Recent Developments Related to Petroleum Engineering

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Recent developments related to petroleum engineering discussed in this paper are:

1. Drilling wells in with oil or the use of chemical compounds or "mud solvents" for removing rotary mud from wells in order to increase or make possible oil production.
2. Comparison of results of electrical logging methods in locating water, as shown in a recent test on a well in the Los Angeles Basin.
3. A new method for logging formations through casing, known as the Stratagraph.

Drilling Wells in with Oil or the Use of Chemical Compounds or Mud Solvents

During the time that the California fields showed high gas pressures, the pressure of the gas within the formation was sufficiently great to break down the mud wall or cake formed while the well was drilling. That this did not always occur was demonstrated by the fact that in some of the older fields new wells sometimes had substantially higher initial productions than other wells near by. The explanation seemed to be that some sands were mudded off in the original drilling. Their pressure was then not great enough to break down the mud wall in competition with the higher pressure of the sands, but the situation reversed itself so that a later well benefited by the pressure in these originally weaker sands. As time passed, in wells deeper than 5000 ft. the difficulty of bringing wells on production became more pronounced. This led to a hunt for substitutes, of which a number have been tried. The one that has proved most successful in our experience at Ventura is known as the Nobs solvent.

At well No. 1 of the Associated-Ventura Land & Water Co. when it was recompleted in February 1936, about 10 days were spent in trying to bring the well in in the regular manner, but only about 113 bbl. of water could be swabbed from the well, and even this quantity decreased as time passed. The Nobs solvent was spotted in the bottom of the hole opposite the perforations, inverted Guiberson swab rubbers were used on the drill pipe and the hole was down-swabbed in stages, beginning

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at the bottom of the hole. The well was allowed to stand and the mud was bailed from the hole. The down-swabbing was repeated and, after standing, mud was again bailed from the hole. This operation was continued as long as substantial quantities of mud were secured. It is estimated that more than two tons of solid material was taken from this particular well. When the well was placed on the pump, it built up a production of more than 200 bbl. of oil per day in less than 10 days, and at present is making 300 bbl. gross and 279 bbl. net. Its production is as great as that of old wells drilled during the time that gas pressures were high. This experience has been checked in several other wells.

In spite of this, however, it must not be assumed that the solvent is a cure for all drilling troubles. Neither can it be said that it represents a final method of completing wells.

Another method being used is to use oil as a circulating fluid in drilling wells in, rather than mud. In one well recently drilled, circulation was not re-established to the surface in drilling the last 800 ft. of hole. About 18,000 bbl. of oil were used as drilling fluid. Despite this fact, the cuttings made in drilling seemed to have gone into cavities or into formations in such a way as not to interfere with the production of the well upon completion.

Experiments are still being conducted with oil as a drilling fluid and with the Nobs solvent for removing the rotary mud. The great fear that formerly existed when well pressures were high—that wells could not be drilled in at great depths after the gas pressure was gone—has, therefore, been eliminated by both of these methods. It is reasonable to hope that further improvements in the art of drilling will make it possible to secure all the production possible at a location without danger of mudding the sands so as to interfere with production.

Results of Electrical Logging Methods in Locating Water

As is well known in California, there are at least two service companies that make electrical logs of drilling wells. In recent months one of these companies has stressed particularly its ability to detect the presence of water in oil horizons. The other service company has always made a similar claim, but has not particularly stressed this part of its service. There are times when the value of this information is very great.

In the drilling of an edge well in one of the fields in the Los Angeles Basin, in order to make the best record possible, engineers of the Associated Oil Co. decided to core carefully the bottom 700 ft. of the hole. The first expected cementing point was around 6000 ft., but streaks of gray sand were found with the oil sand, so that the coring was carried on to 6212 ft., where after more than 50 ft. of oil sand had been found below a shale body, it was decided to cement the water string in the shale.

A successful shutoff was secured. As a precaution, it was decided to core the entire oil zone. Continuous coring, beginning at 6212 ft., was carried on to 6605 ft. One may well imagine the disappointment that resulted from finding gray sand about 4 ft. below 6212 ft. While the core recovery was remarkable during this entire interval, only 3 ft. of the last 15 ft. were recovered, consisting of 1 ft. of loose, coarse-grained oil sand and 2 ft. of firm oil sand.

The two competing electrical coring instruments were run. One was able to run to a depth of 6598 ft.; the other ran to a depth of 6605 ft., but the right-hand side of its record was missing below 6560 ft. The operator reported best saturation from 6530 to 6595 ft. Based on coring, a cementing point of 6410 ft. was chosen, and this point was selected as the proper cementing point by one of the service companies.

With the assurance of the core record, therefore, that nothing but oil sand was cored in the bottom of the hole, with the encouragement of one of the service companies that the best saturation was from 6530 to 6595 ft., and with no warning from the service company that stressed its claim to identify salt water in oil zones, everything seemed to indicate that there was no trouble ahead. But when the well came in it produced 300 bbl. of oil and 100 bbl. of salt water. In fairness to the service company that stressed its ability to locate salt water, it should again be stated that the right-hand curve of the record submitted, from which the water determination was to be based, ended at 6560 ft. In so far, however, as the oil company is concerned, the hole was open to 6505 ft. and the right-hand part of the record was made to that depth.

When the well proved to be wet it was necessary to kill it and have a third service company make a run to locate the water. A very fine record, showing the location of the water from 6580 to 6595 ft., was secured just about in the interval where the last core failed to get a satisfactory recovery and also within the depths to which both service companies were able to run their instruments. The well was then plugged with cement to 6546 ft. When placed on production, and even after washing with the Nobs solvent, it was impossible to get more than about 100 bbl. of fluid out of the hole, of which about half was water and the rest oil. This last evidence confirmed the last test made by the water-locating company that the water was in the bottom of the well. It did not conflict with the coring evidence because most of the last core was not recovered. One of the service companies again reviewed its record and claimed that, in addition to indicating as reported, the best saturation was from 6530 to 6598 ft., the record had been interpreted incompletely and that evidence of water at 6585 to 6590 ft. was indicated by a breaking back of its right-hand curve.

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from the same run attempt to identify the location of sands, shales and waters. It is sincerely to be hoped that progress in this direction will yet be made. Otherwise, it will still be necessary to rely on the water-locating devices that make their runs especially for the purpose of locating water.

Logging Formations through Casing

During the past year and a half the Oil Well Water Locating Co. has been experimenting in the hope of logging formations behind casings. It

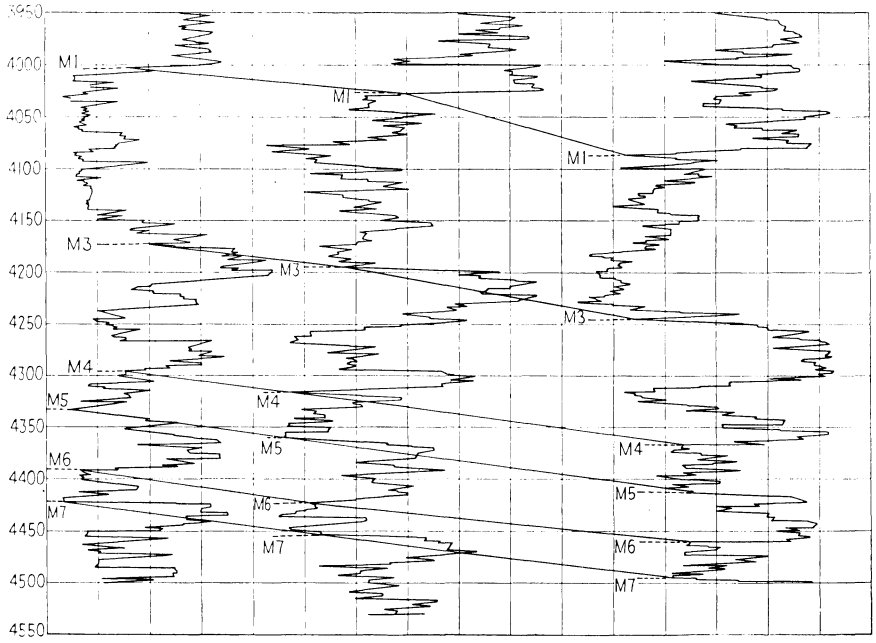

Fig. 1.—Correlation of Santa Fe Springs markers.

is recognized and fairly well accepted, at least by a certain portion of the industry, that formations can be logged electrically in open holes. The new method developed in this experimental work is known as the "Stratagraph." Within the present year it has been used successfully at Santa Fe Springs (Fig. 1) to locate oil sands only 25 ft. thick, and at Ventura it has been used to locate a gas sand. As the ability to make the record and to interpret it grows, this device should be of great value in old fields where it is desired to shoot casing to secure oil sands that have been left behind the pipe.

The method is based upon the electromotive series of metals. Two circuits are established and nearly balanced against one another; the difference between the two making a record that is interpreted (Figs. 2,

3 and 4). Each of these circuits is so regulated with resistance that it has about the same strength as the other, their variations being affected by the electrical effect of the fluid in the formation, which serves as an

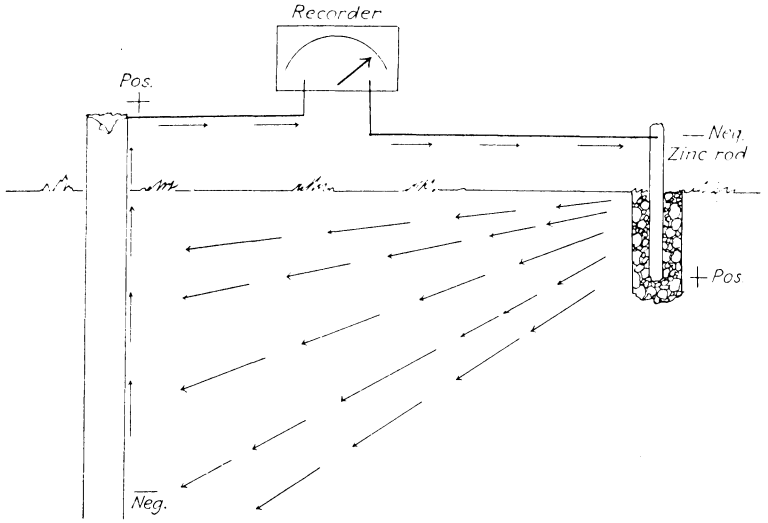

FIG. 2.—FIRST CIRCUIT.

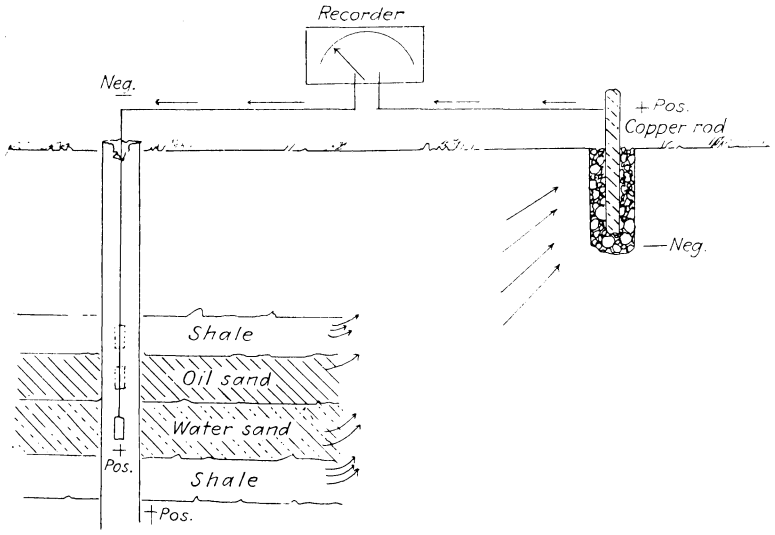

FIG. 3.—SECOND CIRCUIT.

electrolyte. The first circuit includes a zinc rod driven in the ground approximately 150 ft. from the well. The current flows from the zinc rod through the earth to the casing of the well and is returned to the zinc rod from the casing through a wire in which the recording instrument and the resistance are placed. The second circuit includes a zinc plate

suspended on an insulated wire line inside the casing. The fluid in the casing may be oil-field water, fresh water, salt water or mud, but of the same consistency. This creates a constant electrolytic action between the zinc plate and the casing. The current flows from the zinc to the casing and from the casing through the earth to a copper ground located approximately 100 ft. from the well. It returns from the copper ground

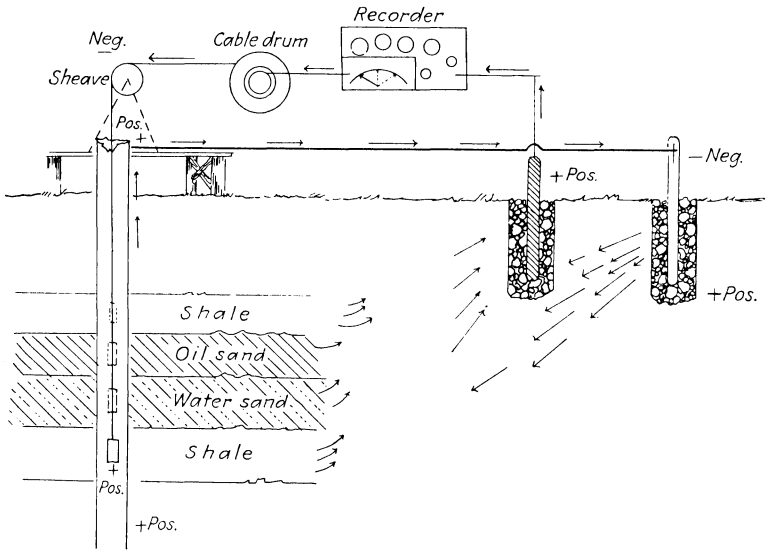

FIG. 4.—COMBINED CIRCUITS.

through the recording instrument and the resistance down the cable to the zinc plate. These two currents flow in opposite directions. The only purpose of introducing the resistance in one of the circuits is to limit the swing of the needle of the recording device to the width of the paper on which the record is made. As the suspended zinc plate is raised or lowered in the well, and comes opposite the different beds outside the casing containing fluids of different strength, currents of different magnitude are set up. Thus the record is made. Where the record swings widely to the left, it indicates shale and where it swings widely to the right, it indicates sand.