TECHNOLOGY

Oil Drilling An Art

Bailing up seepage was the method used to recover petroleum until 1859 when the Titusville 69.5-foot well was drilled, marking the beginning of our oil industry.

By A. C. MONAHAN

➤ DRILLING THE earth for oil was a relatively simple job back in 1859 when the 69.5-foot Titusville, Pa., well was completed. From it to 1949 and the 20,521-foot drilled hole in Sublette County, Wyoming, is a matter of nearly 3.9 miles in depth and 92 years. During this time drilling has become an art requiring high-grade technical skill and expensive scientific equipment.

Petroleum was known and used for centuries before the Titusville well was drilled. It was obtained from places where it seeped out of the ground or into the bottom of dug ditches. It was used for "medicine" but was coming into wider use for kerosene for lighting.

Wells were drilled long before the Titusville oil project, but they were largely to obtain water or salt from brine. The important fact about the Titusville well is that it established drilling as the method of recovering hidden oil and marks the beginning of the modern oil industry.

Early drilling equipment was a very simple tool, supported by a crude tripod and operated by manpower. The drill had either an up-and-down movement or a rotary movement much like the soil auger. Progress was slow but wells over 100 feet in depth were drilled by them.

Steam Power Used

In drilling the Titusville well, however, steam was used for power. William A. Smith, who drilled it, had long experience in drilling brine wells and used the type of equipment with which he was familiar. He used a six-horsepower engine, fired by wood. His drilling bit was made out of round iron and had a 1.5-inch cutting edge. When completed the well produced about 20 barrels of petroleum a day.

Following rapidly after this Titusville well, perhaps better known as the Drake well after Col. Edwin L. Drake, its promoter, came many other wells not only in Pennsylvania but in Ohio and other states. Kerosene was in demand because so-called coal-oil lamps were rapidly replacing candles in American homes. Methods of refining the crude to obtain kerosene were already known. Wax and lubricating oils were obtained as by-products.

Gasoline, the primary product of petroleum production today, was wasted. The internal combustion engine had not been developed. Also wasted in early refining were the several hundred chemicals, now recovered from petroleum, that play a very important part in American life with hundreds of essential applications.

Before the end of the century, the demand for kerosene greatly increased, gasoline came into wider usage, and there was a growing need for other products from petroleum. The result was many new wells, and the search for oil went deeper and deeper into the crust of the earth. By 1900, wells 1,800 feet in depth had been drilled, and equipment for what was then deep-drilling had been developed.

Gasoline Engine Developed

The development of the gasoline engine, and the automobile and the airplane that it makes possible, turned attention to gasoline production. Increased demands for gasoline and heating oils during the past three decades or so have forced oil producers to go deeper into the earth for supplies.

Now wells over 10,000 feet in depth are producing oil, and a few have been drilled close to the 20,000-foot range. For these great depths special drilling equipment has been developed.

Two principal methods of drilling for oil are in use, the so-called cable-tool method and the rotary bit method. The first is employed principally in drilling shallow wells. The rotary bit method is used for both shallow and deep wells, to account for perhaps 90% of the drilling of today.

The cable-tool method uses a drill which is given an up-and-down movement. The drop of the drill pounds and cuts the rock at the bottom of the hole. In action, it is somewhat like the hand drill driven by sledge hammers used in stone quarrying.

Auger-Like Bit

In earlier types, it was a simple device consisting of a drill hung from the end of a horizontal pole so swung that it could be given an up-and-down movement. Modern cable-tool equipment is a great improvement over the early types. This type of drilling is sometimes used even for deep wells where hard rock is encountered or where accurate samples of the rock penetrated are desired.

The rotary method uses a bit that cuts through earth and rock with a rotary movement, and may be likened to the ordinary carpenter's bit or a soil auger. To be able to cut rock, however, it has to be made of special materials, and the drill debris is removed by a liquid mud instead of by a spiral groove on the bit and shaft.

The bit is kept in almost continual rotation by a hollow shaft that extends to the surface and that is rotated by machinery in the drilling rig that stands above the hole. The shaft is made up of jointed sections so that as the hole grows deeper and deeper new sections can be added at the surface.

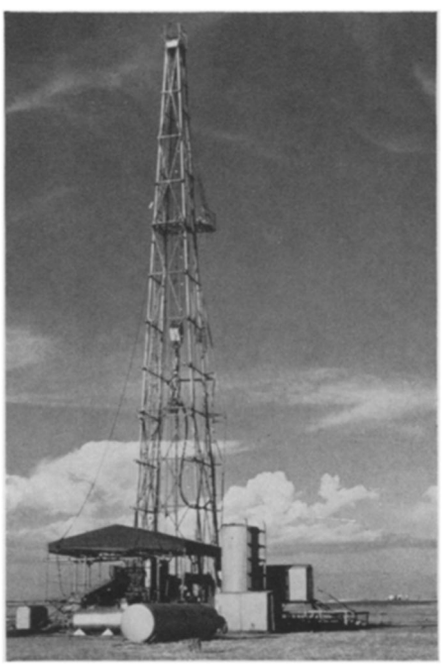
The shaft is hollow so that it may be used to force what oilmen call "mud" down to the bit. Mud is a watery mixture containing clay and sometimes powdered minerals such as barites, chemically barium sulfate. This mud cools the bit but it also brings the debris loosened by the bit to the surface.

"Pulling" the Bit

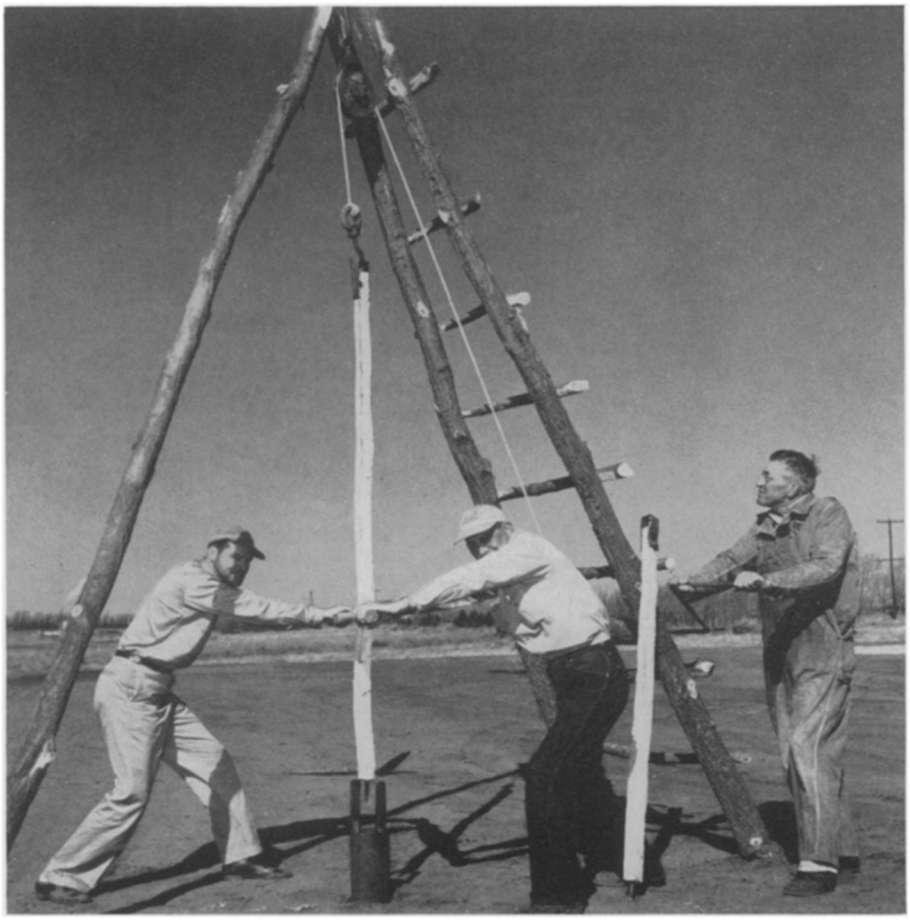
The debris-carrying mud comes up through the well in the space between the shaft and the outside circular wall. Part of it may be deposited on the walls of the hole to help keep them from caving in and also to seal off water seepage into them.

From time to time new cutting bits have to be installed to replace those worn by usage. This requires what the industry calls "pulling" the bit. It means that the shaft and bit must be raised and section after section of the shaft removed until the bit reaches the surface.

When the new bit is positioned to replace the one removed, it is lowered into the hole and the shaft rejointed to its former length. This pulling job is a diffi-



PORTABLE OIL RIG—This modern portable drilling equipment costs about $250,000 and can reach down to depths of more than 9,000 feet.



DRILLING 50 YEARS AGO—A replica of a portable hand drill used about 1900 is shown here. It was operated by turning manually a hollow, auger-like bit. Its cost was about $10 and it could drill a hole 150 feet deep.

cult one that requires much power, highly skilled labor, consumes time and greatly adds to the cost of drilling, particularly in the deep wells of today.

Considerable power is required to rotate the shaft and bit during drilling, and the deeper the hole, the more is needed. The power-applying equipment is within the so-called derrick, a trestle-work tower some 200 feet high that straddles the hole being bored. The derrick is an important tool in well-drilling. Within it, in addition to the rotary table that turns the shaft's bit, is the hoisting equipment for pulling the shaft and bit, pumps and hose for circulating the drilling fluid, valves and equipment for controlling pressure, other essential equipment, and space in which shaft extensions and casing pipe can be stood in upright position ready for use as needed.

Portable Drilling Derricks

Many derricks, with much of the equipment removed, are left as permanent installations at the wells to be used later if pumps or casings have to be pulled. However, portable drilling derricks that can be transported from site to site are coming into use.

A type of portable drilling rig used by the Shell Oil Company may cost as much as $250,000 completely equipped, but it can be used over and over again and can be employed in drilling to depths approaching 10,000 feet.

Special Steel Shaft

The shaft that carries the bit is a special problem in deep drilling. It is made of special steel and must be strong enough to bear its own weight as a bit is being pulled or lowered back in the hole. Also it must be strong enough to withstand the twist that it transmits from the turntable in the derrick to the bit below. It must be a flexible steel because the upper end may have to make several complete revolutions before the bit itself starts to revolve.

Many problems are encountered in drilling to great depths that are of little concern in shallow drilling. The length of the bit shaft is only one. Keeping the hole being drilled straight is another. Formations encountered by the bit may cause it to deviate from the straight downward direction.

Such deviation causes trouble, sometimes being serious enough to cause the abandonment of the well. A weight indicator, which measures the pressure, or weight, on the bit helps the driller keep a proper pressure on the bit. Too much pressure is one cause of a crooked hole.

In drilling a new well, logs of wells already bored within many miles of the site may be of great help to the driller. They give him information concerning underground formations.

A well log is a record of the geological formations encountered in drilling. It is general practice to make such records. Logging can be done by examination of the drilling mud coming to the surface and of cores made by a special bit, and sometimes by the rate of progress made by the drill.

Electric Well Logging

Electric logging has come into use recently. An electrode is lowered into the well. Various rocks, sands and clays offer different electrical resistance. The resistance offered by the various formations as the electrode is lowered on the end of a conducting cable is registered at the surface on a potentiometer.

When oil is struck in drilling, the pressure of the gases contained in the petroleum may cause the crude to rise to the surface, or even above the surface. Few "gushers" occur today, however, because special devices are used to prevent oil coming to the surface from escaping from the well casing. The product of the well is led through pipes to holding tanks or into gathering pipelines.

If much gas is contained, it is separated by gravity in the separation tanks. If only a minor amount of gas is contained, it may be wasted. If in larger quantities, it is fed into gas lines to add to the supply of natural gas or, in some cases, put back under pressure to the oil-bearing formation to create a pressure to increase oil flow.

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The *earth* radiates from its hot interior more heat than it receives from outer space.