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# POSSIBILITIES OF PRODUCTION FROM LIME FORMATIONS GIVEN THE "ACID TEST"

BY
FREDERICK SQUIRES

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# Possibilities of Production From Lime Formations Given the "Acid Test"

## Prophecies pronounced in 1936 relative to Illinois field are given careful checkup in view of subsequent findings

By FREDERICK SQUIRES

IN THE latter part of 1933, the writer began a study of the process of acidizing oil wells in lime formations. Since the method was relatively new, it seemed to present opportunities for expansion. As pioneering ideas occurred, they were submitted for consideration to men familiar with field applications. The resulting conclusions were new to the writer, although they may not in all cases have been new in the art.

In 1936, he was asked to speak on the subject of "The Present Status and Future Possibilities of Acid Treatment in Illinois," before the Fourth Annual Mineral Industries Conference at Urbana on April 24-25 (*Petroleum Engineer,* Vol. 7, No. 12, pp. 40-42, 1936). Giving one's ideas on future possibilities is dangerous because the future always slips back into the past, and the past has an unpleasant way of checking up on prophecies. This paper is written to show to what extent actual performances have checked the "future possibilities" described in the earlier decade. The "future possibilities" will be quoted paragraph by paragraph, each followed by a statement as to what happened to it in the following years. This is the "acid test."

### Side-Wall Cores

"There is little information about Illinois sands and limes from cores and not much more can be expected in a field where new wells in old pools are not likely to pay out. Helpful information could be obtained at small expense from side-wall cores from old wells were a simple tool available for obtaining them. Such cores would give information about the proportions of sand to lime and determine whether or not acid treatment would be useful and would give information as to porosity and permeability, which would determine the pressure required on the acid."

A drawing illustrating a proposed side-wall coring device and its method of operating accompanied the text and is reproduced here as Figure 1. This drawing also illustrates one of the earliest suggestions for the construction of a well caliper.

Although the device shown in Figure 1 has not been constructed, side-wall coring is now an accomplished fact. A side-wall coring implement is in use which operates on rotary tools, and which cores any part of the open hole that has not been enlarged by shooting. A like result is accomplished, even in shot holes, with gun-coring equipment.

A qualitative method of determining the presence of lime in an oil stratum consists of pouring a small quantity of acid into the open hole and examining the gas emerging from the casinghead for the presence of increases in carbon dioxide.

### Heating and Agitation of the Acid

"Heat and agitation increase the speed of chemical action. It would be interesting to find out how beneficial heat would be in acid treatment and how much it would lessen the value of the inhibitor. Heating would be easy in the oil field where every tank is provided with adequate heating means with the use of which every pumper is familiar.

"Agitation of the heated acid in the hole by mechanical means operated from the surface would be simple as also

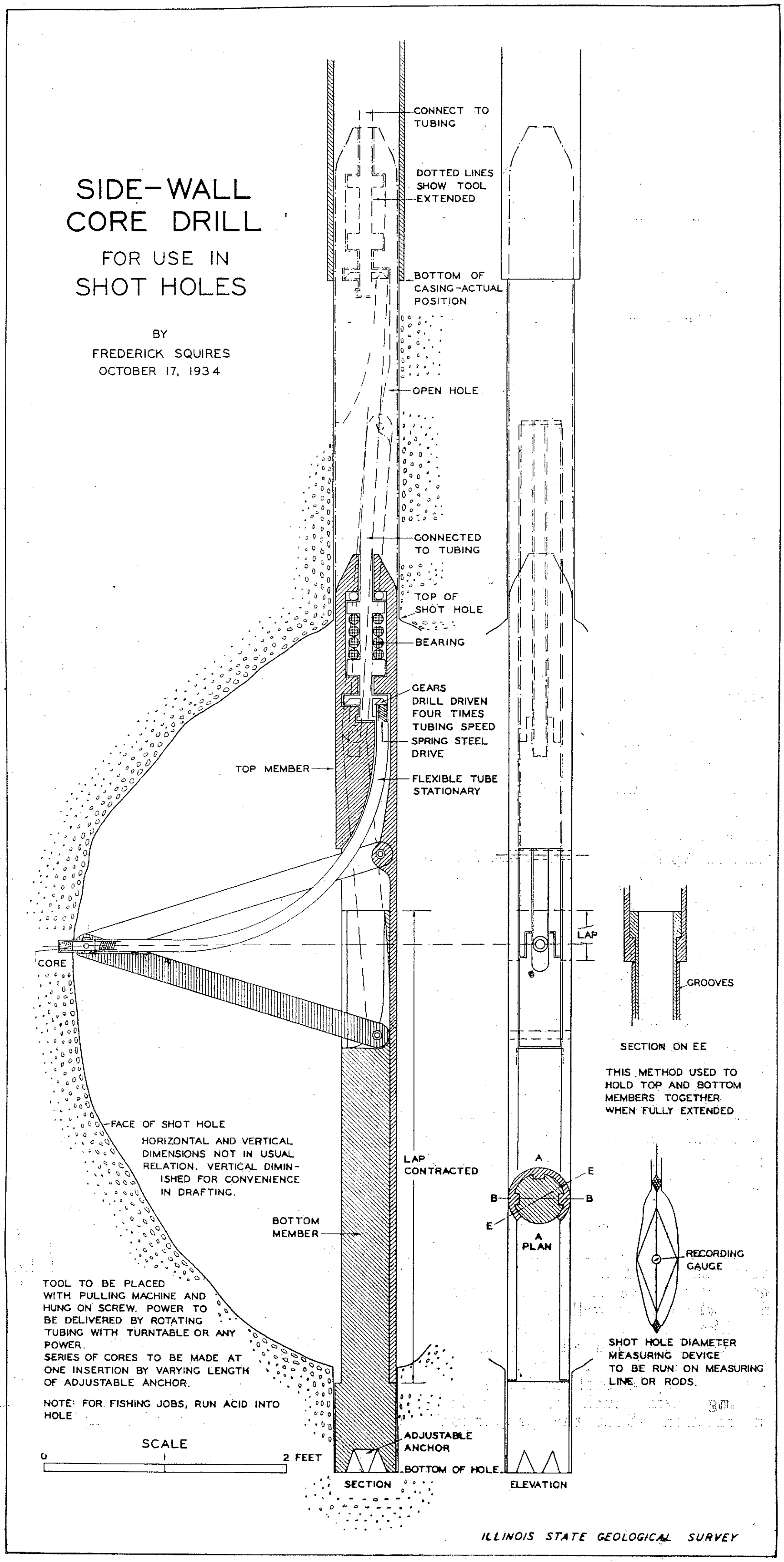

SIDE-WALL CORE DRILL
FOR USE IN SHOT HOLES
BY
FREDERICK SQUIRES
OCTOBER 17, 1934
CONNECT TO TUBING
DOTTED LINES SHOW TOOL EXTENDED
BOTTOM OF CASING-ACTUAL POSITION
OPEN HOLE
CONNECTED TO TUBING
TOP OF SHOT HOLE
BEARING
GEARS
DRILL DRIVEN FOUR TIMES TUBING SPEED
SPRING STEEL DRIVE
TOP MEMBER
FLEXIBLE TUBE STATIONARY
CORE
LAP
GROOVES
SECTION ON EE
THIS METHOD USED TO HOLD TOP AND BOTTOM MEMBERS TOGETHER WHEN FULLY EXTENDED
FACE OF SHOT HOLE
HORIZONTAL AND VERTICAL DIMENSIONS NOT IN USUAL RELATION. VERTICAL DIMINISHED FOR CONVENIENCE IN DRAFTING.
LAP CONTRACTED
A
E
B
B
E
A
PLAN
BOTTOM MEMBER
RECORDING GAUGE
TOOL TO BE PLACED WITH PULLING MACHINE AND HUNG ON SCREW. POWER TO BE DELIVERED BY ROTATING TUBING WITH TURNTABLE OR ANY POWER.
SERIES OF CORES TO BE MADE AT ONE INSERTION BY VARYING LENGTH OF ADJUSTABLE ANCHOR.
NOTE: FOR FISHING JOBS, RUN ACID INTO HOLE
SHOT HOLE DIAMETER MEASURING DEVICE TO BE RUN ON MEASURING LINE OR RODS.
SCALE
0
1
2 FEET
ADJUSTABLE ANCHOR
BOTTOM OF HOLE
SECTION
ELEVATION
ILLINOIS STATE GEOLOGICAL SURVEY

**FIGURE 1**

would be mechanical means of reaming the acid-softened limestone."

### Heat

For years heat has been introduced into oil strata by means of steam in order to increase production, both in cleaning out after a shot and in melting paraffin coatings from the rock face. But to speed a chemical reaction in an oil stratum by heating one of the reacting components is a contribution of the acidizing art. Heating the acid at the surface is practical, but the use of magnesium to react with hydrochloric acid, is better for many reasons, and this practice is now being widely used.

"Magnesium metal, when placed in contact with 15 percent hydrochloric acid, will react with the liberation of 8400 Btu of heat for each pound of magnesium. This heat raises the temperature of the acid and therefore results in a much more rapid reaction." (*The Acidizer,* Vol. 5, No. 2, p. 7, 1941).

Accompanying the original paper was a drawing of an acid reamer, here reproduced as Figure 2. The acid under pressure dissolves the limestone which it contacts, and the rotating drill-heads through which the acid is jetted remove what is left.

The jet-gun, which is now used in standard commercial practice, employs the jetting feature of the acid reamer without the abrading feature. ("Chemical Reconditioning of Old Wells," by S. H. Adkison, *Petroleum Engineer,* pp. 532-91, May, 1942).

### Preparing Input Wells for Water Flooding

"The effect of acid on McClosky wells at the edges of the well known water floods is a promising study."

When these words were written, intentional water-flooding and salt-water disposal in underground lime formations had not been attempted in Illinois, but there is now considerable interest in both of these processes. The use of acid is well adapted for preparing wells for better reception of water by increasing the permeability of the limestone around the drill hole in new wells and in cleaning out obstructing deposits in old wells. Since then, water-flooding and flooded wells in the Illinois McClosky have been acidized. Salt-water-disposal wells in lime formations have received the same treatment.

### Fishing for Lost Tools and Vertical Acid Drilling

"The use of acid as an aid in fishing for tools lost in lime formations is too obvious to need any research. However, the softening of lime formations before rotary drills and even cable tools might be advantageous and is apt to pay if the quantities of acid required are not too great."

### Fishing for Lost Tools

The April 12, 1937, issue of The Oil Weekly gives a description of the method of "Loosening Stuck Drill Pipe," by P. E. Fitzgerald. The process is so obvious that it would seem probable that the process must have been old even in 1934. Dissolution is certainly an effective way of removing an obstruction. The use of acid in this connection is confined to fishing for tools or pipe stuck in limestone formations or by pieces from them. The following is quoted from Fitzgerald's article.

"Ever since rotary drilling has been used in the oil fields, drillers have had to contend with stuck drill pipe. Until very recently the only methods of loosening such pipe have been by brute strength alone and by the circulation of cold or hot oil. Many such attempts have been unsatisfactory since they made matters worse than before and resulted in junking of the hole. It has long been known that certain acids are capable of dissolving both the metal in the drilling equipment and the formation in which the tools may be stuck, but such treatments until recently have always been of a purely experimental nature on the part of the driller or well owner and have never developed into a regular drilling practice. This was true even as late as 1934.

"The advent of acidizing as a regular production practice in oil fields has made available to the industry large quantities of inhibited hydrochloric acid together with equipment to transport it to the well and pumps capable of introducing it into the well against high pres-

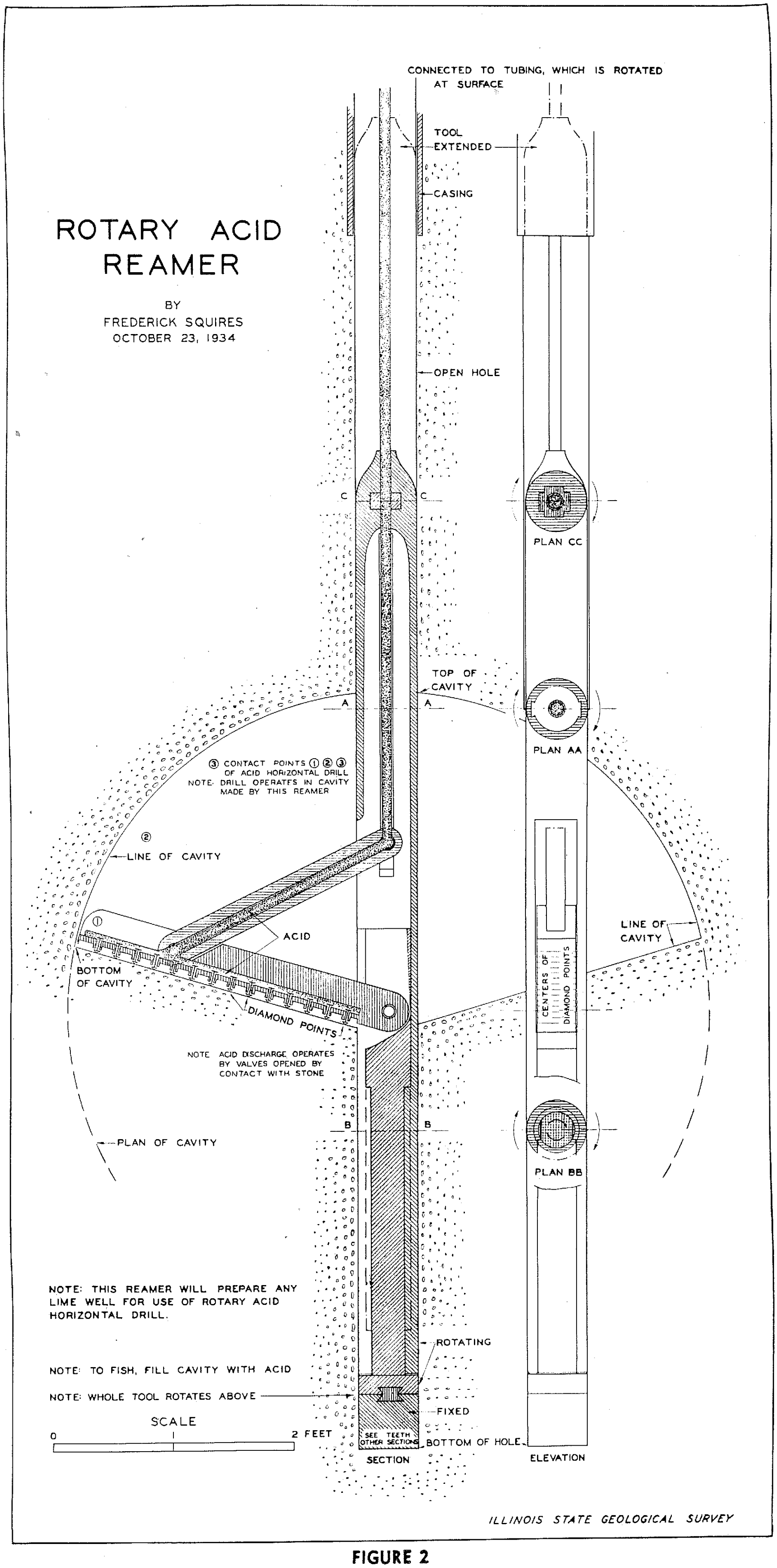

ROTARY ACID REAMER
BY
FREDERICK SQUIRES
OCTOBER 23, 1934
CONNECTED TO TUBING, WHICH IS ROTATED AT SURFACE
TOOL EXTENDED
CASING
OPEN HOLE
C
C
PLAN CC
TOP OF CAVITY
A
A
PLAN AA
③ CONTACT POINTS ① ② ③ OF ACID HORIZONTAL DRILL
NOTE: DRILL OPERATES IN CAVITY MADE BY THIS REAMER
②
LINE OF CAVITY
①
ACID
BOTTOM OF CAVITY
DIAMOND POINTS
LINE OF CAVITY
CENTERS OF DIAMOND POINTS
NOTE: ACID DISCHARGE OPERATES BY VALVES OPENED BY CONTACT WITH STONE
B
B
PLAN BB
PLAN OF CAVITY
NOTE: THIS REAMER WILL PREPARE ANY LIME WELL FOR USE OF ROTARY ACID HORIZONTAL DRILL.
ROTATING
NOTE: TO FISH, FILL CAVITY WITH ACID
NOTE: WHOLE TOOL ROTATES ABOVE
FIXED
SCALE
0
1
2 FEET
SEE TEETH OTHER SECTIONS
BOTTOM OF HOLE
SECTION
ELEVATION
ILLINOIS STATE GEOLOGICAL SURVEY

**FIGURE 2**

sures. Originally intended only for treatment of producing wells for the purpose of increasing production, the use of acid has now become a standard drilling practice in cases of emergency.

"In studying a group of wells treated with acid to loosen stuck pipe, it is difficult to find a percentage figure that will represent a true picture of the success of the method. For example, one string of pipe which had been stuck a week had been shot with glycerine and had not come loose. Probably the pipe had been shattered although it did not give way. No circulation could, therefore, be expected through the bit. Acid did not work in this well. In the well discussed above, an overshot was used but circulation was obtained through the overshot and the acid did no good. Yet next day the pipe was freed by use of acid because an overshot equipped with seal had been used allowing circulation to the bottom of the hole. In other cases, pipe has been stuck in sand, and acid has been used as a last resort because of the small expense compared to the amount to be saved by possible successful treatment.

"An analysis of 38 stuck drill pipe treatments has been made, taking into consideration the above facts, and this analysis clearly shows that treatment to loosen stuck drill pipe is definitely a progressive step in drilling practice. This analysis is as follows:

| | |
|---|---|
| Number of successful treatments.. | 19 |
| No response—Probably pipe stuck in sand .................. | 5 |
| No response—junked wells ....... | 3 |
| No response—due to mechanical Difficulties ...................... | 3 |
| No results obtained................ | 8 |

"Thus treatment for the removal of stuck pipe was successful in 50 percent of the above wells, even taking into consideration that 8 of the 38 wells were poor subjects for treatment and three more proved to be in such mechanical shape that treatment was impossible."

### Vertical Acid-Drilling

*The Oil and Gas Journal,* issue of June 17, 1943, contains an article on "Acid Deepening of Wells," by Leo Courter. In it is described and illustrated a simple way of deepening wells in limestone pay. The following is a summary of Courter's article:

A standard pulling machine to raise the tubing takes the place of the customary drilling derrick. To the tubing is secured a standard steel hose and swivel joint, and the tubing itself is supported on regular elevators. The rotary table is mounted on the casinghead. This equipment is practically the same as that shown in the drawing Figure 4 and the photographs Figures 5, 6, and 7.

Drilling is done with a standard rock bit into which is inserted a 7/64-inch jet through which a stream of acid is directed downward at high velocity. Relief is furnished by ports above the jet. The working pressure across the jet averages about 1000 pounds per square inch, and the quantity injected ranges between 15 to 18 gallons per minute.

This outfit will drill at the rate of 7 feet per hour in average limestone.

### Horizontal and Inclined Drilling

"The use of an acid jet through a rotary drill to accomplish horizontal or inclined drilling in the producing formation of an old well is in the realms of possibility. The work to be done when drilling into an acid-softened lime is very little."

### Horizontal Drilling

This text was accompanied by a drawing illustrating a device for horizontal drilling by rotary drill and acid jet which is here reproduced as Figure 3. The first drawing for this was made on July 25, 1934. This device and its companion, the acid reamer (Figure 2), combine the use of acid jetting and mechanical drilling. The jetting idea shown here but divorced from mechanical abrasion is the principle employed in the widely used acid jet gun. This is a tube pierced by a series of equally spaced nozzles, usually about 1/16-inch in diameter, through which acid is forced with a velocity of 365 feet per second, resulting in a differential of 1000 pounds per square inch. Its use is confined to enlarging any part of the well bore where it is surrounded by

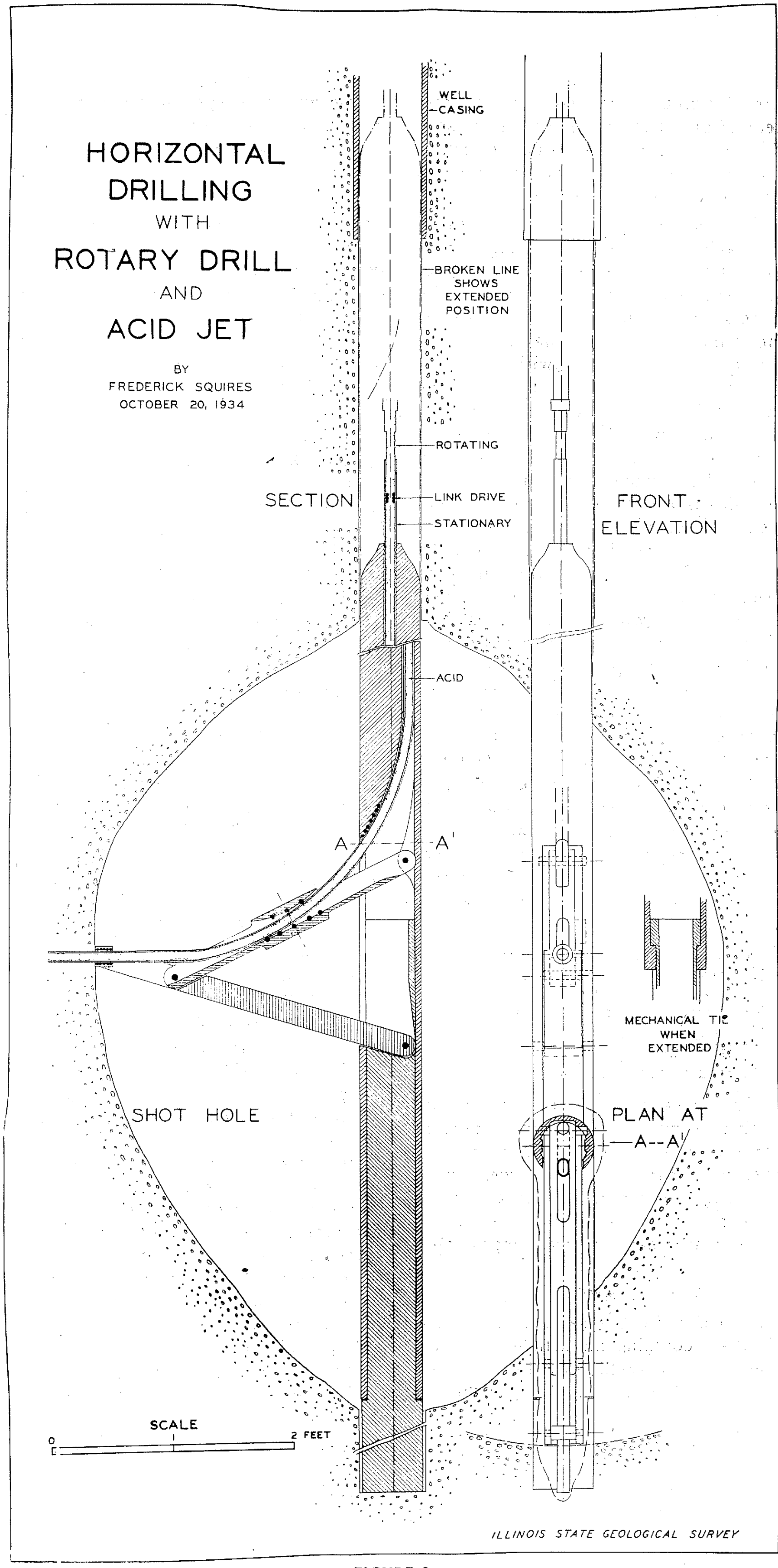

HORIZONTAL
DRILLING
WITH
ROTARY DRILL
AND
ACID JET
BY
FREDERICK SQUIRES
OCTOBER 20, 1934
WELL
CASING
BROKEN LINE
SHOWS
EXTENDED
POSITION
ROTATING
LINK DRIVE
STATIONARY
SECTION
FRONT
ELEVATION
ACID
A
A'
MECHANICAL TIE
WHEN
EXTENDED
SHOT HOLE
PLAN AT
A--A'
SCALE
0
1
2 FEET
ILLINOIS STATE GEOLOGICAL SURVEY

FIGURE 3

limestone, but is not intended to drill horizontally to any great distance.

The following description of the method of horizontal drilling is quoted from P. E. Fitzgerald, *Bulletin of the American Association of Petroleum Geologists*, Vol. 24, No. 8, pp. 1361-9, (August, 1940).

"Almost since the beginning of the petroleum industry, forward-thinking men have been attempting to devise tools with which to drill lateral holes into an oil-producing formation. All of these have been mechanical devices involving rotary or percussion processes. The most successful recent lateral drilling has been done in eastern Ohio along an outcrop and is described in a paper by Leo T. Ranney, "Horizontal Drilling Through Outcrop Brings Results," *Oil and Gas Journal,* pp. 68-69 (April 20, 1939). This method can also be used in buried formations provided a shaft large enough to accommodate drilling operations is sunk to the pay zone.

"Chemicals have been utilized in conventional drilling operations for more than 50 years, as witnessed by a patent issued to Albert Krouse in 1887 (U. S. Patent 372,154), which included the use of various acids as an aid to cable-tool drilling operations.

"It has only been during the last few years, however, that attention has been called to the possibilities of chemicals as a means of drilling horizontal holes in deeply buried oil-producing formations. Research carried on in the laboratory and field has resulted in the development of a horizontal drilling device which utilizes a flexible armored hose, hose guide, and suitable jets. The hose with a jet on the bottom end is lowered into the well on a string of small tubing. The small tubing assembly is introduced into the well through the conventional tubing string which has the hose guide at its lower end. The small pipe is attached to a weight indicator which provides a means of controlling the contact pressure of the jet against the formation. The hose guide directs the armored hose and the jet against the formation. Chemicals capable of solvent action are pumped into the small tubing and thence through the jet against the formation. The combination solvent and jetting action drills a hole into the formation.

This tool has been used experimentally in several areas, and in Kansas a hole was drilled laterally a distance of 40 feet into the Kansas City formation.

" * * * Some of the factors to be considered if this type of drilling becomes practical are its effect upon well spacing, ultimate recovery, and possible proration. There is no doubt that such a well-completion method would permit a more efficient use of available reservoir energy by reducing the pressure differential necessary to cause flow of oil into the well. By drilling several holes laterally a distance of about 10 feet, the oil can be produced with probably one half the pressure differential drop, since it has been proved experimentally by Uren and theoretically by Muskat that about 50 percent or more of the available energy is dissipated within 10 feet of the well.

"If these horizontal holes are drilled in formations that lend themselves to chemical treatments, the pressure differential will be reduced still more, allowing for a more efficient use of the available reservoir energy.

"The tendency of water coning through vertical permeability would be minimized also, and in a gas-drive field it is probable that the economic life of the well would be longer."

This type of horizontal drilling may be used in deposits of salt, sulfur, and coal by the use respectively of hot water, steam, or air-gas mixture burning against a heated surface. The hose, drill-head, and pipe are shown in figures 8 and 9.

### Inclined Drilling

In addition to the well drilled horizontally 40 feet into the Kansas City formation, there have been three successful operations for directional acid-drilling into the Chalk formation of the Pine Island pool, Caddo Parish, Louisiana. These will be identified as No. 69, No. 100, and No. 118.

In well No. 69 the whipstock was set at 1574.9 feet and a hole drilled 157

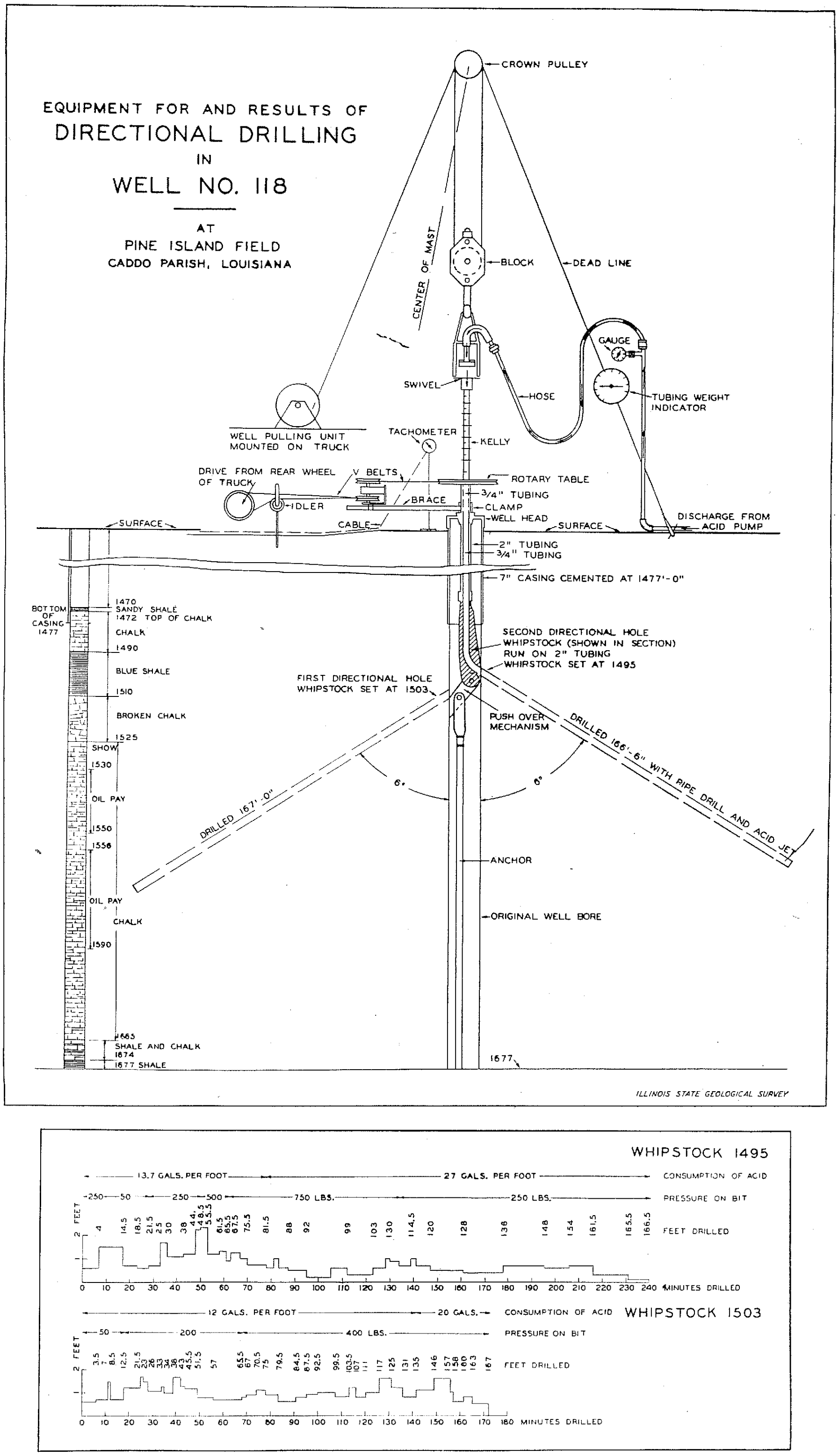

EQUIPMENT FOR AND RESULTS OF
DIRECTIONAL DRILLING
IN
WELL NO. 118
AT
PINE ISLAND FIELD
CADDO PARISH, LOUISIANA
CROWN PULLEY
CENTER OF MAST
BLOCK
DEAD LINE
GAUGE
SWIVEL
HOSE
TUBING WEIGHT INDICATOR
WELL PULLING UNIT MOUNTED ON TRUCK
TACHOMETER
KELLY
DRIVE FROM REAR WHEEL OF TRUCK
V BELTS
ROTARY TABLE
3/4" TUBING
IDLER
BRACE
CLAMP
CABLE
WELL HEAD
SURFACE
DISCHARGE FROM ACID PUMP
2" TUBING
3/4" TUBING
7" CASING CEMENTED AT 1477'-0"
BOTTOM OF CASING 1477
1470 SANDY SHALE
1472 TOP OF CHALK
CHALK
1490
BLUE SHALE
1510
BROKEN CHALK
1525
SHOW
1530
OIL PAY
1550
1556
OIL PAY
CHALK
1590
1665
SHALE AND CHALK
1674
1677 SHALE
SECOND DIRECTIONAL HOLE
WHIPSTOCK (SHOWN IN SECTION)
RUN ON 2" TUBING
WHIPSTOCK SET AT 1495
FIRST DIRECTIONAL HOLE
WHIPSTOCK SET AT 1503
PUSH OVER MECHANISM
DRILLED 166'-6" WITH PIPE DRILL AND ACID JET
DRILLED 167'-0"
6°
6°
ANCHOR
ORIGINAL WELL BORE
1677
ILLINOIS STATE GEOLOGICAL SURVEY
WHIPSTOCK 1495
13.7 GALS. PER FOOT
27 GALS. PER FOOT
CONSUMPTION OF ACID
250 LBS.
750 LBS.
PRESSURE ON BIT
FEET DRILLED
2 FEET
MINUTES DRILLED
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240
12 GALS. PER FOOT
20 GALS.
CONSUMPTION OF ACID
WHIPSTOCK 1503
50
200
400 LBS.
PRESSURE ON BIT
FEET DRILLED
MINUTES DRILLED
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180

**FIGURE 4**

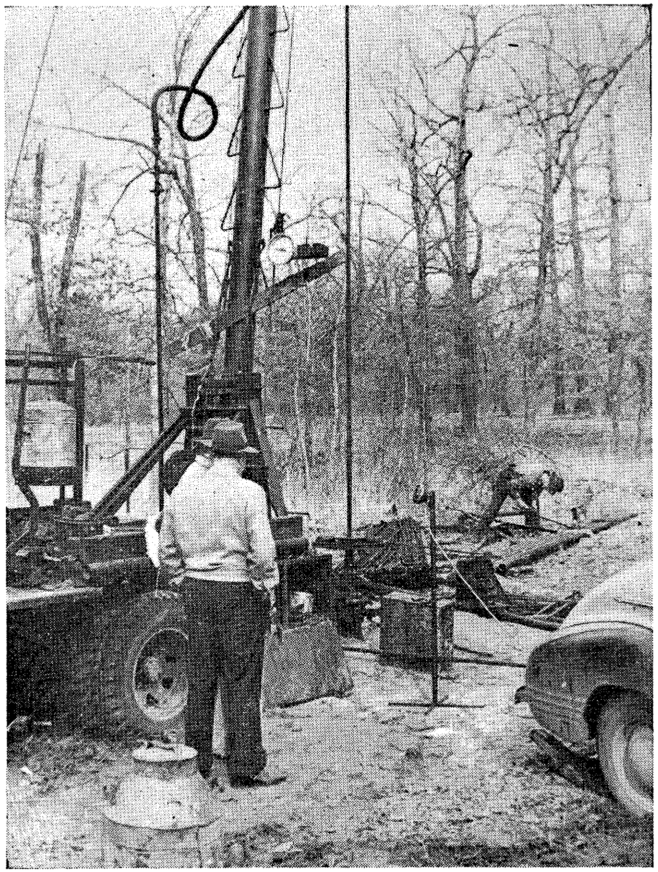


FIGURE 5
Here are shown the weight and torque indicators, a part of the pulling machine, and the hose, kelly and rotary table. Right foreground shows rear of the automobile, the opposite rear wheel of which furnishes power to turn the rotary table.

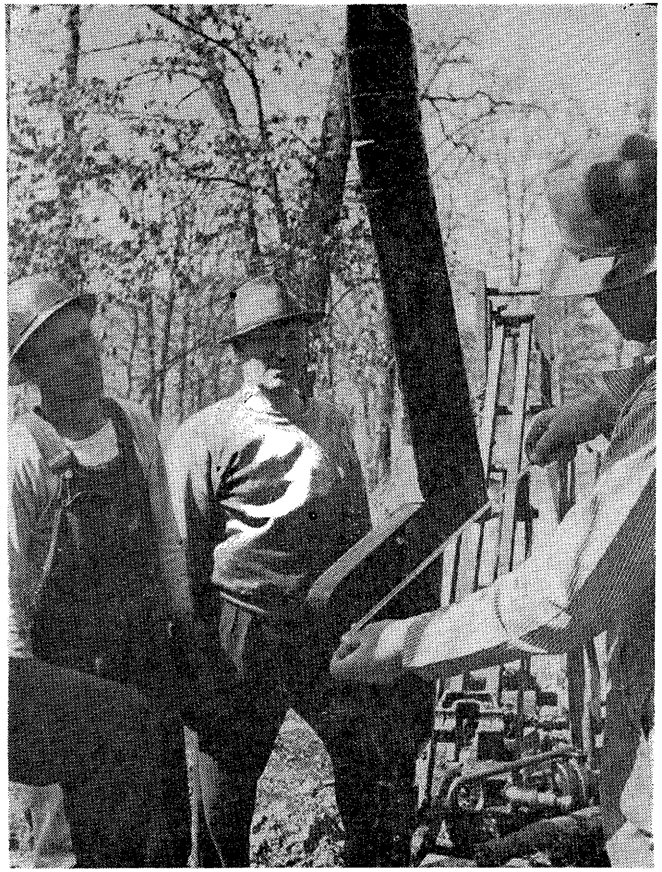


FIGURE 7
Whipstock guide and pushover mechanism.

feet in length; then with the whipstock reset as 1570 feet, a total of 156.8 feet was drilled.

In well No. 100, the whipstock was set at 1545.5 feet from which point directional acid-drilling was completed to a distance of 156 feet, using an average of 26 gallons of acid per foot at the rate of about 1 foot in 2 minutes.

In well No. 118, two holes were drilled in directions 180 degrees from each other, one beginning at a depth of 1503 feet was drilled a distance of 167 feet and the other starting at a depth of 1495 feet extended 166.5 feet.

The drilling rig for well No. 118 is shown in the drawing (Figure 4) and in photographs (Figures 5, 6, and 7). The acid-pumping outfit was a standard well acidizing truck. This set-up is practically the same as that used in vertical deepening of wells in limestone formations previously described. The outfit shown in Figure 4 is practically the same above ground as that described previously for vertical acid-drilling, the main difference being found underground at the point where the whipstock changes the direction of the hole. In each, a pulling machine lowers and raises the pipe in and out of the well, the rotary table is powered by the rear axle of an automobile, and a standard acid-pumping truck supplies the acid at the required pressure.

In vertical drilling, acid is pumped through a rotating fishtail bit which operates in a vertical position. In the directional drilling, the bit is turned at an angle to the vertical by a whipstock and is driven by a string of pipe turned by the rotary table. The following description applies to directional drilling.

Figure 4 indicates the mast of a pulling machine and its drum from which runs a wire line over a crown pulley, down and through a block, back over the crown pulley and thence to the ground. A tubing-weight indicator is mounted on the line. To the block is hooked a swivel, supporting the kelly, which connects with ¾-inch pipe. The

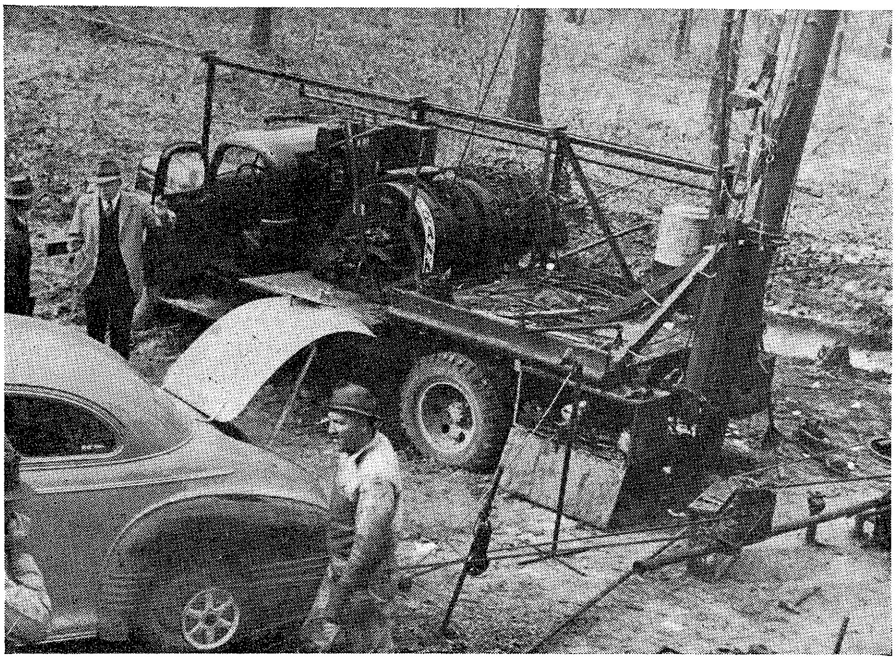


**FIGURE 6**

**Picture shows all equipment used in the drilling operation except the acid-pumping truck. It gives a clear idea of the lightness of the work to be done and the equipment to do it.**

upper end of the kelly is connected to the discharge from the acid pump. Two-inch tubing is run, to which the whipstock is secured.

The ¾-inch pipe runs inside the 2-inch tubing, terminating in a fishtail bit pierced by two jets for the discharge of the acid. The rotary table is revolved by V-belt, drive-powered by a pulley fixed to the rear axle of an automobile. All these parts are shown in Figure 4. Figure 5 is a photograph showing the pulling machine, the torque and tubing weight indicators, the acid hose, the ¾-inch pipe, and the rotary table. Figure 6 shows both the pulling machine and the automobile power hook-up. The whipstock guide and push-over mechanism are pictured in Figure 7.

The drilling procedure is briefly as follows: The whipstock is made up on the 2-inch tubing, run, and set. The bit is connected to the first joint of ¾-inch pipe and run into the 2-inch tubing, joints of ¾-inch pipe being added until the bit contacts the formation through the whipstock. The pipe is connected to the kelly which in turn is connected to the acid hose. Drilling then begins as in any rotary operation. The results in distances drilled are shown in Figure 4.

The graphs tell the story of drilling speed in feet per minute, consumption of acid per foot of hole, and the weight carried on the bit at each stage of the drilling.

To the left is a column indicating the thickness and character of the formation and the positions of the several oil pays.

**FIGURE 8**

**This shows the drilling bit, the flexible armored hose, and the ¾-inch pipe which are connected up and rotated to provide the abrasive feature of the drilling. Acid pumped at high pressure through this assembly provides the jetting action and the chemical reaction.**

The information given above and in Figure 4 was furnished to the writer by the acidizing company, with the permission of the company which conducted the directional drilling operation.

### Acidizing by Gas Loading

"In present practice, acid is driven into the oil-producing lime with pressure obtained by pumping more oil into a full hole. The same result can be obtained by putting a pressure on top of the acid with gas, delivered by compressors from gasoline or repressuring plants that are often available near lime production, especially McClosky areas, or by portable compressors. Gas pressure would have advantages. Probably it would force acid farther into the lime and would bring oil back with it when released."

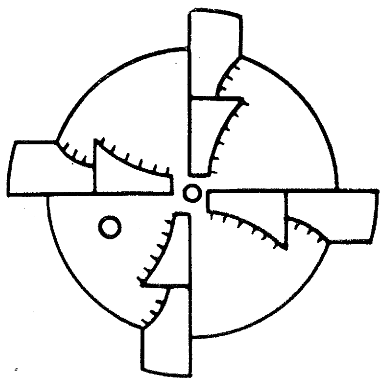
Some years ago, the writer developed the method of using alternate slugs of water and gas in secondary recovery. When acidizing was studied, it seemed reasonable to use gas to force the acid into the lime rather than to import enough oil to the site to accomplish a like result. With this experience in mind, the above suggestion presented itself. This has since been proved practical as gas loading of acid is now standard practice, especially in the gas fields in the Texas Panhandle and at Monroe, Louisiana. ("Record Acidizing Program Lifts Output of Monroe Gas Fields," by George Weber, *Oil and Gas Journal,* February 20, 1941.)

According to Weber, gas pressure from a gas well or a compressor is a "clean, cheap, rapid and convenient means of displacing acid into" gas formations in limestone. "The release of the gas pressure at the well head provides a high differential across the producing formation and starts a flow of the spent acid and insoluble matter into the well bore and out of the well head."

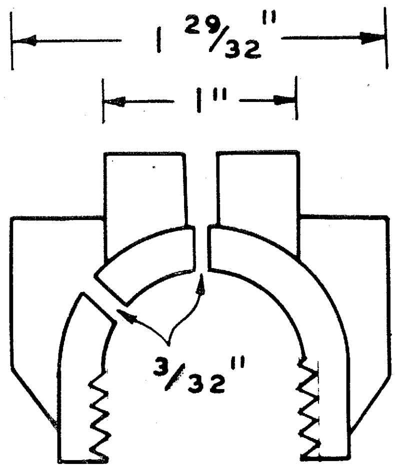
### Conclusions

The possibilities as seen in 1933, including side-wall coring, application of heat, agitation, acid preparation of water-intake wells, acid used for fishing and as an aid in vertical, horizontal, and inclined drilling, and gas loading, have been tried out on oil-field scale in the intervening time, and all have stood the "acid test."

The 1936 paper mentioned one possibility which has not as yet been proved—secondary recovery by the use of natural gas or air and gaseous hydrochloric acid.



Cutting edges built up with hard metal and then ground.




Details of "8" point bit used on end of flexible steel hose in lateral drilling.

FIGURE 9

If the writer were asked today to give a new paper on the subject of "Present Status and Future Possibilities of Acid Treatment in Illinois," the "present status" would be vastly different from its predecessor. Among the "future possibilities" proposed in the earlier paper, but not included in the published version, one would be repeated:

"The use of gaseous HCl accompanied by air or natural gas should be tried as a secondary-recovery process, the gas and gaseous HCl being introduced under pressure at input wells, passing into the permeable limestone stratum and emerging from the pumping wells carrying oil with it. In its journey, the gaseous HCl would come in contact with connate water, be absorbed in it, and the resulting aqueous HCl would react chemically with the limestone. This violent chemical action would result in freeing the oil entrapped in capillary pores which would be rendered less viscous by the heat of chemical action, and the produced $CO_2$ would reinforce the volume of gas pumped into and moving through the formation. The oil would be carried to the pumping wells by the action of the moving gas as in the usual repressuring operation."

Many oil-field problems would be benefited by a study along the lines of their "Present Status and Future Possibilities," especially by emphasis on the "future possibilities." Nowhere is there a more interesting and promising field than in the application of chemistry to oil-field production. The oil sands and limes provide enormous underground laboratories calling for chemistry to unlock the vast quantities of oil which up to now we have found no way of bringing to the surface.

### Acknowledgments

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