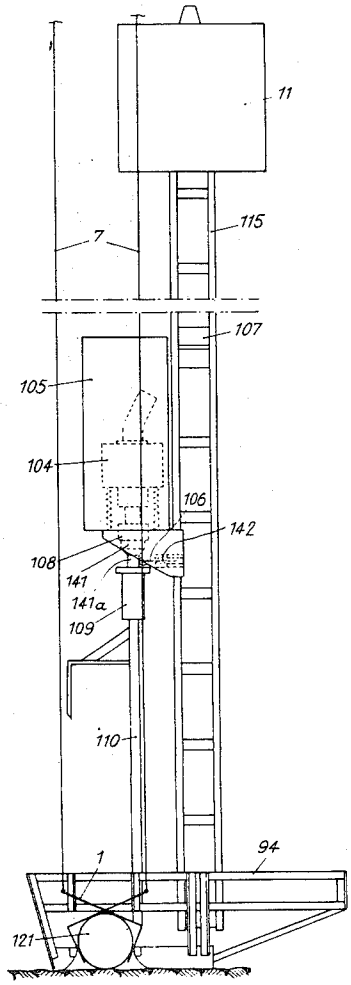

FIG. 2

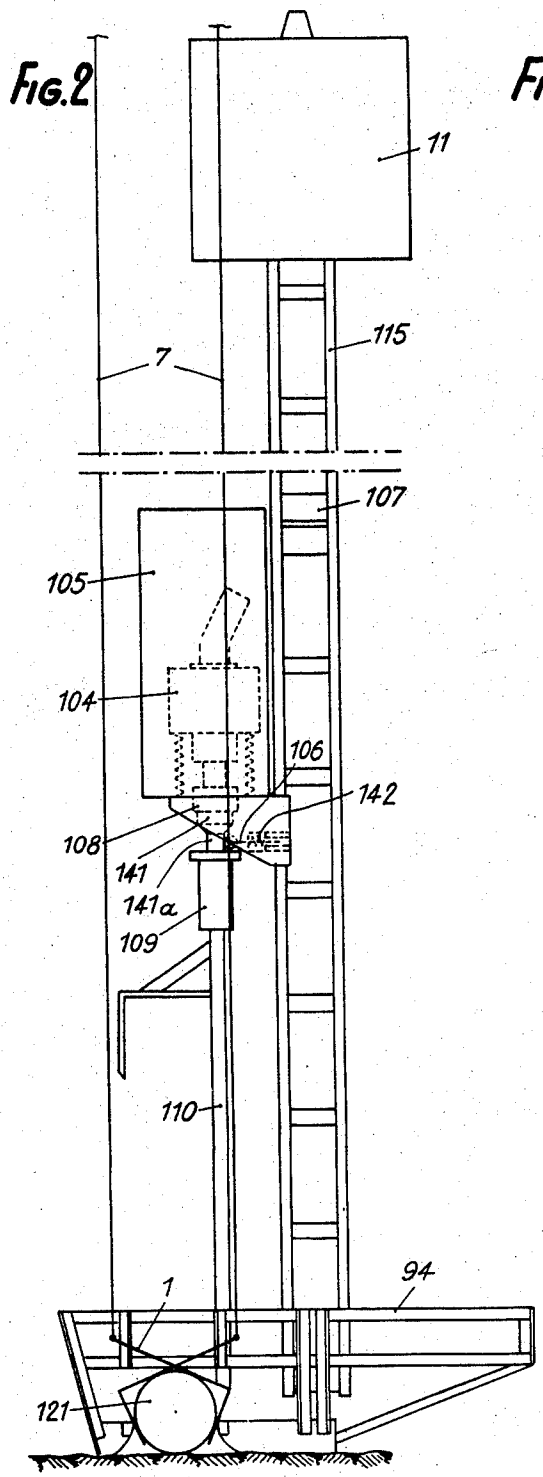
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FIG. 1

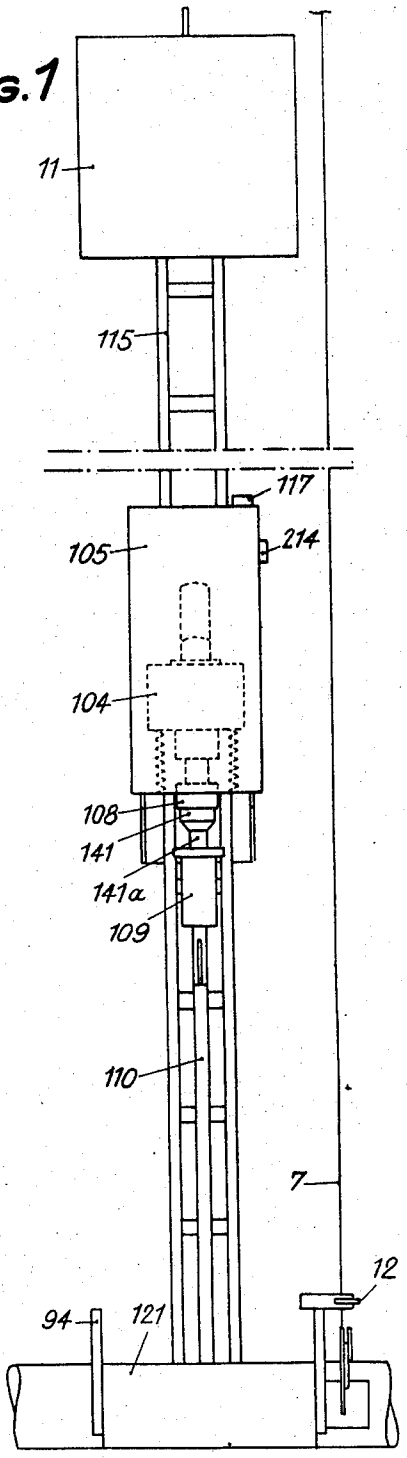
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FIG. 3

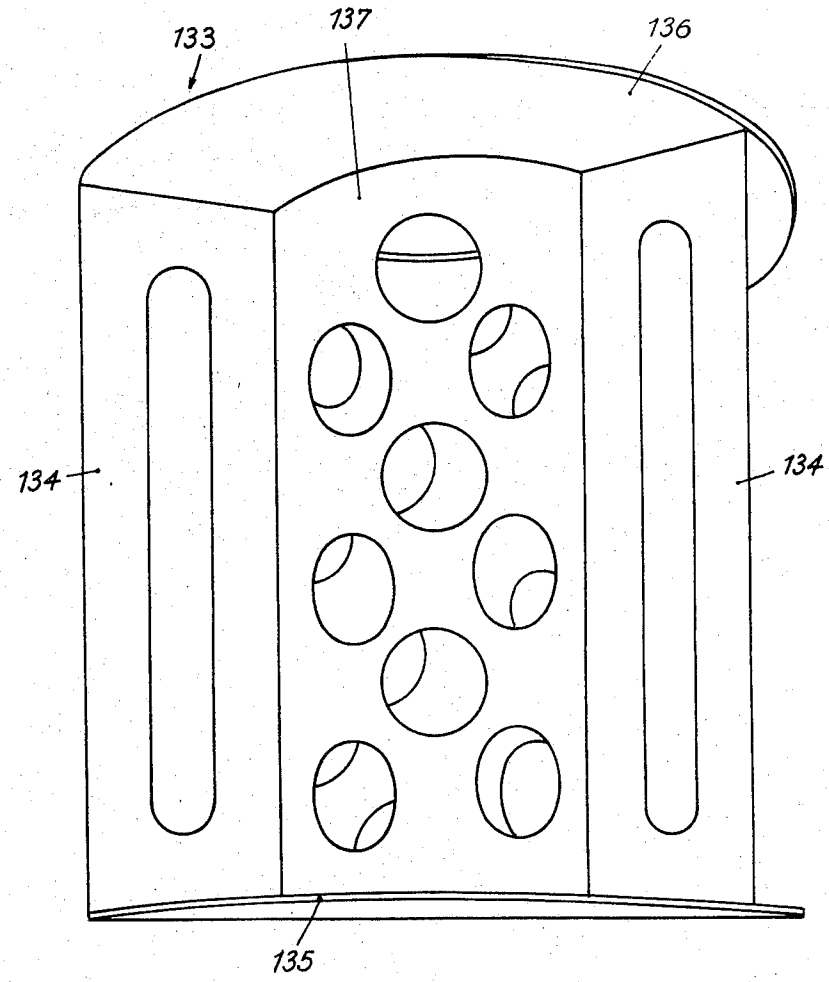
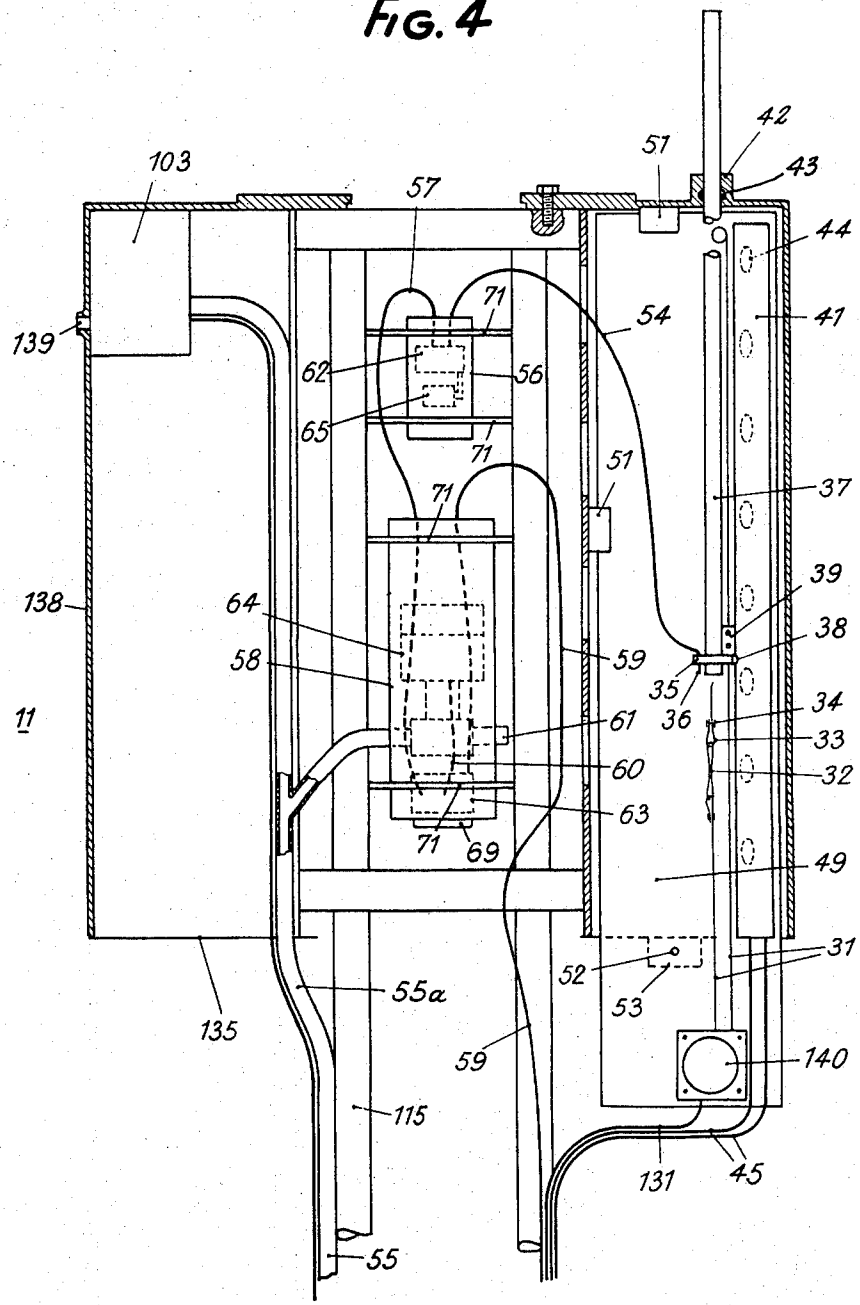


FIG. 4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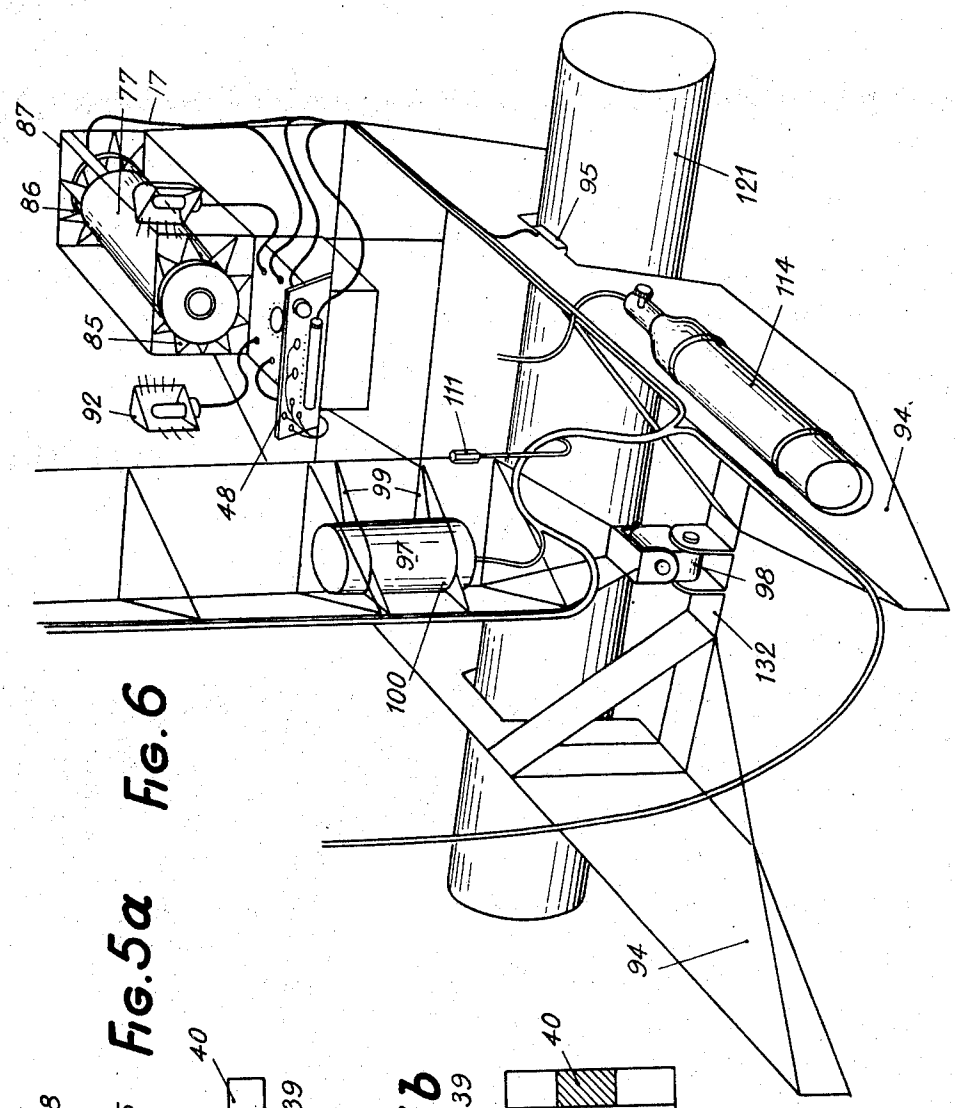


FIG. 6

FIG. 5a

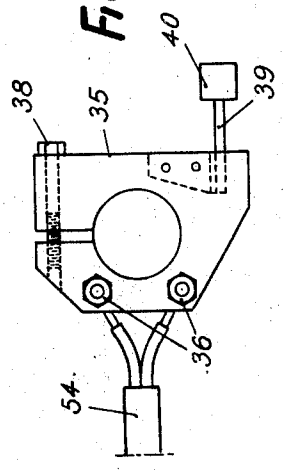
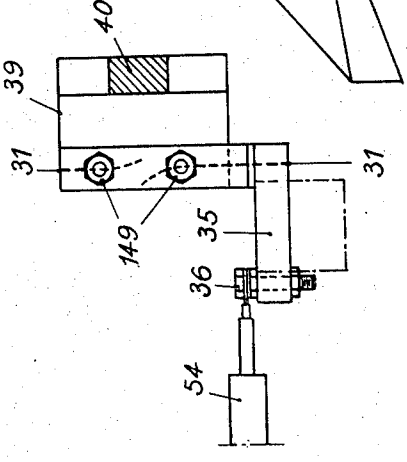


FIG. 5b



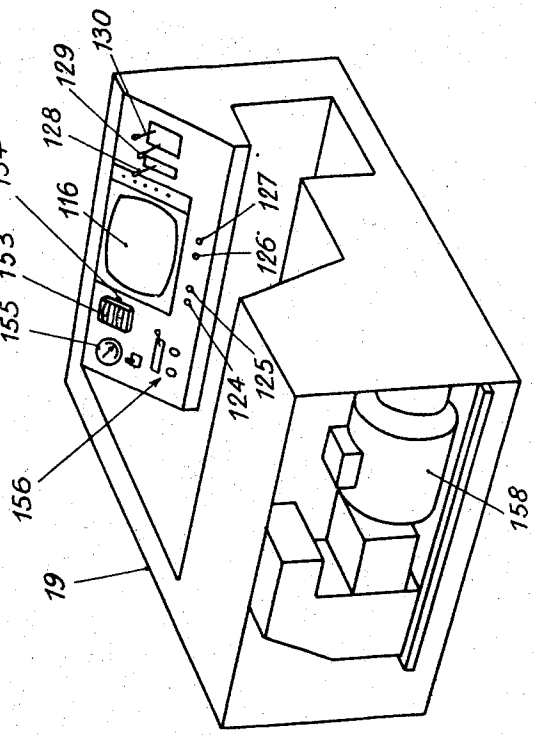


FIG. 9

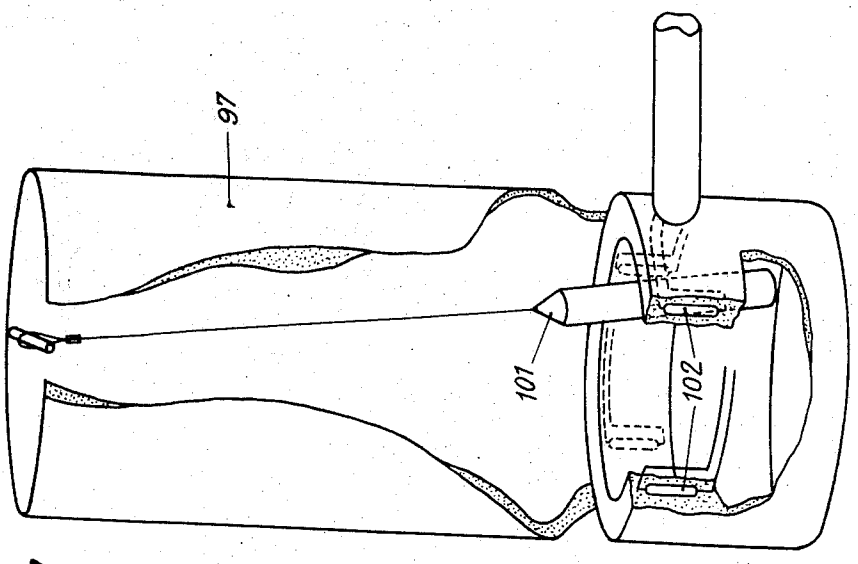


FIG. 7

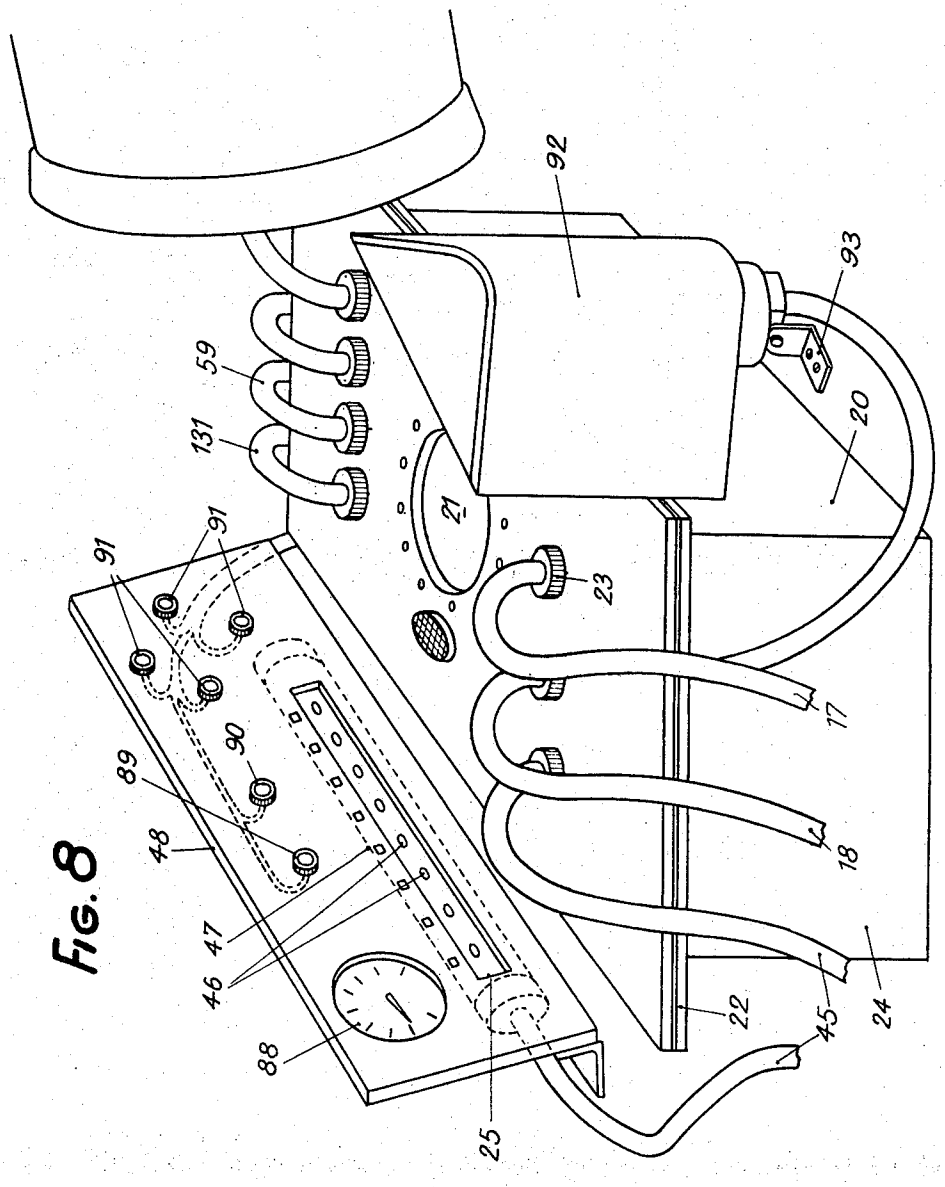


FIG. 8

FIG. 10

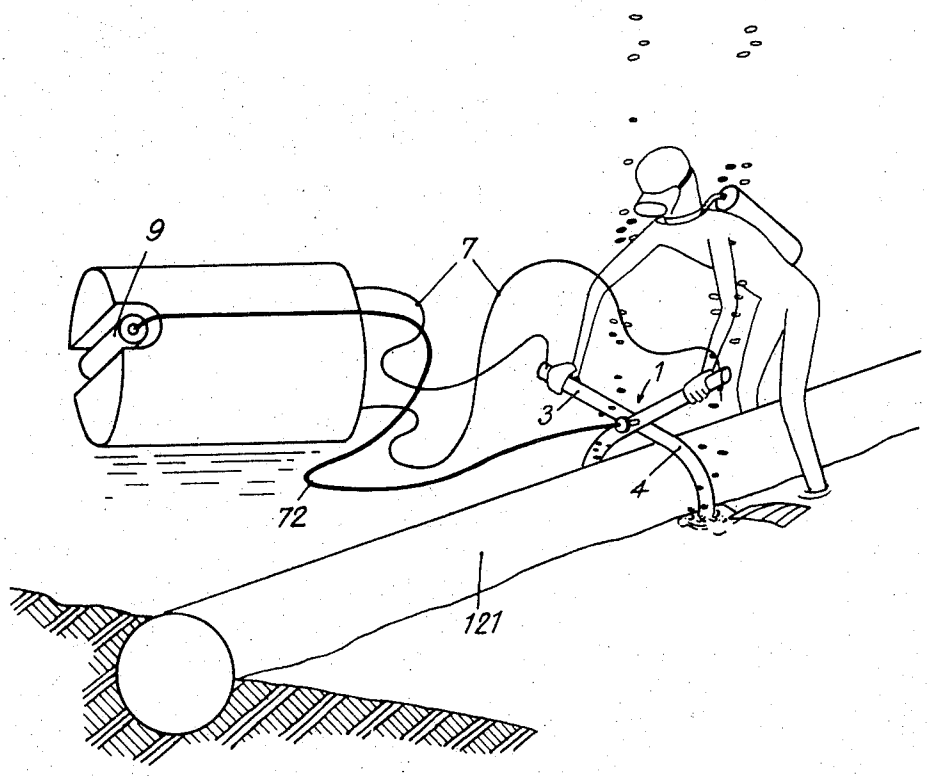


FIG. 12

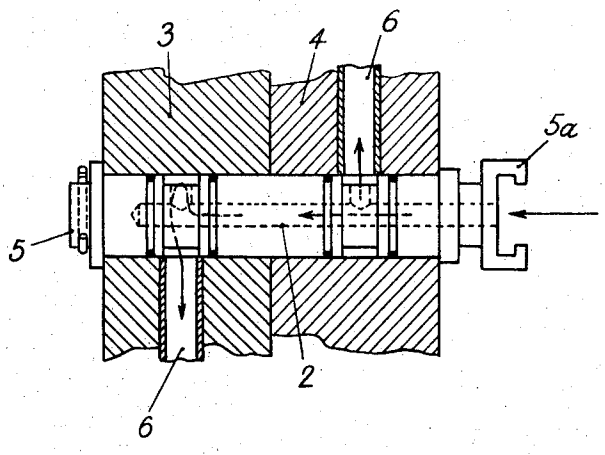


FIG. 11

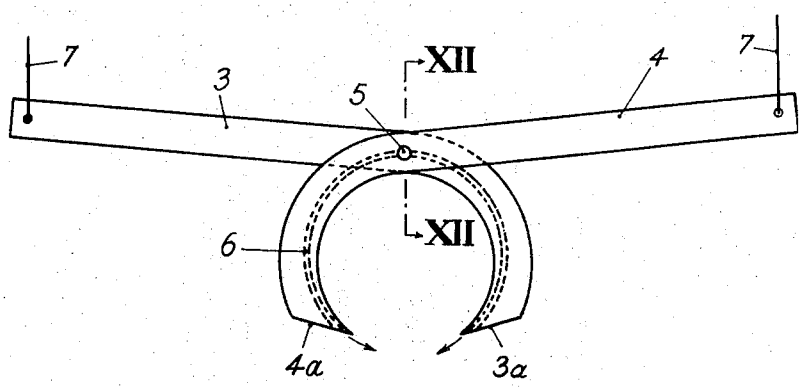


FIG. 13

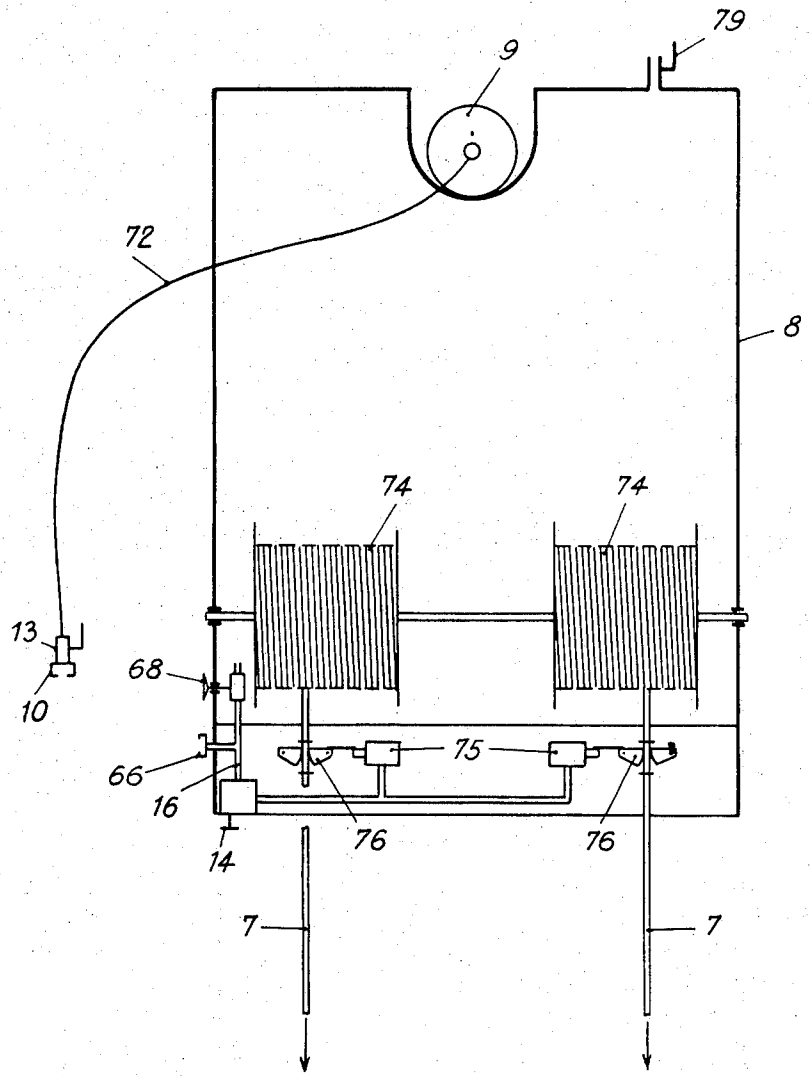


FIG. 14

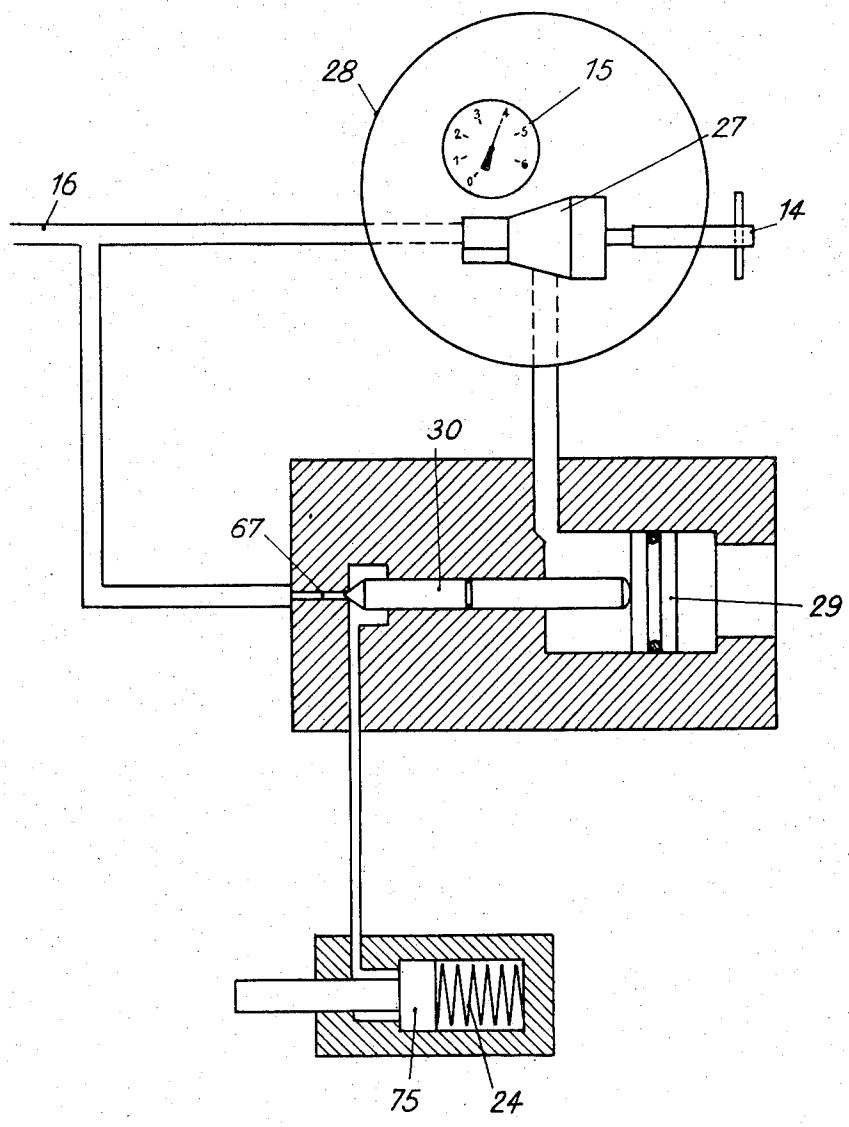


FIG. 15

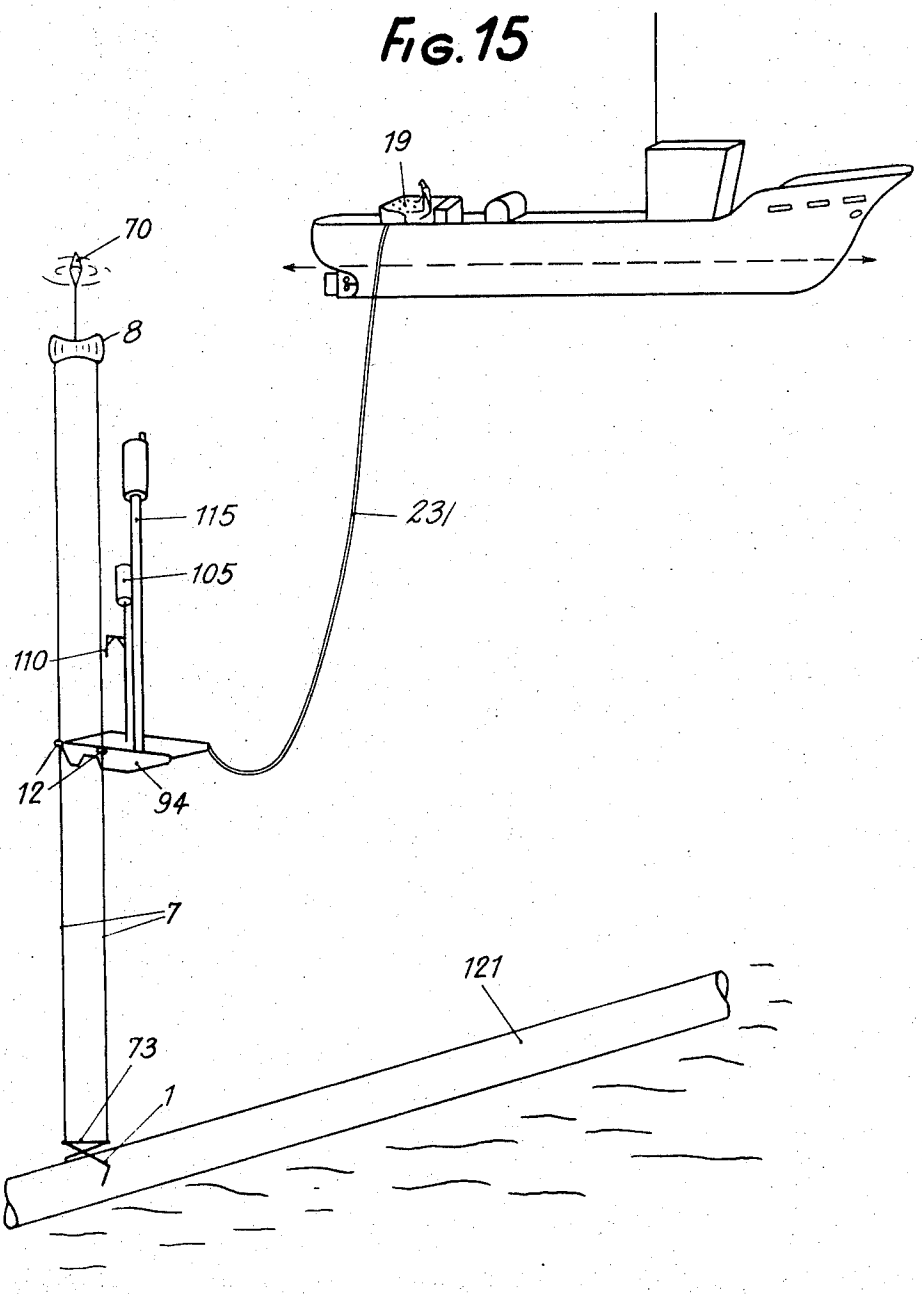
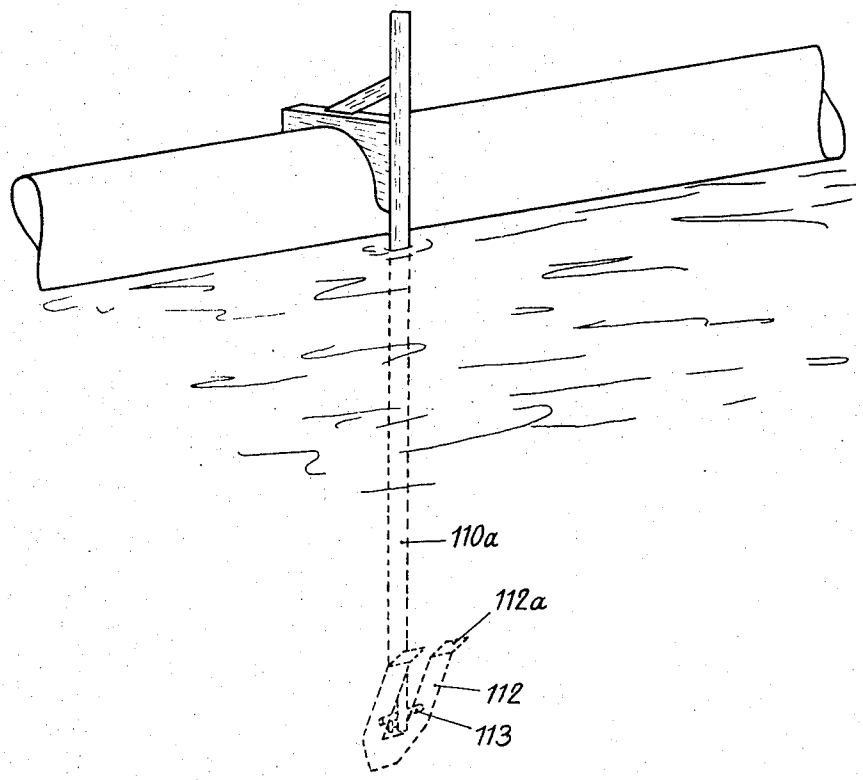


FIG. 16



DEVICE AND METHOD FOR THE ATTACHMENT OF PIPELINES TO AN UNDERWATER SURFACE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a device for the automatic (pile) driving of anchoring means into an ocean bottom for holding a conduit, such as a pipeline, for example, resting on the bottom, as well as the method for implementing the attachment.

2. Description of the Prior Art

The method presently used for attaching underwater pipelines consists of anchoring piles which hold the pipeline in position. In certain cases, the piles can be very heavy, so as to avoid the necessity of anchoring to the underwater bottom. The inconvenience of this method results from the difficulty which divers have in guiding these piles above the pipeline. Moreover, these piles can be used only for certain ocean bottoms and more particularly, for very flat bottoms.

Another method consists of using piles whose circumference surrounding the pipeline is prolonged by two plates each of which is attached by means of an anchor driven in by explosives. The gun permitting this method of anchoring does not, however reduce the work that has to be done underwater and the application of this method is both expensive and laborious.

Another method consists of anchoring piles with the help of a vibration-piledriver which is lowered to the ocean bottom. Although this method offers the advantage of no longer requiring the anchoring gun, it nevertheless does force the diver to perform numerous operations and it makes it necessary for him in any event to watch over the proper operation of each one of the two anchoring devices necessary to attach a collar.

As anchoring means, one can also use augers, but regardless of the method adopted, the diver is forced to do heavy work so that it is necessary in general to prepare two advance holes for the two anchoring devices, and furthermore, it is necessary in each case, to place a collar and finally, if the terrain constituting the underwater bottom is inclined, there are considerable placement difficulties. These difficulties are all the more annoying when the bottom, on which the pipelines must be attached, is a submarine bottom, the means for implementing these methods this involving hoists on the surface vessel which must then be equipped with an antiramming device so as to facilitate intervention on the bottom in case of a surface surge.

SUMMARY OF THE INVENTION

The primary objective of the present invention is to provide an apparatus for driving anchoring means into an underwater bottom characterized by a base plate for the purpose of putting it into working position on the underwater bottom, a boom to support a device for the driving of an anchoring means, a cardan joint connecting the base plate to the boom, and a ballast equipped with its own control means that comes in one piece with the upper part of the boom.

This apparatus makes it possible to eliminate the inconveniences of the methods mentioned above and furthermore offers a series of unexpected advantages such as the ease of access to the place where the anchoring means are to be put down, the instantaneous and stable placement of the apparatus on the underwater bottom itself even if the latter is not properly flat, the relative

independence of the apparatus from the vessel, and the possibility of performing a vertical pile driving operation, even in case the apparatus is not set up horizontally.

Another object of the invention is to provide an apparatus of this type, using as anchoring means a hook possessing an upright arm, a head for the purpose of capping the upper portion of the pipeline, and an anchoring shovel which can be moved around an axis attached to the lower end of the upright arm.

Such a combination is worthwhile because it enables us to use a simple vibro-piledriver apparatus as the driving device and to accomplish the simple and effective attachment of the pipelines with a single operation of the vibro-piledriver, which at the same time, prevents upward and lateral movement of the pipelines while eliminating any possibility of the withdrawal of the attachment means.

Another object of the invention is a device of this type in which the base plate, which, at its base, involves at least one means of attachment to the pipeline so as to place the apparatus in a predetermined position with respect to the pipeline, furthermore comprises at least one passage for the placement and driving of the anchoring means for the attachment of the pipeline.

We thus have an apparatus which is both flexible and practical and which permits the automation of the entire placement and driving operation for the pipeline anchoring means.

Another object of this invention is an apparatus of the type indicated, where the ballast involves a bell whose upper portion comprises an opening with a tube open at its ends, sliding in a tight fashion in the opening, means to make the tube slide in the opening, means for the detection of the water level inside the bell, the means being carried by the sliding tube, a valve controlling the admission of air into the interior of the bell, and water level detection means controlling the opening and closing of the valve.

Thus, the buoyancy of the ballast depends essentially on the position of a tube with respect to the water level, and it suffices to vary its position with respect to a reference marker attached to the bell so as to multiply the positive or negative buoyancy of the apparatus.

Another object of this invention is an apparatus of this type, involving means for connection with a surface vessel, including means for the transmission of the energy necessary for the control of the driving device and of the means for the control of the position of the tube sliding in the ballast, as well as a means for surface transmission of the indication of the level of water in the ballast.

It is possible to control all of the operations of driving the anchoring means of the pipelines from the surface vessel, since the apparatus is capable of itself taking on a predetermined position with respect to the pipelines, ensuring its vertical position in spite of the placement of the base plate on an area that is not horizontal, and assuming the desired bupyancy in order to insure any descent or ascent maneuver.

Another object of this invention is a method of using the placement apparatus described above, according to which a removable clip is attached to the pipeline to be immobilized on the underwater bottom. The end of each arm of the clip has a cable, equipped at its other end with a float which is inflated under the water and which the cable keeps at a certain level below the sur-

face of the water and in a zone where the effect of the water surge is no longer felt. Placement apparatus is slid along the cables, and the descent speed of the apparatus is controlled by the buoyancy of the ballast. After attachment of the base plate of the apparatus to the pipeline, we trigger the operation of the driving device for the anchoring means, and after the driving-in of the apparatus, we raise the ballast by regulating the buoyancy. We recharge the apparatus, submerged, with another anchoring means, slack off on one of the cables so as to detach the removable clip and then proceed in a similar manner on the next site.

Another object of this invention is a method of this type where we roll up the cables on a reel whose assembly is connected to a float which is inflated underwater after the placement of the removable clip.

BRIEF DESCRIPTION OF THE DRAWINGS

These various features, as well as other objects and advantages of the present invention, will emerge better from the following specifications, given here with reference to the attached drawings which represent one of the ways of implementing the device for the driving of anchoring means of pipelines laid on an underwater bottom.

In the drawings:

FIG. **1** is a schematic elevation and front view of the apparatus;

FIG. **2** is a schematic profile view of the apparatus;

FIG. **3** is a perspective view of the frame of the ballast of the apparatus;

FIG. **4** is a schematic inside view of the ballast of the apparatus after the removal of a portion of the external and internal lateral walls;

FIGS. **5***a* and **5***b* are the respective plan and elevation views of a detail of the means for the attachment of the device for the control of the ballast;

FIG. **6** is a schematic perspective view showing the devices incorporated in the base plate and at the base of the boom of the apparatus;

FIG. **7** is a schematic perspective view of the pendulum mounted in the boom;

FIG. **8** is a schematic view of the table for the automatic attachment of the apparatus controls;

FIG. **9** is a schematic view of the apparatus control (piloting) post;

FIG. **10** is a view illustrating the placement of the removable clip;

FIG. **11** is a schematic elevation view of the removable clip;

FIG. **12** is a view of the cross section made along line XII—XII in FIG. **11**, with the arms of the clip removed;

FIG. **13** is a schematic view of the float housing the cable-carrying reel;

FIG. **14** is a schematic view of the reel control;

FIG. **15** is a view illustrating the operation of lowering the apparatus and

FIG. **16** is a view showing the attachment of a pipeline by means of the anchoring hook.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In order to facilitate the description of the apparatus shown in FIGS. **1** and **2**, we have assumed that the apparatus is in working position with the base plate of the apparatus, consisting essentially of hanger **94**, more visible in FIG. **6**, straddling the pipeline **121** which rests on the underwater bottom. The hanger **94**, in the version shown by way of example here, includes two bearings **12** FIG. **15** which can be opened or closed so as to introduce a guide cable **7** into each one of them.

The two cables **7**, attached to the ends of the arms of a clip **1**, are held by an appropriate float **8**, FIG. **15**, situated at a level below the surface zone which is affected by waves. We can provide a supplementary float **70** whose only purpose is to serve as reference marker for the place where the anchoring means of pipeline **121** are being driven in.

Hanger or seat **94** is made in one piece with boom **115** by a cardan joint **98**, FIG. **6**, connecting the brace **132** of hanger **94** to the base of boom **115**. The boom **115** can be made up of tubular elements assembled so as to form a prism with a triangular base, for example, the axis of the boom coinciding with the vertical axis of the cardan joint when the boom is vertical.

At the top of the boom **115**, there is ballast **11** whose inside frame **113** has been shown in FIG. **3**. The operation of the members serving the ballast has been shown in FIG. **4**.

Frame **133** consists preferably of an assembly of perforated panels **134** made of polyester and welded with araldite, for example. In the disclosed embodiment, three panels **134** ensure the rigidity of the assembly made up of lower ring-shaped panel **135**, upper ring-shaped panel **136**, and central tube **137**. The panels **134**, as well as tube **137**, present large openings so as rapidly to regulate the flow of water or air introduced into the ballast.

The lower panel **135** has likewise large openings in the shape of a portion of a ring, serving to provide direct communication between the internal portion of the ballast and the environment into which it is submerged. Each one of these openings is preferably arranged between two panels **134**. Panels **134** and **136** serve as support for wall **138**, FIG. **4**. of ballast **11**.

One of the panels **134** also serves as a support for the ballast control mechanisms contained in bores **103**, and the upper portion of boom **115** is attached to the upper portion of ballast **11** and serves as support for two tight boxes **56** and **58**.

In addition to the large openings provided in panel **135**, ballast **11** has four small lateral upper openings **139**, each serving for the ejection of compressed air under the control of an individual electric valve placed in a box such as **103**. An upper opening permits the placement of a bearing **42** made of erlaton which traverses a tube **37** made of polyvinyl chloride. A toric joint **43** preferably made of teflon provides tightness for the guidance device of tube **37**.

The lower end of this tube is made in one piece with a movement mechanism by means of an erlaton collar **35**, more visible in FIGS. **5**a and **5**b. This collar is kept tight on tube **37** by screw **38**. A runner or slider **39**, made in one piece with collar **35**, is attached by ties **149** to the ends of a loop of cable **31** made of steel and sheathed with nylon. Runner **39**, made of stainless steel, for example, has a permanent magnet **40** whose role will be explained later on. This magnet slides in a groove made in the fixed slide **41**, FIG. **4**.

Collar **35** furthermore carries two electrodes **36**, each being connected to an electric cable, these cables being shown schematically by casing **54**.

An assembly of circuits, shown schematically by cables **45**, is controlled by switches **44** which can be car-

ried by fixed slide **41.** These switches, controlled by the passage of the permanent magnet **40,** are well known in themselves and therefore are shown only schematically at **44.**

This assembly makes it possible to easily determine the level of the permanent magnet **40** with respect to slide **41** and consequently the level of the lower end of tube **37.** For this purpose, each one of the circuits shown by cables **45** is supplied, for example, with 24-V alternating current and, with its switch, involves a bulb **46,** which is visible on plate **25,** FIG. **8.** In the example chosen, this plate is submerged in a flexible transparent tube **47** filled with oil and it is a part of the on-board table **48,** attached to hanger **94,** FIG. **6,** of the apparatus.

The movement of collar **35,** upward or downward, is performed with the help of endless cable **31** whose tension is kept constant by an extensible rubber spring **32** attached to copper eyelets **33** and set by cleats **34.** The endless cable is moved by an electrical motor which is enclosed in oil inside a tight chamber **140,** the oil being kept at the pressure of the surrounding environment by means of a membrane. By means of a reducing gear, the motor moves a drum on which cable **31** is reeled. Chamber **140** is preferably made of polyvinyl chloride. Its tightness is ensured, at the place of the junction of the body of the box and its lid, by flat joints made of neoprene and at the places where the strands of cable **31** pass, by stuffing boxes. The mechanisms contained in the box are all known and none of them were shown. The motor is controlled by cable **131** from a central post **19,** FIG. **9,** situated preferably on the surface, on board a ship, FIG. **15.** Cable **131** in fact involves several circuits so as, by means of button **124,** to bring about the rapid rotation of the motor that moves the cable **31** in the rising direction, and, by means of button **125,** its slow rotation, and by means of buttons **126** and **127,** the rotation of the motor so as to move cable **31** in the opposite direction, button **126** here controlling the slow rotation and **127** the rapid rotation. The motor is preferably supplied by means of a direct current of **12** or 6 volts.

The assembly of the slide **41,** the collar **35,** cable **31,** and tight chamber **140** is preferably arranged on a removable plate **49** which is introduced into the ballast and which is maintained with the help of blocks or wedges **51.** It is attached to the ballast by an inoxidable steel bolt **52** going through wedge **53.**

Assuming that collar **35** is located at a certain place above water level inside the ballast, the latter's weak buoyancy brings about the descent of the placement apparatus. Consequently, by virtue of the increase in the ambient pressure, the volume of air which the ballast contains is reduced, and the water level comes into contact with electrodes **36.** This contact brings about the closing of electrical circuit **54,** which is supplied by a battery **65,** which furnishes a voltage of 9 volts, for example, to a transistorized relay **62.**

Relay **62** thus placed in operation brings about the excitation of an electromagnetic relay **63** which is supplied with 24 volts, one of whose contacts closes a circuit **60** supplied with 220 volts and controlling electric valve **64.** The electric valve, in turn, controls the opening of a compressed air circuit **55** coming from two bottles **114,** placed on either side of seat **94,** FIG. **6.** The air released at **61** increases the captive air volume of the ballast and causes the water level to drop. Electrodes **36** are no longer in contact with the water and circuit **54** is opened, bringing about the de-excitation of relays **62** and **63** and consequently the stoppage of electric valve **64** which, by virtue of this fact, cuts off the air flow.

We thus obtain an easy means for regulating the buoyancy of the apparatus from the central control post **19,** FIG. **9,** since the water level is finally determined by the position of the collar **35** whose movement is regulated by buttons **124–127.**

For greater ease, tight boxes **56** and **58** contain, respectively, on the one hand, the relay **62** and its supply **65** and, on the other hand, relay **63** and electric valve **64,** both of them supplied by compressed air circuit **55.** Container **56** can be made or erlaton, and the passages of cables **54** and **57** into its lid are maintained tight by means of glueing with araldite. The lid can be bolted onto the body of the container and the tightness of the junction is ensured, for example, by a toric joint.

Chamber **58** is preferably made of stratified polyvinyl chloride. It is filled with oil that is kept at the pressure of its ambient environment by means of a membrane. The passages for electric cables **57** and **59,** as well as the passages of the air pipelines **55** and **61,** are made tight by a polyester resin.

The chambers **56** and **58** are suspended from rings **71** which come in one piece with boom **115** by means of elastic rubber springs with the help of a mounting similar to the one shown at **85** in FIG. **6.**

Boom **115** carries, in its lower portion and above cardan joint **98,** a container **97,** FIG. **6,** suspended from elastic rubber springs **99** between collars **100** and the boom. FIG. **7** shows a pendulum control means. Body **101** is magnetized and, depending upon the inclination of the boom, makes it possible to close one or the other of the four switches **102** which are distributed over a circle at an interval of 90°.

Each switch **102** controls the marker **91** which is assigned to it and which is on the on-board table **48,** FIG. **8.** Each switch controls, in parallel with the marker **91** assigned to it, an electric valve contained in the boxes **103,** FIG. **4.** The selected opening **139,** arranged in the upper portion of the lateral wall **138** of the ballast, releases a flow of compressed air from circuit **55, 55***a* the moment the electric valve in the box **103** corresponding to the selected opening is moved. The thrust produced by the reaction if the air straightens out the boom in the proper direction.

A vibro-piledriver **104,** placed in its bell **105** as shown in FIG. **1,** is kept at the head of the boom by a finger **106** which butts into a plate **107** welded on the boom.

When the operator controls the jack **108** in order to bring the piston **141** back up, finger **106,** driven toward the piston by its spring **142,** leaves plate **107,** falling on part **141***a* which has a smaller diameter. This releases the vibro-piledriver assembly **104,** the hydraulic anvil **109,** and the anchoring hook **110.** The drop of the assembly can be observed on television screen **116,** FIG. **9,** at the central control post.

Referring to FIG. **6,** a camera, whose lens is placed in the axis of the port-hole of the tight caisson **77,** makes it possible, by means of the cable **17,** to transmit the coaxial images observed. Caisson **77** is suspended from a rubber extensible spring **85,** stretched between collars **86** and frame **87.** Projectors **92,** mounted on orientable support **93,** FIG. **8,** made in one piece with

hanger **94**, make it possible to illuminate the observation zone and in particular the on-board table **48**.

This table is made of transparent polyvinyl chloride so as not to conceal the rear plan which is in the field of vision of the camera. In addition to control lamps **46**, which indicate the buoyancy, and lamps **91**, which indicate the vertical position of the boom, it includes the bathymeter **88**, which enables the operator to follow and control the descent of the apparatus, and the markers **89** and **90**.

Marker **89** lights up the moment hanger **94**, astride pipeline **121**, activates a pedal **95**, FIG. **6**, carrying a magnet whose function is to close a contact, not shown here, establishing the circuit of the marker **89**.

Marker **90** lights up the moment pedal **111** FIG. **6**, is activated at the end of the course of the vibro-piledriver, that is to say, when the latter has completely driven in the hook **110**, FIG. **1**.

In order to guarantee the operation of the apparatus, the central control post, which is located on the surface, on board a ship, is connected to the apparatus by a rope **114**, FIG. **15**, combining the cables **131** and **17** and pipelines for the electric and hydraulic power supply. These pipelines are up of two pipelines with a large diameter for control of the vibro-piledriver device **104**, FIG. **1**, controlled by the handle **130** of the central control post, FIG. **9**; two pipelines with average cross section for the control of jack **108**, FIG. **1**, controlled by handle **129**, FIG. **9**; one pipeline for the drainage of the leaks from device **104**, FIG. **1**; and one pipeline for the control of the hydraulic anvil **109**, controlled by handle **128**, FIG. **9**. The rope **231** furthermore involves a coaxial cable **17**, FIG. **8**, for the video circuits and an electrical cable **18** involving the conductors with single-phase 220-volt current and 12-volt direct current.

The electrical cables penetrate the tight supply box **20**, made of stratified polyvinyl chloride and filled with oil, kept at ambient pressure by means of a membrane **21**. All cables penetrating and leaving the box pass through stuffing boxes **23**, tightness being assured by means of a silicon resin. A neoprene joint **22** guarantees the tightness of the lid of box **20**.

The various supply circuits are known in themselves and will not be described.

The apparatus thus made enables us to use a new method for the attachment of pipelines to an underwater bottom.

Although this method is facilitated by the appropriate adaptation of the means used here, the method may, be used with any kind of commercially available clips designed to serve as a means for anchoring two guide cables that are stretched by means of one or more floats. We thus understand that the means described below can, with regard to the method itself, be replaced by any kind of clip **1**, two cables **7**, and at least one float **8**, FIG. **15**.

According to the method involved in this invention, a diver descends down to the pipeline **121** to be attached to the ocean bottom and ties clip **1** to the tube. If the pipeline has already penetrated an ocean bottom with too little resistance, we preferably use a clip such as shown in greater detail in FIGS. **11** and **12**. The curved-backends of arms **3** and **4** of the clip are tapered so as to facilitate the penetration of the ends into the ground and furthermore involve an internal channel **6** which comes out on the oblique sections **3***a* and **4***a*, which give the ends the desired tapered form. Channels **6**, more visible in FIG. **12**, come out into a tubulature **2** of the articulation axis **5** of the clip. Connection **5***a* can receive connection **10**, FIG. **13**, equipped with a valve **13** and connected by tube **72** to a compressed air container **9**. The opening of valve **13** makes it possible to inject compressed air into the bottom on which rests the pipeline **121**, as shown in FIG. **10**, thus facilitating the penetration of the ends of the clip **1**. We can thus achieve a good tie-up, even when the pipeline is already sunk into the ground.

It then suffices for the diver to tie, to the still free ends, the cables **7** of buoys (not shown) which he fills with the help of a compressed air bottle. A rubber extensible spring **73** can also be attached to the ends of arms **3** and **4** of clip **1**, FIG. **15**.

However, in order to prevent the diver from having to vary the points of attachment clamps of such buoys as a function of the depth where the pipeline is attached, we preferably use a reel **74** mounted inside a float **8** made of polyvinyl chloride, FIG. **13**. The diver then connects the connection **10** to the connection **66**, opens valve **13**, and with the help of screw **14** sets the pressure corresponding to the height at which float **8** is supposed to be stabilized. This height is read off on the pressure gauge **15**, FIG. **14**. The high-pressure air, arriving through duct **16**, penetrates the pressure regulator **27**, placed in a tight container **28**. The air, kept at pressure h (height below surface), acts on the inside face of piston **29**. Because the pressure of the ocean acts upon the outside face of piston **29** and this pressure is much greater than the pressure which has been adjusted for, piston **29** pushes rod **30** which closes opening **67**.

The diver then puts in place a simple supplementary float **70**, FIG. **15**, and opens valve **68**, FIG. **13**, in order to lighten float **8**. He closes this valve the moment the ascent starts.

Reels **74** are then unwound as the float **8** rises. When the pressure of the ocean becomes smaller than the pressure which has been set, piston **29**, FIG. **14**, moves toward the outside, releasing rod **30**. Since the high-pressure air exerts a greater force than the spring **24**, piston **75** compresses the sring, releasing the wedging blocks **76**, FIG. **13**, which block the guide cables **7**.

The level at which the reels, supporting the guide cables **7**, are submerged is so selected as to avoid any disturbance caused by waves, and float **70** only acts as a signaling device here.

We then put the apparatus, which we can equip with its attachment hook **110**, FIG. **15**, in the water. This hook preferably in its upper portion has a shovel **112**, FIG. **16**, which is capable of moving away from the plane containing the axis of the riser **110**a so that, due to the action of the underwater currents or any other action, hook **110** cannot be shifted and release the pipeline which it must keep in place. By way of example, shovel **112** is made in one piece with axis **113**, traversing the end of riser **110***a*. In order to facilitate the tipping of the shovel in the course of traction exercised upon the hook, the edges **112**a can have a certain inclination.

The diver attaches the bearings **12** of hanger **94** around cables **7**, FIG. **15**, and the operator submerges the apparatus from his control station **19**.

The television screen enables him to read all of the indications furnished by the control lamps of the placement apparatus and it is easy for him to follow all of the

phases of the operations described above and consequently to trigger the release of the vibro-piledriver only after he has made sure that the boom is vertical and that the placement of the apparatus is correct on the basis of the fact that marker **89** is lit up. Moreover, if, following the release of the vibro-piledriver, the boom should assume a bad inclination, the operator could begin this operation all over again and in any fashion whatsoever act upon the vertical position of the boom, as described earlier.

The moment the hook **110** has been driven in, that is to say, at the end of the course of the vibro-piledriver **104,** the marker **90** is lit up so that it suffices for the operator to separate the hydraulic anvil **109** from hook **110** and to increase the buoyancy of the ballast so that the apparatus will go back up, still guided by cables **7.** Since the air volume increases in the ballast and since the pressure decreases, tube **37** evacuates a portion of the air from the ballast **11** FIG. **4.** The operator stops the ascent at a level where the effects of the waves can not be felt. The diver once again loads another hook which one can make lighter by means of auxiliary floats, not shown, for easier handling. This maneuver is also followed on the operator's television screen.

The diver then increases the buoyancy of bell **105** of the vibro-piledriver by opening cock **214,** FIG. **1.** thus releasing a circuit of high-pressure air. As soon as the bell has arrived in the top position, he signals before the camera to the effect that the operator can reset the blocking finger **106.** The diver can then disengage cables **7** from bearings **12,** FIG. **15** and give weight back to the vibro-piledriver assembly by partially emptying bell **105** with the help of cock **117.**

He signals the end of the operation and, in order to release clip **1** in the proximity of the surface, he can slack off one of the strand of the reel so as to raise the entire assembly and to go on to the next site. A valve **79,** FIG. **13,** enables him to make the float **8** heavier and to bring it back down in preparation for attaching the removable clip at the next site.

It is clear that numerous modifications can be introduced in the means described and that one can add, to the elements already reported in connection with the control post **19,** FIG. **9,** all control apparatuses: voltmeter **153,** ammeter **154,** revolution-counter **155,** and starter **156** for alternator **158.**

Likewise, means for guiding the vibro-piledriver device, moving parallel to the axis of the boom, can be any whatsoever and the materials indicated as constituting the various parts of the apparatus can be replaced by equivalent materials.

In particular, the vibro-piledriver device can be replaced by any other control device and especially by a rotation control member, the invention residing in the means described above, which serve as mobile support for said device supported by the boom. Thus we would not go beyond the framework of the invention by replacing the vibro-piledriver with measurement, drilling and boring apparatuses, or all optical, acoustic, or other detectors, accompanied by their transmission circuits.

What is claimed is:

1. Apparatus for the placement and anchoring of underwater pipelines to the bed of a body of water comprising:

a boom;

a float;

means for connecting the boom to a pipeline comprising a first means connecting the pipeline to the float and a second means for sliding the boom on the first means,

means for connecting the pipeline to the underwater bed;

means on the boom for automatically embedding the connecting means in the underwater bed;

a remotely controlled ballast tank means connected to the upper portion of the boom, and

control means for remotely controlling the buoyancy of the ballast tank means and of the embedding means, whereby the apparatus can be easily moved from anchor point to anchor point along the pipeline.

2. Apparatus as in claim **1,** where the means connecting the pipeline to the float include a clip member and at least one line, whereby the boom can be connected to the line and slid into place adjacent the pipeline.

3. Apparatus as in claim **1,** where the means for connecting the pipeline to the underwater bed include a substantially inverted L-shaped pile.

4. Apparatus as in claim **1,** wherein the means for embedding the connecting means in the underwater bed include a remotely controlled vibro-piledriver.

5. Apparatus as in claim **1,** further including a sled like base member capable of being removably mounted over the pipeline and connected to the boom by a cardan joint.

6. Apparatus as in claim **1,** further including means mounted on the boom for detecting departures from verticality in any direction and means operatively connected thereto for vertically aligning the boom by thursts of compressed air.

7. Apparatus as in claim **1,** where the means for embedding the connecting means is a vibro-piledriver device having a jack placed under a bell, the bell having a high-pressure air intake valve so as to increase its buoyancy and an air evacuation valve so as to reduce it, the boom supporting the vibro-piledriver device and having a locking mechanism and a stop in its upper portion cooperating with the locking mechanism which is controlled by the jack of the vibro-piledriver device, the jack having a hydraulic anvil cooperating with the connecting means, so that, during the unlocking of the locking mechanism, the assembly of the vibro-piledriver, anvil, and anchoring means will fall parallel to the boom.

8. Apparatus as in claim **2,** where the float carries at least one reel and a source of compressed air for varying the buoyancy.

9. Apparatus as in claim **2,** where the clip member is hollow and a source of compressed air can be connected to the clip so as to permit the compressed air to be blown through the hollow interior of the clip, thereby facilitating connection of the clip to a partially embedded pipeline.

10. Apparatus as in claim **5,** where the boom is prismatic and where the vertical axis of the cardan joint which connects the boom to the sled-like base member coincides with the axis of the boom when the latter is vertical.

11. Apparatus as in claim **5,** where a tube of compressed air is mounted on the sled-like base member.

12. Apparatus as in claim **5,** where a control panel operatively connected to the control means is mounted on the sled-like base member.

13. Apparatus as in claim 12, where a television camera for monitoring the control panel and the connecting operation of the pipeline to the bed is mounted on the sled-like base member.

14. A method of anchoring an underwater pipeline to a bed of a body of water comprising the steps of:

attaching a removable clip to the pipeline;

inflating a float attached by a line to the clip, which float is adapted to float at a level selected so as to avoid any disturbance caused by waves

attaching a buoyant boom means to the line and remotely regulating the buoyancy of the boom means so it descends to the pipeline;

activating means on the boom means to sink a pile member into the bed for securing the pipeline;

increasing the buoyancy of the boom means by remote control after securing the pipeline so that it ascends, and removing the clip.

15. A method of anchoring as in claim 14, where the buoyant boom is vertically aglined by a pendulum control means which activates a discharge of compressed air to produce an aligning thrust force.

16. A method of anchoring as in claim 14, where compressed air is ejected from the ends of the clip during attachment to facilitate attachment to a partially embedded pipeline.

17. Apparatus for the placement and anchoring of underwater pipeline to the bed of a body of water comprising:

a boom;

a remotely controlled ballast tank means connected to the upper portion of the boom;

means for connecting the boom to a pipeline;

means for automatically embedding the connecting means in the underwater bed;

control means for remotely controlling the buoyancy of the ballast tank means and of the embedding means, whereby the apparatus can be easily moved from anchor point to anchor point along the pipeline.

18. Apparatus as in claim 17, where the remotely controlled ballast tank means further includes a sliding collar member and a pair of electrodes mounted thereon for determining the relative position of water in the ballast tank and generating a signal to the control means.

19. Apparatus as claimed in claim 17, where the remotely controlled ballast tank means contains an internal framework surrounding a perforated cylindrical tube capping the boom and radially perforated panels serving as support for the outside walls of the tank.

20. Apparatus as in claim 17, where the remotely controlled ballast tank means has an opening in its upper wall, a tube with both ends open sliding in a sealing fashion in the opening, means to make the tube slide in the opening, a valve for the admission of air into the interior of the ballast tank means, and water level detection means controlling the closing of the valve.

21. Apparatus as claimed in claim 20, where the remotely controlled ballast tank means contains a thick slide carrying a series of contacts closing or opening an electrical circuit including an indicator marker in case of the passage of the means for the detection of the water level opposite the contact.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,765,184 Dated October 16, 1973

Inventor(s) Louis Francois A. Menard

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 15, delete comma (,) after "time" Column 4, line 3, insert comma (,) before and after "Figure 15"; line 38, delete period (.) after "Figure 4" and insert comma (,). Column 6, line 15, delete "or" and substitute -- of --; line 48, "if" should read -- of --; line 64, after "of the" insert -- coaxial --. Column 7, line 24, insert colon (:) after "are"; line 24, delete "up of"; line 25, before "control" insert -- the --; line 29, delete "the" before "leaks"; line 51, delete comma (,) after "may". Column 8, line 43, delete "sring" and substitute -- spring --. Column 9, line 26, "Figure 1." should read -- Figure 1, --; line 31, insert comma (,) after "15". Column 10, line 23, "wherein" should read -- where --. Column 11, line 10, insert semicolon (;) after "waves".

Signed and sealed this 17th day of September 1974.

(SEAL)
Attest:

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FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.