

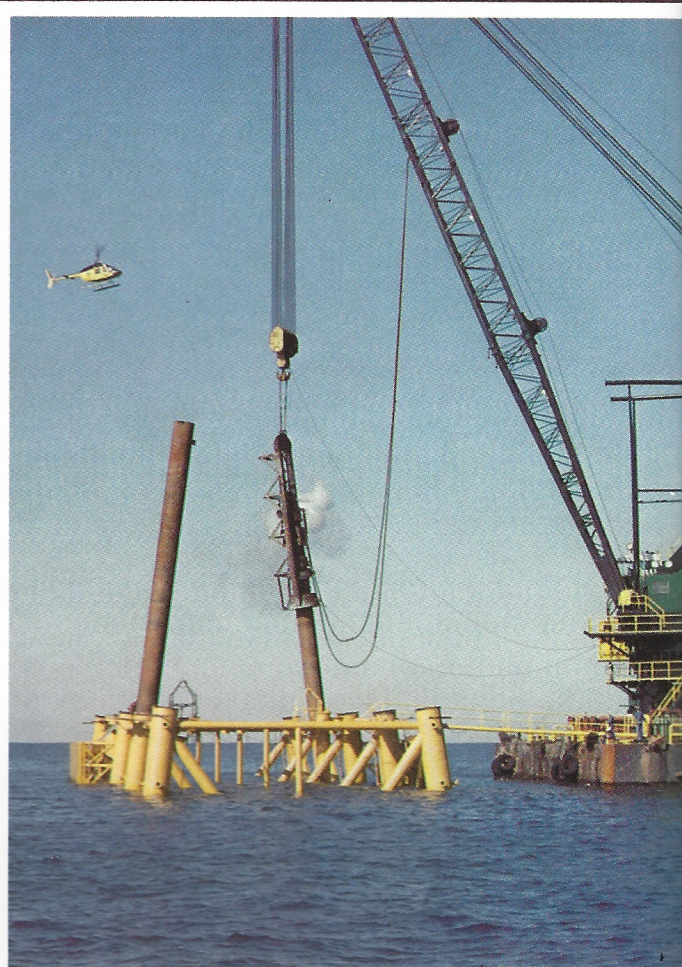
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Fifteen stories of steel go to sea...Page 18





THE ART OF DIRECTIONAL DRILLING

BY GARY WITZENBURG

NEAR ROMEO, MICHIGAN, there is a producing gas field directly under a subdivision. But the wellhead isn't gracing some poor soul's backyard. It's across the highway and out of sight.

In Muttonville, Michigan, northeast of Detroit, there's a storage well under a lovely stand of trees. But the wellhead stands in a natural clearing in the woods some distance away.

At Capac, Michigan, the casing in a gas well collapsed, pinching it nearly closed and obstructing gas flow to the surface. But Michigan Wisconsin drillers were able to start a new hole 2,700 feet down inside the old casing. Angling out from the old well, the new hole bypassed the obstruction and retapped the gas field, thus saving much of the cost of running a new well from the surface.

These are but a few examples of a technique called directional drilling, which Michigan Consolidated Storage Geology Manager Curt Lundy defines as "intentionally drilling toward an underground target that is not under the surface location of the rig."

Normal straight-down drilling, Lundy explains, is allowed by law to deviate no more than three degrees from the vertical. But a directionally drilled well may slant about a degree per 100 feet of depth, and the bottom-most sections of pipe can end up running at an angle of 20 or 25 degrees or even more. (A 20-degree slope approximates that of a ladder leaning against a house.)

"Offshore directional drilling can deviate by as much as two degrees per 100 feet," Lundy adds, "and the angle may become so severe that tools have to be hydraulically pumped down into position."

Directional drilling is about 10 percent more costly than vertical drilling. But the technique has become increasingly common in recent years for a number of good reasons. Environmental concerns often preclude drilling ver-

tically, as in the case of the Muttonville well where the rig was installed without having to destroy the stand of trees. Exploration in populated and developed areas, as in many locations in southeast Michigan, may require directional drilling — under the Romeo subdivision, for instance. Branching off at an angle to resurrect the damaged Capac well is an example of an economic reason to employ the directional technique.

But to reach gas and oil deposits is more than just drilling a hole in the ground. Sometimes it takes a number of drilling attempts to pinpoint the precise location of these deposits. And this is where the art of directional drilling becomes especially valuable.

"The only way to know for sure whether oil or gas is in the ground is to drill for it," Lundy explains. "From drilling we may get indications that we're close to something, back up, fill that hole with cement and then use directional tools to search in a new direction."

"There are Niagaran reefs under Michigan that grew back when the area was covered by an inland sea. These reefs often contain trapped oil and gas. About 350 have been located in the northern part of Michigan's Lower Peninsula since 1969, and 50 or so in the more heavily-populated southern portion at depths of 2,000 to 4,000 feet.

"Seismic information, such as shock reflections from a small explosive charge, or electromechanical vibrations, gives us clues to where their locations might be. Then we have to obtain the lease rights before setting up a rig and starting to drill."

Of course, getting those lease rights can become a bit more complicated when you plan to bottom out some distance away from your starting point. "Surveys are made by a directional drilling contractor to determine where the bit is going," Lundy continues.

"When we're drilling for Niagaran reefs, we're allowed one well per 40 acres in Macomb, Oakland and St. Clair counties and one per 80 acres in the rest of the state. Every landowner in a given area is entitled to a share of the royalties proportional to the amount of land he owns. So if you own, say, an eighth of a 40-acre area overlying oil or gas you get one-eighth of the proceeds from whatever comes up, whether the well actually is under your land or not."

In the wide-open spaces, lease rights are normally granted by a single landowner. In heavily-populated southeastern Michigan, ANR people often have to lease one lot at a time.

But the complexities of leasing are relatively easy to understand compared to the basic question: How do drillers make a hole curve?

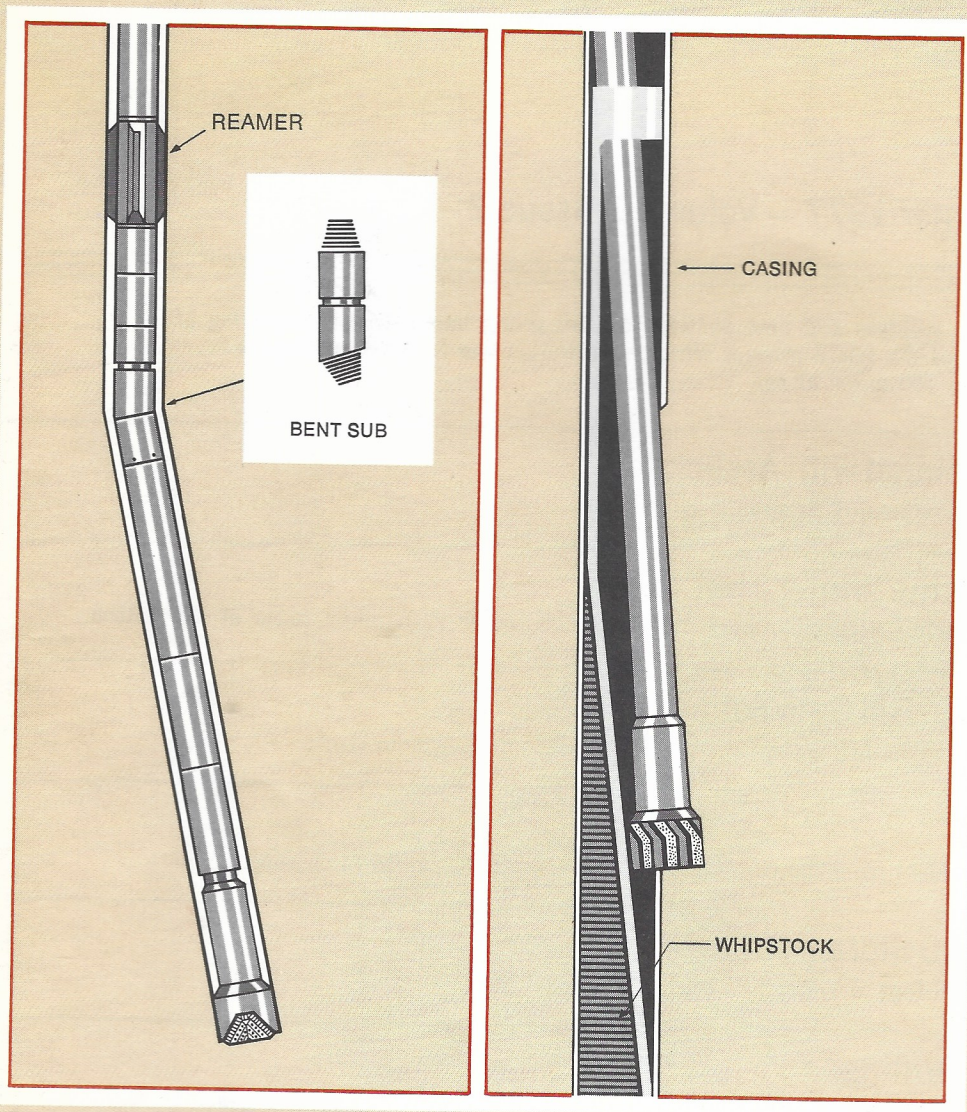
Lundy explains that a long string of seemingly rigid pipe is actually flexible enough to bend as it gradually descends into a directional hole, provided there are no sharp doglegs. "We drill 1,000 to 1,200 feet straight down, then we can deviate in the planned direction."

ANR drillers use several methods to reach "planned direction." One is a turbine-powered drill called a "Dyna-Drill" which is rotated by drilling fluid pumped down from the surface. A short, slightly-angled coupling called a "bent sub" is connected between sections of drill pipe just above the Dyna-Drill and serves to angle the Dyna-Drill relative to the existing hole. (See drawing.) Then the Dyna-Drill is positioned in the desired direction and used to establish a pilot hole. Once this directional pilot hole is established, drilling with a normal bit is resumed, and the hole takes the planned direction. It will continue to curve slightly after the original deviation, but additional adjustments can be made to steer it in the proper direction.

A second tool commonly used inside

Bent sub, in panel at left, is inserted into string of drill pipe to produce slight change in direction (exaggerated in this drawing). Reamer enlarges hole and smooths it, thus helping to prevent buckling of drill pipe.

Panel at right shows how metal wedge called whipstock is used to change direction of hole. Placed in bottom of vertical hole, whipstock deflects drill bit so that it cuts through well casing and takes new direction.



Dyna-Drill Assembly

Whipstock Method

casing to deviate a directional hole is a metal wedge called a "whipstock," which is lowered into the hole — big end down — and carefully positioned to become a man-made obstruction. When the drill bit encounters the whipstock, the bit slides off to one side. With the new direction thus established, the

whipstock is withdrawn and drilling continues as before.

Yet another tool used frequently in directional drilling is the "reamer," which has a center section larger in diameter than the drill pipe and serves to stabilize the pipe above where the pilot hole is being started. It does this

by "leaning" on the side of the hole and preventing the pipe from trying to kink because of downward pressure.

Naturally, it's especially important that a directional hole be constantly surveyed to determine exactly where it is and where it's going. This is done by using a non-magnetic section of pipe called a "Monel collar" through which magnetic survey tools are lowered. One way of measuring the hole's exact angle relative to the vertical is by means of a magnetic device that points at a steel target. A camera lowered on a wire photographs the angle of the pointer. Along with precise depth information, this knowledge of the angle allows plotting of both horizontal and vertical progress of the hole.

"Perhaps the best example of directional drilling in this area is provided by one of the first Romeo locations," Lundy points out. "When Michigan Consolidated drilled the first hole it bottomed out some 1,100 feet south of the road but did not hit the reef we were after. Yet we had indications we were close to something so we tried again. The second hole was run at a steeper angle and it proved successful just 350 feet south of the road — about 550 feet from the well-head.

"It's also possible to tap two separate reefs from the same location. This not only saves money but is ecologically more sound since fewer trees have to be cut and less surface area is affected. The important point is that directional drilling gives us a number of opportunities from the same surface location."

Natural gas supplies are no longer easy to find. Today, the nation's needs dictate that energy explorers find new ways to search in populated areas. Directional drilling is one way American Natural reaches for hard-to-get hydrocarbons deep in the earth while protecting Michigan's environment and remaining a good neighbor to its citizens.

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