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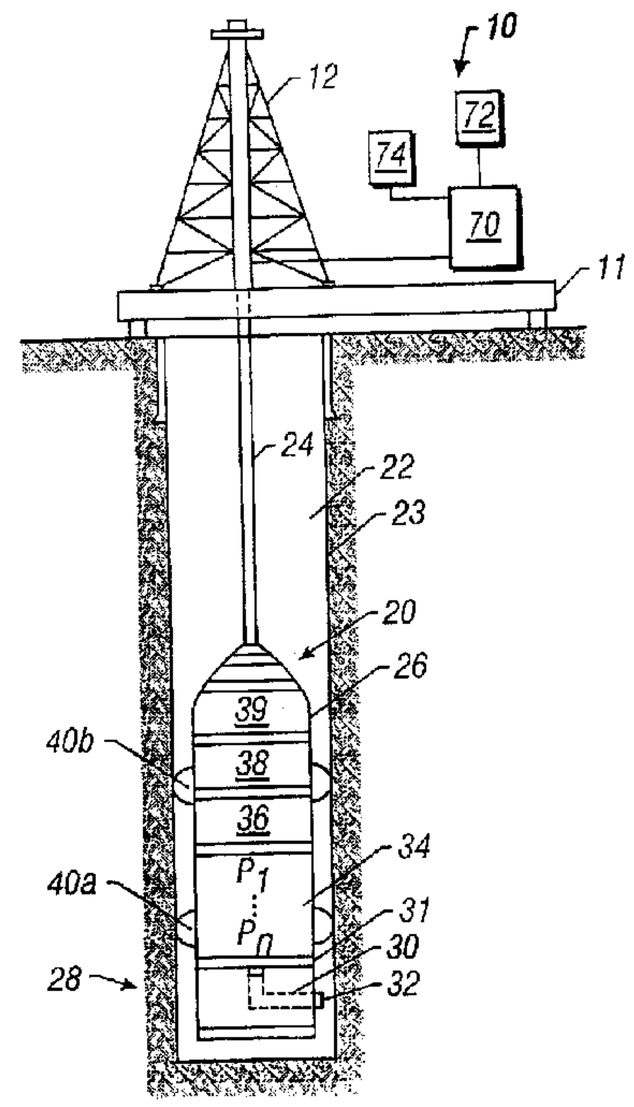
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(57) Abrégé/Abstract:
The present invention provides a downhole cutting tool (20) for cutting materials at a worksite in a wellbore (22). The cutting tool includes a cutting end (32) that is adapted to discharge a high pressure fluid therefrom. A power unit (34) in the tool includes a plurality of serially arranged pressure stages, wherein each such stage increases the fluid pressure above its preceding stage. The high pressure fluid is discharged through the cutting end as a jet stream. A pulsar (35) in the tool is provided to pulse the fluid before it is discharged through the cutting end. A control unit (36) controls the position and orientation of the cutting end relative to the material. The downhole cutting tool can be programmed to cut materials according to predetermined patterns. The cutting tool may be utilized to cut support members of offshore structures, either from the inside or the outside of such support members. In a preferred method, the cutting tool is utilized to remove the earthen material from around the embedded support members and then to cut the support members below the sea bed. The cutting tool may be utilized in cutting nested pipes after pulling a selected length of such nested pipes from the wellbore.

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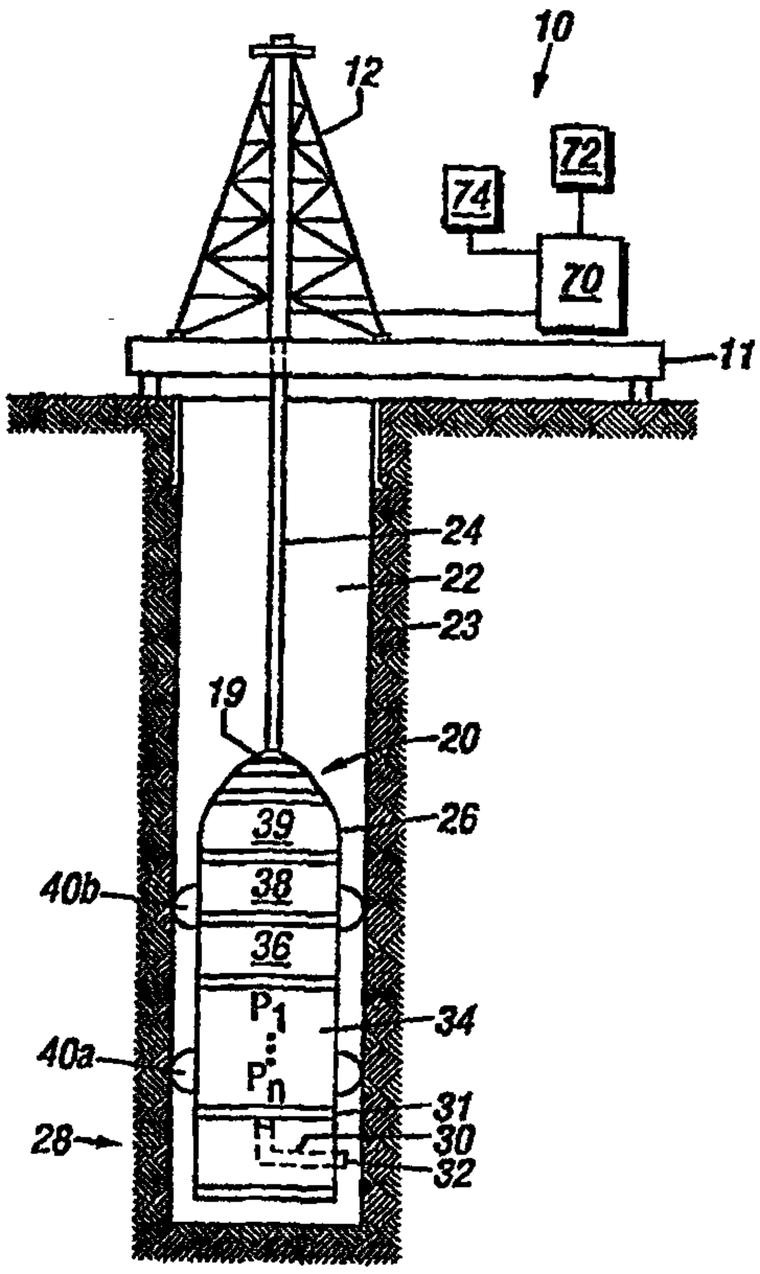
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(57) Abstract

The present invention provides a downhole cutting tool (20) for cutting materials at a worksite in a wellbore (22). The cutting tool includes a cutting end (32) that is adapted to discharge a high pressure fluid therefrom. A power unit (34) in the tool includes a plurality of serially arranged pressure stages, wherein each such stage increases the fluid pressure above its preceding stage. The high pressure fluid is discharged through the cutting end as a jet stream. A pulsar (35) in the tool is provided to pulse the fluid before it is discharged through the cutting end. A control unit (36) controls the position and orientation of the cutting end relative to the material. The downhole cutting tool can be programmed to cut materials according to predetermined patterns. The cutting tool may be utilized to cut support members of offshore structures, either from the inside or the outside of such support members. In a preferred method, the cutting tool is utilized to remove the earthen material from around the embedded support members and then to cut the support members below the sea bed. The cutting tool may be utilized in cutting nested pipes after pulling a selected length of such nested pipes from the wellbore.



TITLE: SYSTEM FOR CUTTING MATERIALS IN WELLBORES

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to cutting or milling tools for cutting materials and more particularly to cutting tools utilizing a pressurized fluid for cutting materials in wellbores and other oilfield structures.

2. Background of the Art

To produce hydrocarbons (oil and gas) from the earth's formations, wellbores are formed to desired depths. The first few hundred feet of the wellbore are typically large in diameter, usually between 12 and 18 inches, and are lined with a metal casing measuring about one half inch thick or more, to prevent caving in of the wellbore. The wellbore, typically between nine and twelve inches in diameter, is then drilled to recover hydrocarbons from the subsurface formations. After the wellbore has been drilled to the desired depth, a metal pipe, generally referred to in the art as the casing or pipe, is set in the wellbore with cement injected in the space (annulus) between the casing and the wellbore. Branch or lateral wellbores are frequently drilled from a main wellbore to form deviated or horizontal wellbores for improving hydrocarbon

production from subsurface formations.

Several cutting and milling operations are performed to prepare a wellbore for production and also during the producing life of the wellbore. Some cutting and milling examples are noted below.

In many applications, the branch or lateral wellbores are formed after the wellbore has been cased. This requires milling or cutting a section (window) in the casing at a predetermined depth to initiate the drilling of the lateral wellbore. It is highly desirable to cut such windows with enough precision to preserve the eventual juncture integrity. In older wellbores, the juncture between the main wellbore and the lateral wellbore may have eroded and thus may require the removal of certain materials to repair such juncture or to perform secondary operations. It is desirable to remove the materials from the juncture with precision in order to properly reconstruct the juncture. Therefore, it is desirable to have a downhole cutting or milling tool that can selectively and relatively accurately cut windows in the casing downhole and can also remove desired amounts of materials around the junctions. The present invention provides such a downhole cutting tool.

After the wellbore has been cased, various types of equipment, such as liner hangers, permanent packers, fluid flow control devices, etc., are set in the

wellbore and must be milled to perform secondary operations. Other devices, although designed to be retrievable without being milled, cannot be so removed from the wellbore due to malfunctions of such devices or excessive corrosion and, therefore, these devices must be milled. Additionally, sediments tend to slowly settle along the interior surfaces of production tubings, which reduces the effective flow area of such tubings. From time to time, such sediments must be reamed to maintain the desired fluid flow through the production tubings.

Various types of downhole cutting and milling tools have been utilized in the oil and gas industry. These tools have been used for tasks such as removing materials from within wellbores including cutting existing casings, boring through permanently set packers and removing loose joints of pipes. Milling tools have been used to ream collapsed casings, to remove burrs or other imperfections from windows in the casings, to place whipstocks for drilling directional wellbores and to perform other reaming operations.

Prior art cutting or milling tools typically include a tool body that is adapted to be conveyed into the wellbore. A plurality of cutting blades are placed on the body at spaced intervals extending outwardly therefrom. Each of the blades typically has a base with a leading surface relative to the direction of rotation. A suitable hard cutting material such as carbide is secured to the

blade's cutting edge. To perform a cutting or milling operation, the tool is placed at a desired location within the wellbore and rotated to cut the intended material. The weight on the tool and the rotational speed determine the cutting speed. The tool blades are designed to cut the material in small segments so that the cuttings may be transported to the surface by circulating a fluid in the wellbore or dropped to the wellbore bottom.

The cutting elements of such prior art must remain in hard contact with the material to be cut which erodes the cutting elements. The operating life of such cutting elements in some applications, therefore, can be relatively short. In such cases, the cutting tool must be retrieved for changing the cutting element. This type of operation can result in down time for the well and rig, which can cost several thousand dollars per day.

The cutting area of prior art cutting tools is relatively large and, thus, ill-suited to cut relatively precise sections or windows in the casings. It is also difficult to orient such prior art cutting tools to perform contoured cutting of areas within the wellbores.

The present invention addresses many of the deficiencies of the prior art cutting and milling tools for downhole use and provides cutting tools wherein the cutting element is relatively small, does not contact the surface to be cut

and can cut materials relatively precisely. The small cutting element makes precise cuts possible while the lack of surface contact extends its useful life. The cutting element can be positioned and oriented in the wellbore to continuously cut materials according to a predetermined profile or trace. The cutting tool of the present invention can also be utilized for cutting other structures, such as nested pipes and offshore platforms.

Also, it would be advantageous to be able to "see" (image) a particular worksite, determine what specific work needs to be performed based on the imaging information and then perform the work, preferably with tools that have been run downhole at the same time as the imaging equipment. The current technique is to run imaging equipment downhole, collect the imaging information and then pull the imaging equipment out of the borehole before running the necessary tool(s) downhole to do the work. The cutting tool of the present invention is preferably run with a suitable imaging device, which enables imaging the worksite before, during and after the cutting operation. This allows the operator to determine the type of cut that needs to be made, send the proper signals to the cutting tool and perform the cutting operation during a single trip downhole, thus reducing lost time.

SUMMARY OF THE INVENTION

The present invention provides a downhole cutting tool for cutting materials at a worksite in a wellbore. The cutting tool includes a cutting element that is adapted to discharge a high pressure fluid therefrom. A power unit in the tool includes a plurality of serially-arranged pressure stages, wherein each such stage increases the fluid pressure above its preceding stage until the desired high pressure has been obtained. The high pressure fluid is discharged through the cutting element as a jet stream to effect cutting of a material. A pulsar in the tool is provided to pulse the fluid before it is discharged. Pulsed jet streams require lower pressure compared non-pulsed jet streams to perform the same cutting operation. A control unit in the tool contains devices which operate the cutting element, power unit and pulser. The operation of the devices in the control unit is controlled by a microprocessor-based downhole circuit according to programmed instructions. The program may contain predetermined cutting pattern or profile. The downhole circuit communicates with a surface computer via a two-way telemetry system. An imaging device may be included in the downhole cutting tool to obtain images of the worksite prior, during and after the cutting operations.

In accordance with one aspect of the present invention there is provided a cutting tool adapted to be positioned in a wellbore for cutting a material in the wellbore, comprising:

(a) a cutting unit having:

(i) a nozzle for discharging a high pressure fluid therefrom; and

(ii) a power unit in the tool for supplying the fluid to the nozzle at pressure that is sufficient to cut the material; and

(b) a device within the cutting tool for orienting the nozzle at a predetermined position in the wellbore for effecting the cutting of the material.

In accordance with another aspect of the present invention there is provided a system for cutting a material in a wellbore, comprising:

(a) a downhole tool having:

(i) a cutting unit having a nozzle for discharging a high pressure fluid therefrom, and

(ii) a power unit for supplying the high pressure fluid to the nozzle that is sufficient to cut the material;

(b) a downhole control unit, said downhole control unit causing the nozzle to orient in a predetermined position in the wellbore for effecting the cutting of the material; and

(c) a surface control unit adapted to communicate with the downhole control unit, said surface control unit cooperating with the downhole control unit to cause the nozzle to orient along a predetermined direction and cause the power unit to supply the fluid to the nozzle at a predetermined pressure.

The present invention also provides methods for deploying a cutting tool underwater and cutting structural support members embedded in a seabed to disengage an offshore structure from the seabed or for cutting portions of such underwater structures. Additionally, the present invention provides a method of cutting sections of nested pipes to facilitate the removal of such pipes from a borehole.

Features of the invention have been summarized rather broadly in order that the detailed description thereof that follows may be better understood, and in order that the contributions to the art may by appreciated. There are additional features of the invention that will be described hereinafter and which will form the subject of the claims appended hereto.

BRIEF DESCRIPTION OF THE DRAWINGS

For detailed understanding of the present invention, references should be made to the following detailed description of the preferred embodiments, taken in conjunction with the accompanying drawings, in which like elements have been given like numerals, and wherein:

FIG. 1 is a schematic diagram of an embodiment of a cutting system wherein the cutting element of the downhole cutting tool is shown positioned in a wellbore for performing a cutting operation.

FIG. 2A shows a manner of positioning the cutting element in the downhole cutting tool of **FIG. 1** to cut a member beneath the cutting tool.

FIG 2B-C illustrate an alternative manner for positioning the cutting element in the downhole cutting tool to cut materials beneath the cutting tool.

FIG 3 is a schematic diagram of an example of a predetermined profile a section of the casing to be cut that may be stored in a memory associated with the cutting system of **FIG. 1** for later use.

FIG 4 is a schematic diagram of the downhole tool of **FIG. 1** adjacent a

juncture with a downhole imaging tool attached thereto for obtaining images of the work area.

FIG. 5 is a schematic functional block diagram relating to the operation of the cutting system shown in **FIGS. 1-3**.

FIG. 6A-B show two different methods of disengaging an offshore structure that is supported on tubular members embedded in the seabed by utilizing the cutting tool of the present invention.

FIG. 6C is a partial exploded view of the cutting tool of **FIG. 6A-B**.

FIG. 7 illustrates a method of removing nested pipes from a wellbore utilizing the cutting tool of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

FIG. 1 is a schematic diagram of a system **10** for cutting or milling materials in a wellbore (borehole) **22**. In general, the cutting system **10** includes a downhole tool that discharges high pressure jet stream through a cutting element to cut materials downhole. A downhole power unit supplies the high pressure fluid to the cutting element. The system **10** can be programmed to continuously position the jet stream to cut materials according to predefined profiles. A downhole circuit controls the operation of the downhole devices and provides two-way communication with a surface computer.

Referring to **FIG. 1**, the system **10** includes a downhole cutting tool (herein referred to as the "cutting tool") **20** conveyed from a platform **11** of a derrick **12** into a borehole **22** by a suitable conveying member **24**, such as a coiled-tubing, jointed tubulars or wireline. The cutting tool **20** has a housing **26**, which adapted for connection with the conveying member **24** via a suitable connector **19**. The housing **26** preferably contains the various elements of the cutting tool **20**, which include a cutting element section **28**, a power section **34** for supplying pressurized fluid to the cutting element section **28**, a control unit **36** which controls the vertical and radial position of the control element section **28** and a downhole electronic section **38** that houses circuitry and memory associated with the downhole tool **20**.

The cutting element section **28** houses a cutting element **30** that terminates in a nozzle or probe **32** suitable for discharging a relatively high pressure fluid therefrom in the form of a high pressure jet stream of a relatively small cross sectional area. A majority of the downhole cutting operations require cutting or milling metallic materials less than one inch thick, for which high pressure of sixty thousand pounds or less is usually sufficient. For thicker materials, higher pressure may be required. The nozzle **32** can be made strong enough to withstand discharge pressures of greater than 200,000 psi. The cutting element section **28** is rotatable about a joint **31** that connects the cutting element section **28** with a fluid power section, generally denoted herein by numeral **34**. The fluid can be water or wellbore fluid or any other fluid having similar properties. Abrasive material can be mixed with the fluid to improve cutting characteristics.

The power section **34** preferably includes a plurality of serial section P_1-P_n. Each successive section increases the pressure of the fluid above the pressure of the preceding section by a predetermined amount. The last section P_n discharges the fluid into the cutting element section **28** at the desired pressure. The power section **34** also may contain a device **35** that pulses the fluid supply through one or more of the power sections P_1-P_n such that the fluid supplied to the cutting element **30** is pulsed at the predetermined rate or frequency. High pressure pulsed jet streams are generally more effective in

cutting materials than non-pulsed jet streams. The cutting element **30** may be a telescopic member, in that it moves axially (along the tool longitudinal axis) within the cutting element section **28**. This movement is calculated to allow positioning the nozzle **32** at the desired depth adjacent to the wellbore casing **23**. The cutting element section **28** or the cutting element **30** can be rotated to position the nozzle **32** at a radial location within the wellbore **22**. These movements of nozzle provide degrees of freedom along the axial and radial directions of the wellbore **22**, allowing accurate positioning of the nozzle **32** at any location within the wellbore **22**. Any other desirable movement of an element of cutting the tool **20** may be incorporated for the purpose of this invention.

A control section **36**, preferably placed above the power section **34**, contains devices for orienting the nozzle **32** at the desired position. One or more such devices rotate the cutting element section **28** to radially position the nozzle **32**. Any suitable hydraulically-operated devices or electric motors are preferably utilized to perform such functions. Any such suitable device, however, may be utilized for the purpose of this invention. The control section **36** also preferably includes sensors for providing information about the tool inclination, nozzle position relative to the material to be cut and to one or more known reference points in the tool. Such sensors, however, may be placed at any other desired locations in the tool **20**. In the configuration shown in **FIG.**

1, the cutting element 30 can cut materials along the wellbore interior, which may include the casing 23 or an area around a junction between the wellbore 22 and a branch wellbore 37, as shown in FIG. 4.

In applications where the material to be cut is below the cutting tool 20, the cutting element 30 may be configured to suit such applications. FIG. 2A shows a configuration of a cutting element 30' that is designed to cut materials below the cutting tool 20. In this configuration, the nozzle 32' discharges the fluid downhole along the tool axis. The cutting element 30' can be moved to any laterally within the section 28'. Arrows A-A indicate that the cutting element 30' may be moved laterally while the arrows B-B indicate that the cutting element 30' may be moved along a circular path within the section 28'. The cutting element configuration shown in FIG. 2A is useful for performing reaming operations in tubular members, such as a production tubings. Reaming is required when the interiors of such tubings are lined with sediments.

To remove devices such as permanent packers or packers that cannot otherwise be removed because they are stuck in the wellbore, it is desirable to cut away only the packing elements and associated anchors, if any, which typically lie between a packer body and the wellbore interior. The packers and anchors engage the casing. Prior art tools typically cut through the entire packer, which generally require excessive time. The packers can be removed

relatively quickly by cutting only the packing elements and any associated anchors. In such applications, the cutting nozzle **30** is positioned over the packing element alone. **FIGS. 2B-C** show a configuration of the cutting element **30"** whose nozzle **32"** may be placed at any desired location within the wellbore. Arrows **C-C** indicate that the probe **32"** may be moved radially within the section **28"** while the circular path defined by arrows **D-D** indicates that the cutting element may be rotated within the wellbore **22**. **FIG. 2C** shows the position of the cutting element **30"** after it has been moved radially a predetermined distance. As is seen in **FIG. 2C**, the nozzle **32"** extends beyond the section **28"** which will allow the tool **20** to cut materials of larger sizes than the tool **20** diameter anywhere in the wellbore **22** below the tool **20**.

As shown in **FIG. 1**, electrical circuits and downhole power supplies for operating and controlling the operation of the cutting element **30**, the power unit **34**, and the devices and sensors placed in section **34** are preferably placed in a common electrical circuit section **38**. Electrical connections between the electrical circuit section **38** and other elements are provided through suitable conductors and connectors.

A surface control unit **70** placed at a suitable location on the rig platform **11** preferably controls the operation of the cutting system **10**. The control unit **70** includes a suitable computer, associated memory, a recorder for recording

data and a display or monitor **72**. Suitable alarms **74** are coupled to the surface control unit **70** and are selectively activated by the control unit **70** when certain predetermined operating conditions occur.

The operation of the cutting system **10** will now be described with respect to cutting a section or window in a casing while referring to **FIGS. 1** and **3**. The tool **20** is conveyed downhole and positioned such that the nozzle **32** is adjacent the section to be cut. The stabilizers **40a-b** are then set to ensure minimal radial movement of the tool **20** in the wellbore **22**. A cutting profile **80** (**FIG. 3**) defining the coordinates for the outline of the section to be cut is stored in a memory associated with the system **10**. Such memory may be disposed in the electrical circuit section **36** or in the surface control unit **70**.

An example of such profile **80** is shown in **FIG. 3**. The arrows **82** define the vectors associated with the profile **80**. The profile **80** is preferably displayed on the monitor **72** at the surface. An operator orients the nozzle tip **32** at a location within the section of the casing **23** to be cut. The desired values of the fluid pressure and the pulse rate are input into the surface control unit **70** by a suitable device, such as keyboard, or are selected from a prerecorded data, preferable in the form of a menu. The tool cutting **20** is then activated to generate the required pressure and the pulse rate, if any. The power section **34** causes the fluid to pulse at a predetermined rate and the fluid

pressure to rise to a predetermined value. The fluid to the tool **20** is preferably provided from the surface via the tubing **24**. Alternatively, the wellbore fluid may be used.

If the section to be cut is one that it will remain in position after it has been cut, perhaps due to the presence of a cement bond, or if the cut section can be dropped to the wellbore bottom as debris, then the system **10** may be set so that the nozzle tip **32** will follow the profile **80**, either by manual control by the operator or due to the use of a computer model or program in the system. If the section must be cut into small pieces or cuttings to be transported to the surface by a circulating fluid, the cutting element is moved within the profile at a predetermined speed along a predetermined pattern, such as a matrix. Such cutting methods ensure that the materials will be cut into pieces that are small enough to be transported by circulating fluids. During operations, the downhole circuits contained in the electrical circuit section **38** communicate with the surface control unit **70** via a two-way telemetry, which is preferably contained in a section **39**.

FIG. 4 shows the downhole tool of **FIG. 1**, with an imaging device **90** attached below the cutting section **28**. Imaging tools to image a borehole interior have been provided in the art and, therefore, are not described in detail herein. The imaging device **90** is utilized to confirm the shape of the section

of the casing or the junction after the cutting operation has been performed. The imaging device **90** may also be utilized to image the area to be cut to generate the desired cutting profile and then to confirm the cut profile after the cutting operation. Alternatively, the imaging device **90** may be placed in or at any suitable location above the cutting element section **28**.

FIG. 5 is a functional block diagram of the control circuit **100** for the cutting system **10** (see **FIG. 1**). The downhole section of the control circuit **100** preferably includes a microprocessor-based downhole control circuit **110**. The downhole control circuit **110** determines the position and orientation of the tool as shown in box **112**. The downhole control circuit **110** controls the position and orientation of the cutting element **30** (**FIG. 1**) as shown in box **114**. During operations, the downhole control circuit **110** receives information from other downhole devices and sensors, such as a depth indicator **118** and orientation devices, such as accelerometers and gyroscopes.

The downhole control circuit **110** communicates with the surface control unit **70** via the downhole telemetry **39** and via a data or communication link **85**. The downhole control circuit **110** preferably controls the operation of the downhole devices, such as the power unit **34**, stabilizers **40a-b** and other desired downhole devices. The downhole control circuit **110** includes memory **120** for storing therein data and programmed instructions. The surface control

unit **70** preferably includes a computer **130**, which manipulates data, a recorder **132** for recording images and other data and an input device **134**, such as a keyboard or a touch screen for inputting instructions and for displaying information on the monitor **72**. The surface control unit **70** communicates with the downhole tool via a surface telemetry **136**.

FIG. 6A-6B illustrate two methods of disengaging an offshore platform structure **300** from a seabed **318** utilizing cutting tools such as those described above. As shown in **FIG. 6A**, the offshore platform structure **300** is supported on a plurality of structural members **310** that are connected to a base **312** and then extend downward through water **316** until they are embedded in the seabed **318** at a predetermined depth.

To disengage the platform **300**, a cutting tool **324** is conveyed from the platform base **312**, via a device such as coiled tubing **326** with a tracking device **323** which is controlled by the surface control unit **70** (shown in **FIG. 1**) or by an underwater controller **325**, along the outside periphery of the structural member **310** until it reaches a desired cutting point **328** on the structural member **310**. The tracking device **323** can be tracking members (not shown) on the cutting tool **324** that enable the cutting tool **324** to remain latched onto the structural member **310** or a robotics device that guides the cutting tool **324** along the periphery of the structural member **310**. The structural member **310**

can be of any shape used in the industry. Some examples include a tubular member and an I-beam type member. The cutting tool **324** also is adapted to travel axially and radially along the structural member **310**, controlled by the surface control unit **70** (shown in **FIG. 1**).

Earthen material **320** surrounding the cutting point **328** is displaced such that the cutting tool **324** can be positioned in its cutting position adjacent the structural member **310.** Prior art methods typically use an underwater excavation tool (not shown) to clear an area approximately forty feet in diameter and twenty feet in depth around the area to be cut.

With the present invention, however, this expensive and time-consuming method can be eliminated by using the cutting tool **324** itself to clear a pathway. To displace the earthen material **320**, the cutting tool nozzle(s) **32** can be oriented downward, as shown by solid and dotted lines in **FIG. 6C**, and a regulated amount of pressurized fluid released to move the earthen material **320** out of the way of the cutting tool **324** as it progresses towards the cutting point **328**. The cutting element **32** is then oriented substantially perpendicular to the surface to be cut (as shown in **FIG. 1**) to cut the support member. Another method of positioning the cutting tool **324** is to utilize a vibratory source that can be included in the underwater **controller 325.** The vibrations allow the cutting tool **324** to easily move through the earthen material **320** to

the desired cutting point **328**. Once the earthen material **320** has been displaced, the cutting tool **324** continues downward along the outside surface of the structural member **310** until it reaches the predetermined cutting point.

The cutting tool **324** then performs the required cut, such as a circumferential cut, around the outside of the structural member **310**. To accomplish this cut, the cutting tool **324** is moved around the periphery of the structural member **310** while a jet of high pressure fluid is directed from the cutting tool nozzle **32** at the predetermined cutting line under control of the surface control unit **70** or the underwater controller **325**. If a robotics device is used, the system can be programmed wherein the robotics device moves the cutting tool to a desired location and then move the tool to cause it to cut the structure along the predetermined cutting pattern. The cutting tool **324** then is retrieved via the coiled tubing **326** or by the robotics device as the case may be or the cutting tool **324** can be repositioned along the next structural member **310**. This process is continued until all structural members **310** have been cut.

Another preferred method of disengaging an offshore platform **300** is illustrated in **FIG. 6B**. In this example, the structural members **310** are hollow and have such dimensions that the cutting tool **324** can be conveyed to the desired cutting position 328 through the inside of the structural member **310**. The cutting tool **324** is lowered from the base **312** of the platform **300** through

the hollow structural member **310**, via a device such as coiled tubing **326**, until the cutting tool **324** is at the desired cutting position **328**. A suitable anchoring device (not shown) is then engaged such that the cutting tool **324** is held at the proper level within the structural member **310** while the cutting tool nozzle **32** rotates axially around the inside diameter of the structural member **310** while performing the cut.

The cutting tool **324** then performs the desired cut (such as described above) along the inside diameter of the structural member **310** and is retrieved via the coiled tubing **326** for repositioning inside the next structural member **310**. This process is repeated until all structural members **310** have been cut. This method can be used to cur only portions of such structural members, such as a windows.

Another preferred method relating to cutting processes at a borehole **358** and utilizing a cutting tool such as the one of the present invention is illustrated in **FIG. 7**. A typical borehole **358** contains nested pipes **350** which may vary in length. In this example, the nested pipes **350** contain three pipes **352**, **354** and **356** and may have cement between the pipes. To remove the nested pipes **350** from the borehole **358**, the nested pipes **350** are first pulled a distance **d** from the borehole **358** such that the bottom of a first section **s** of the nested pipes **350** is above the surface **364**. This section **s** of the nested pipes **350** is

then connected together at a location **360** above the bottom of the section **s**. The connection can be made by many methods known in the art such as by drilling through the nested pipes **350** and inserting a connecting rod **361**. A cutting tool (not shown) is then used to cut through the nested pipes **350** at the point below the connecting rod **361** near the bottom of the section **s** of the nested pipes **350**. This section **s** then is removed and conveyed to another location. The process is repeated for additional sections **s** of the nested pipes **350** until the desired amount of nested pipes **350** have been removed from the borehole **358**.

While the foregoing disclosure is directed to the preferred embodiments of the invention, various modifications will be apparent to those skilled in the art. It is intended that all variations within the scope and spirit of the appended claims be embraced by the foregoing disclosure.

What is claimed is:

1. A cutting tool adapted to be positioned in a wellbore for cutting a material in the wellbore, comprising:

(a) a cutting unit having:

(i) a nozzle for discharging a high pressure fluid therefrom; and

(ii) a power unit in the tool for supplying the fluid to the nozzle at pressure that is sufficient to cut the material; and

(b) a device within the cutting tool for orienting the nozzle at a predetermined position in the wellbore for effecting the cutting of the material.

2. The cutting tool of claim 1, further having a device for causing the nozzle to move radially within the wellbore.

3. The cutting tool of claim 2, further having a device for moving the nozzle in an axial direction with respect to the wellbore axis.

4. The cutting tool of claim 3, wherein the device for moving the nozzle in the axial direction includes a telescopic device.

5. The cutting tool of any one of claims 1 to 4, further having an electrical control circuit associated therewith for controlling the operation of the cutting unit.

6. The cutting tool of claim 5, wherein at least a portion of the electrical control circuit is contained in the cutting tool.

7. The cutting tool of claim 5, wherein the electrical control circuit further comprises a surface control circuit that is in data communication with the electrical control circuit in the cutting tool for controlling the operation of the cutting tool.

8. The cutting tool of claim 1, wherein the power unit further comprises a plurality of successive stages, wherein each successive stage increases the pressure of the fluid by a predetermined amount above the preceding stage.

9. The cutting tool of claim 8, further comprising a device for pulsing the fluid discharged from the nozzle.

10. The cutting tool of claim 9, wherein the pulse rate and the fluid pressure define the cutting rate of the material.

11. The cutting tool of any one of claims 1 to 4, further having a surface control unit for controlling the operation of the cutting tool, said surface control unit having stored therein a cutting profile defining a section of the material to be cut by the cutting tool.

12. The cutting tool of claim 11, wherein the surface control unit causes the cutting tool to cut a section of the material according to the cutting profile.

13. The cutting tool of claim 12, wherein the surface control unit causes the cutting tool to cut the section according to a predetermined pattern within the boundaries of the cutting profile in a manner that will produce cuttings of the material being cut of a size that is conducive to be transported to the surface by circulating a fluid through the wellbore.

14. The cutting tool of any one of claims 1 to 4, further having stored within the cutting tool a cutting profile defining a section of the material to be cut by the cutting tool.

15. The cutting tool of claim 14, wherein the cutting tool cuts a section of the material according to the cutting profile.

16. The cutting tool of any one of claims 1 to 15, further comprising an imaging device which is adapted to obtain an image of a working area containing the material.

17. The cutting tool of claim 16, wherein the imaging device is placed above the power unit.

18. The cutting tool of claim 1, wherein the fluid is supplied from the surface.

19. The cutting tool of claim 1, wherein the fluid is wellbore fluid supplied from the wellbore.

20. The cutting tool of any one of claims 1 to 19, wherein the fluid further comprises an abrasive material.

21. The cutting tool of claim 1, wherein the nozzle is further used to discharge high pressure fluid to displace earthen material surrounding the material to be cut such that the cutting tool can be positioned at the desired cutting location.

22. The cutting tool of claim 6, wherein said electrical control circuit has stored therein a cutting profile defining a section of the material to be cut by the cutting tool.

23. The cutting tool of claim 22, wherein said electrical control circuit causes the cutting tool to cut a section of the material according to said cutting profile.

24. The cutting tool of claim 7, further comprising a two-way telemetry system which allows for communication between said electrical control circuit and said surface control circuit.

25. The cutting tool of claim 24, wherein said two-way telemetry system is located downhole.

26. The cutting tool of claim 24, wherein said two-way telemetry system is located at the surface.

27. A system for cutting a material in a wellbore, comprising:

(a) a downhole tool having:

(i) a cutting unit having a nozzle for discharging a high pressure fluid therefrom; and

(ii) a power unit for supplying the high pressure fluid to the nozzle that is sufficient to cut the material;

(b) a downhole control unit, said downhole control unit causing the nozzle to orient in a predetermined position in the wellbore for effecting the cutting of the material; and

(c) a surface control unit adapted to communicate with the downhole control unit, said surface control unit cooperating with the downhole control unit to cause the nozzle to orient along a predetermined direction and cause the power unit to supply the fluid to the nozzle at a predetermined pressure.

28. The system of claim 27, wherein the fluid further comprises an abrasive material.

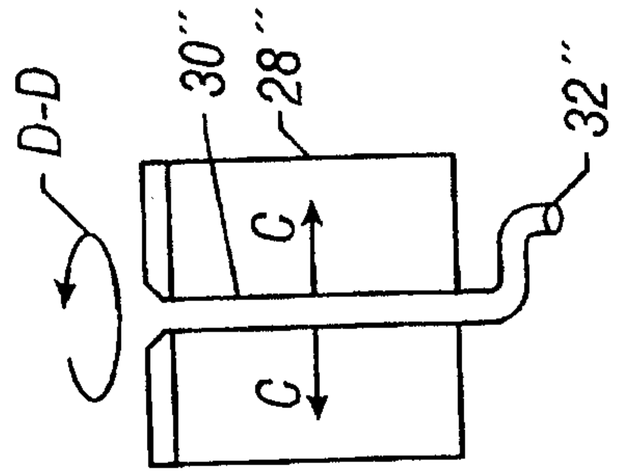


FIG. 2B

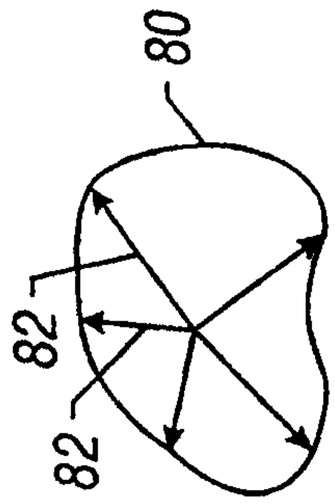


FIG. 3

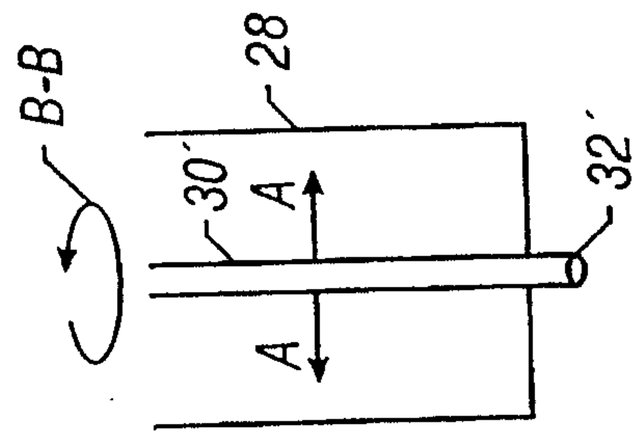


FIG. 2A

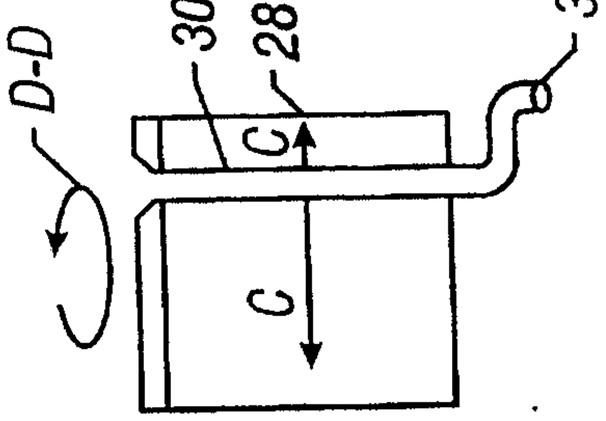


FIG. 2C

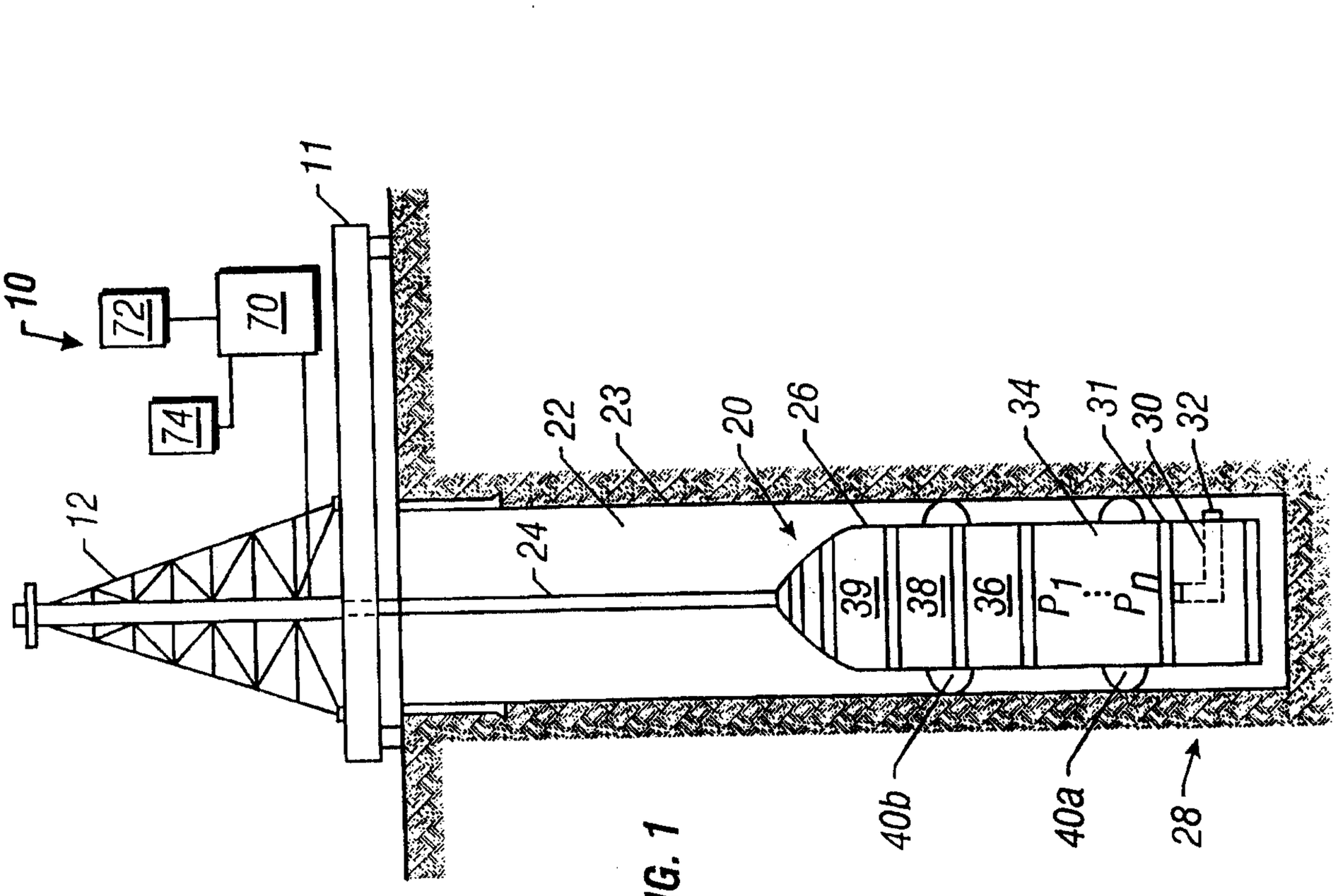


FIG. 1

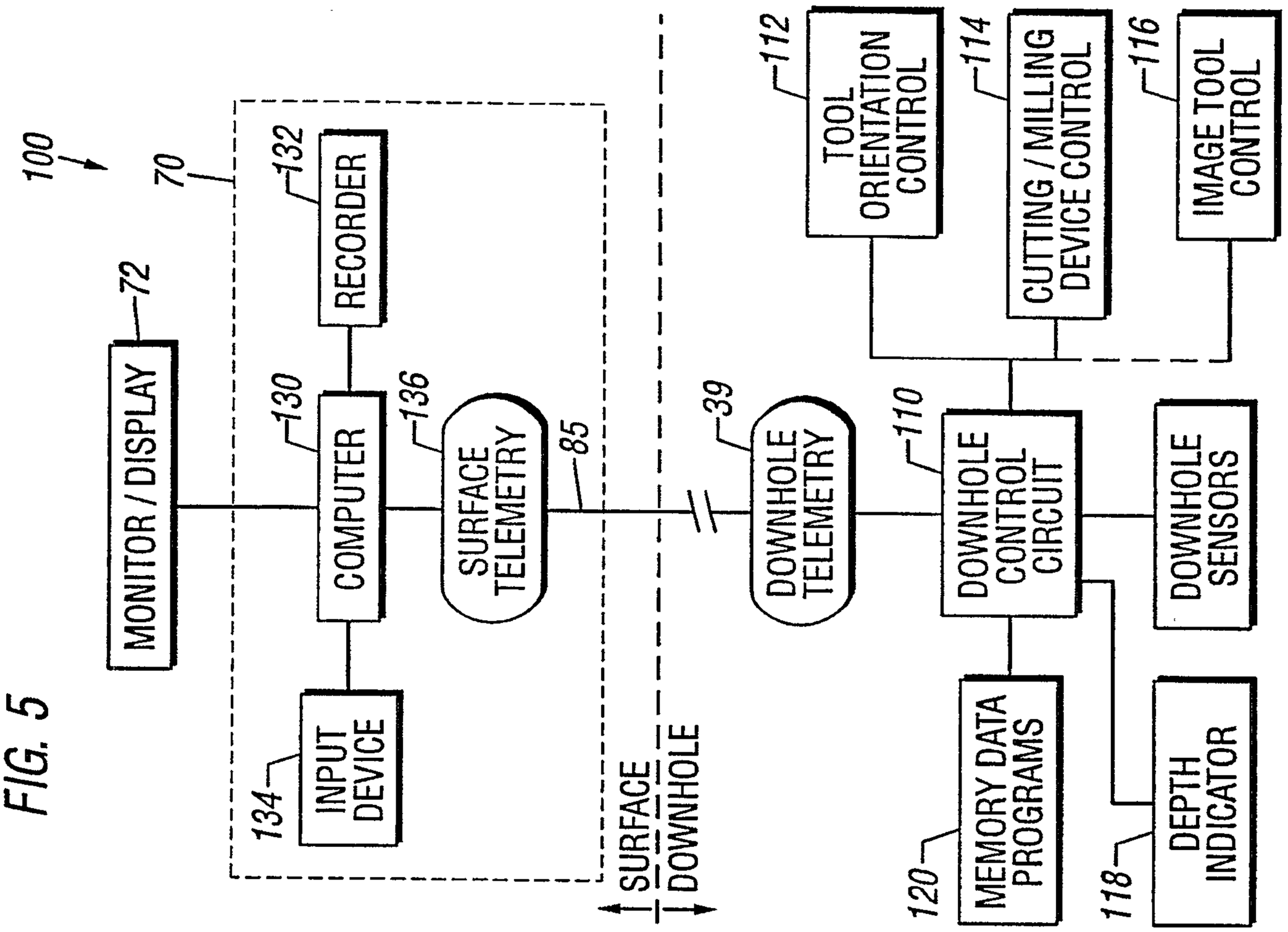

100
70
72
132
RECORDER
MONITOR / DISPLAY
130
COMPUTER
136
SURFACE TELEMETRY
85
134
INPUT DEVICE
SURFACE
DOWNHOLE
39
DOWNHOLE TELEMETRY
110
DOWNHOLE CONTROL CIRCUIT
112
TOOL ORIENTATION CONTROL
114
CUTTING / MILLING DEVICE CONTROL
116
IMAGE TOOL CONTROL
DOWNHOLE SENSORS
120
MEMORY DATA PROGRAMS
118
DEPTH INDICATOR

FIG. 5

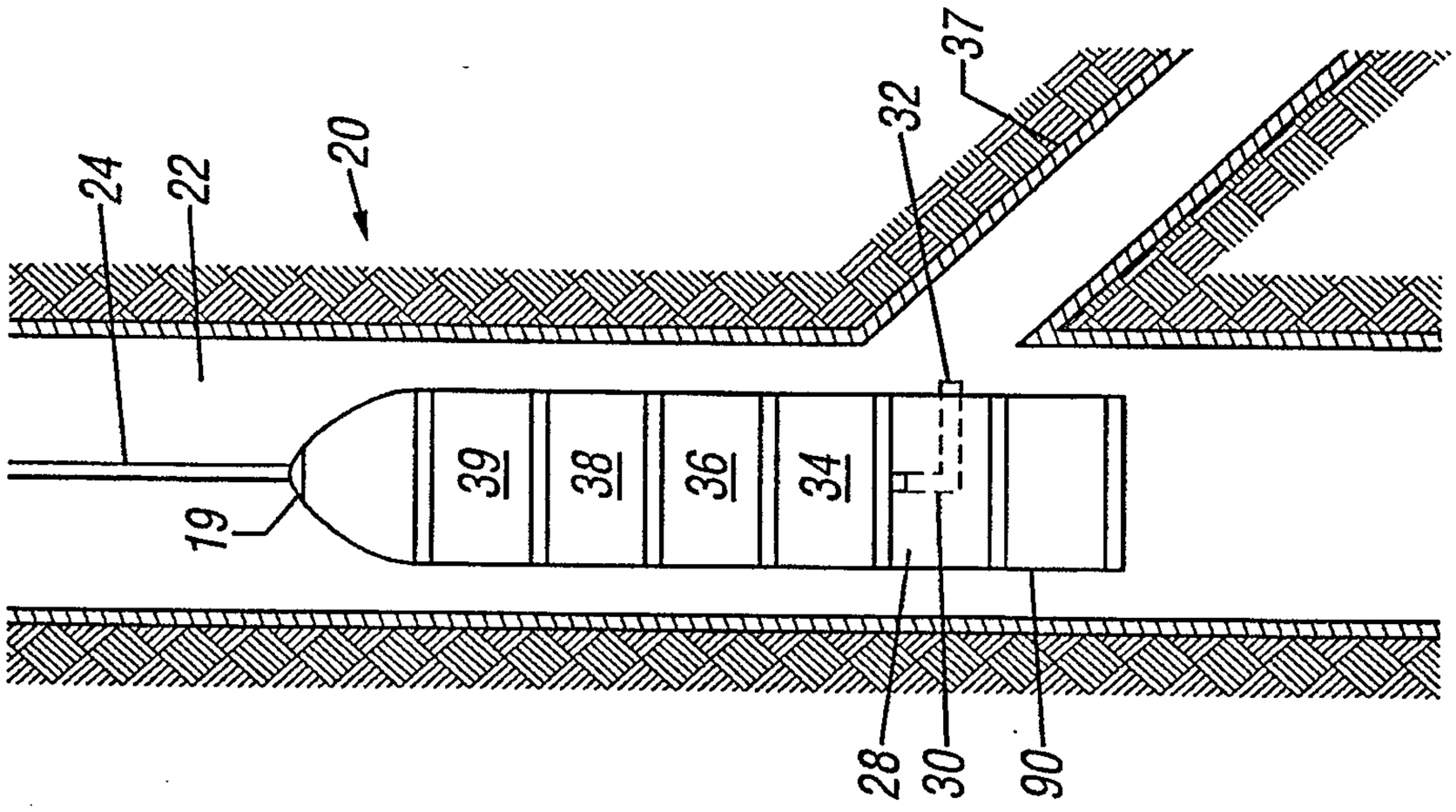

24
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FIG. 4

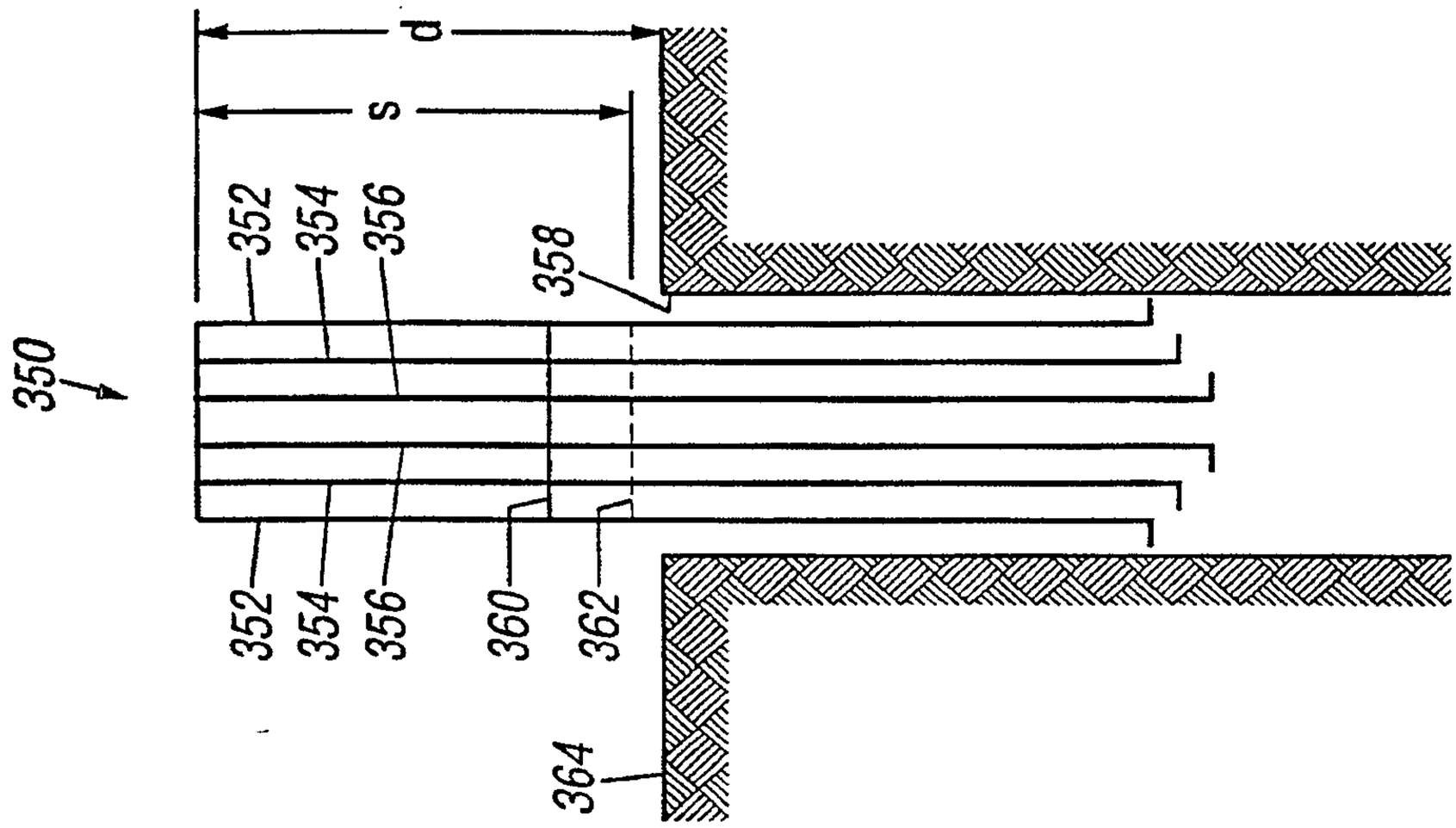


FIG. 7

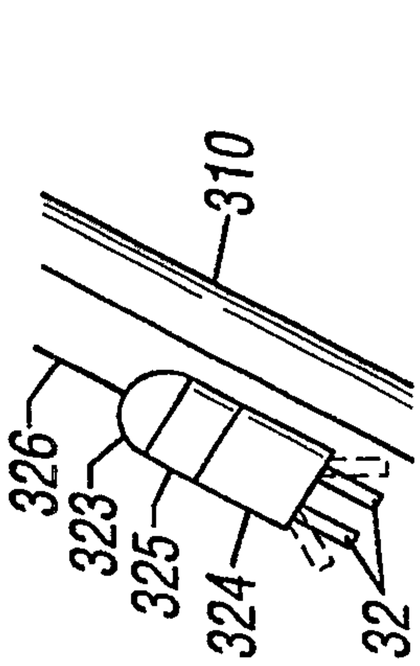


FIG. 6C

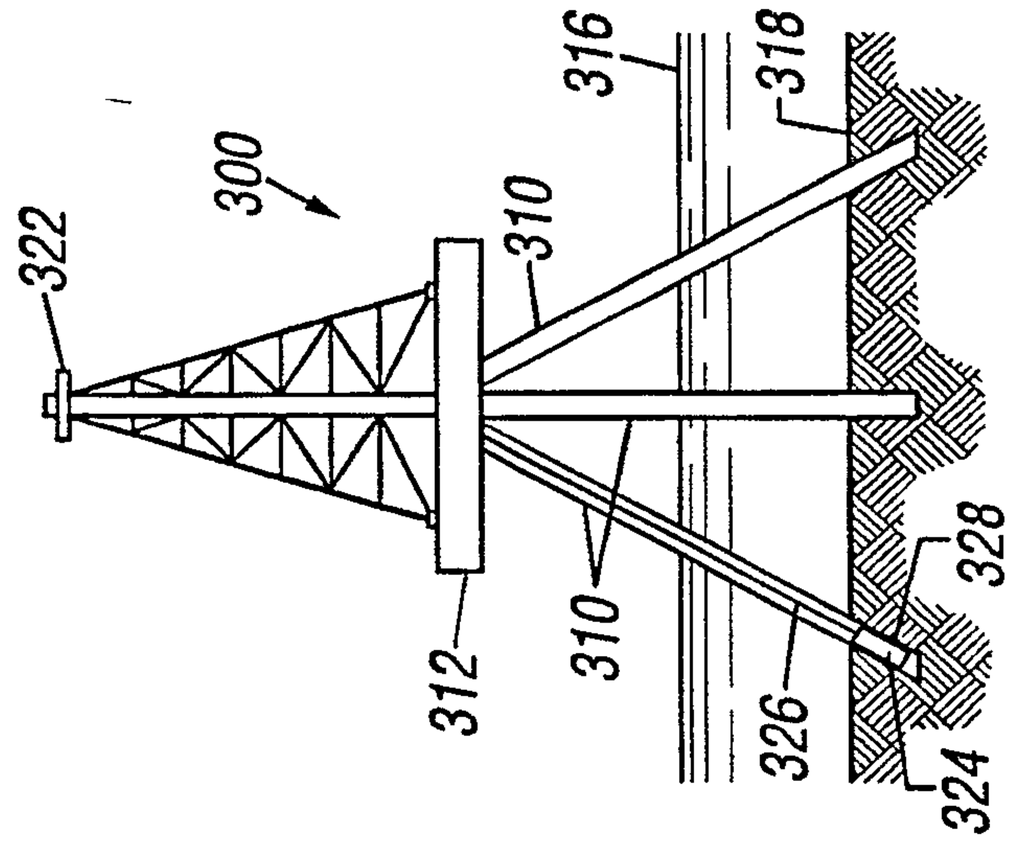


FIG. 6B

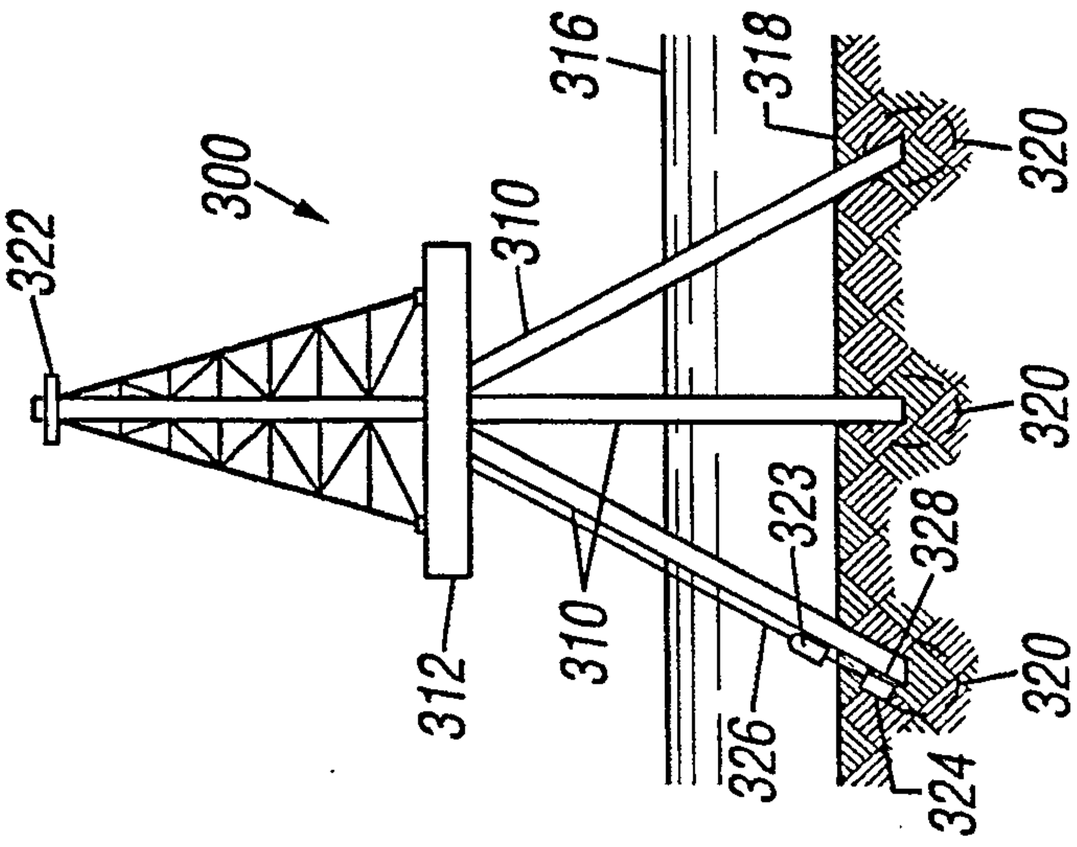
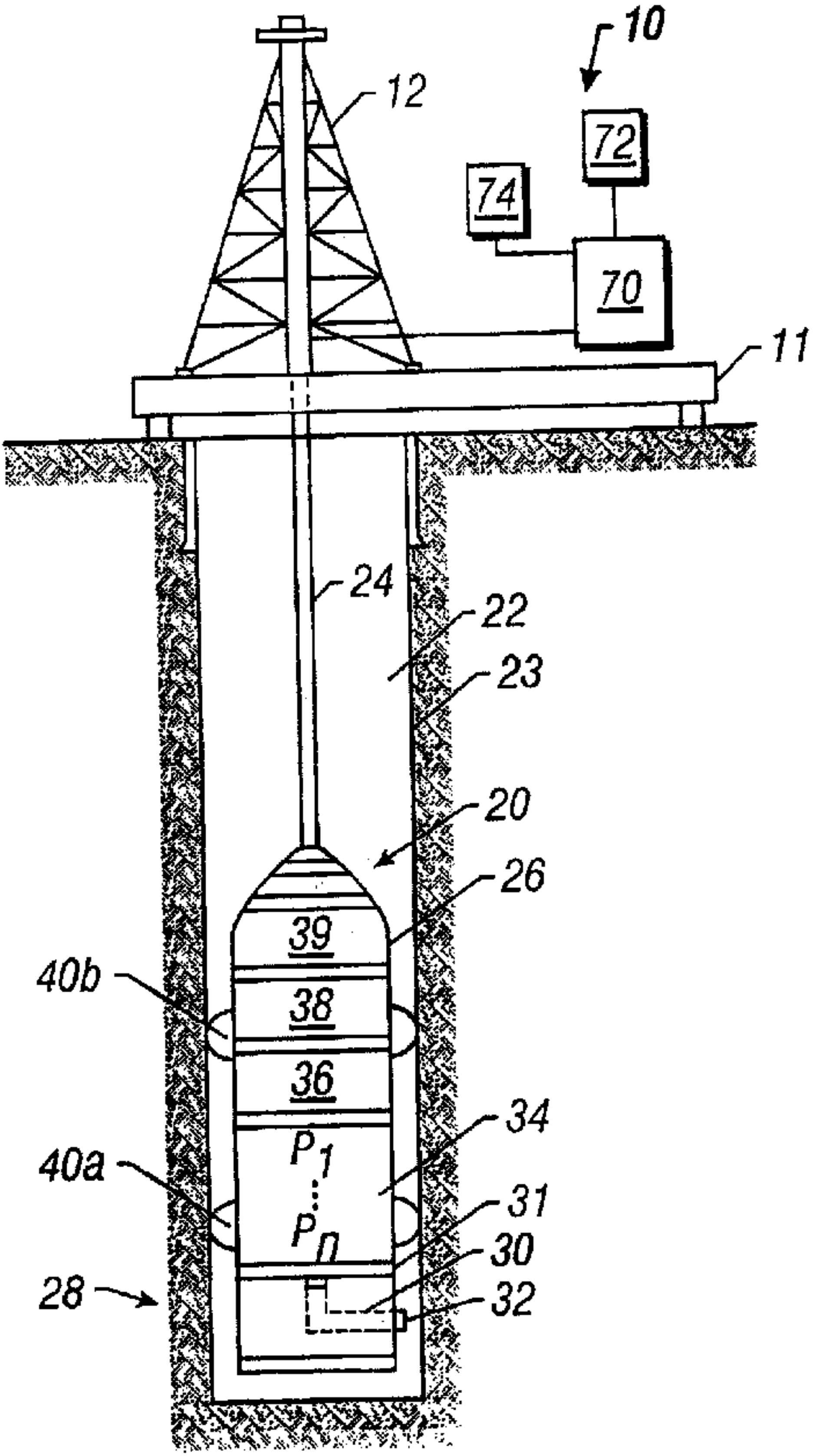


FIG. 6A


10
12
72
74
70
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24
22
23
20
26
39
40b
38
36
34
40a
P_1
P_n
31
30
28
32