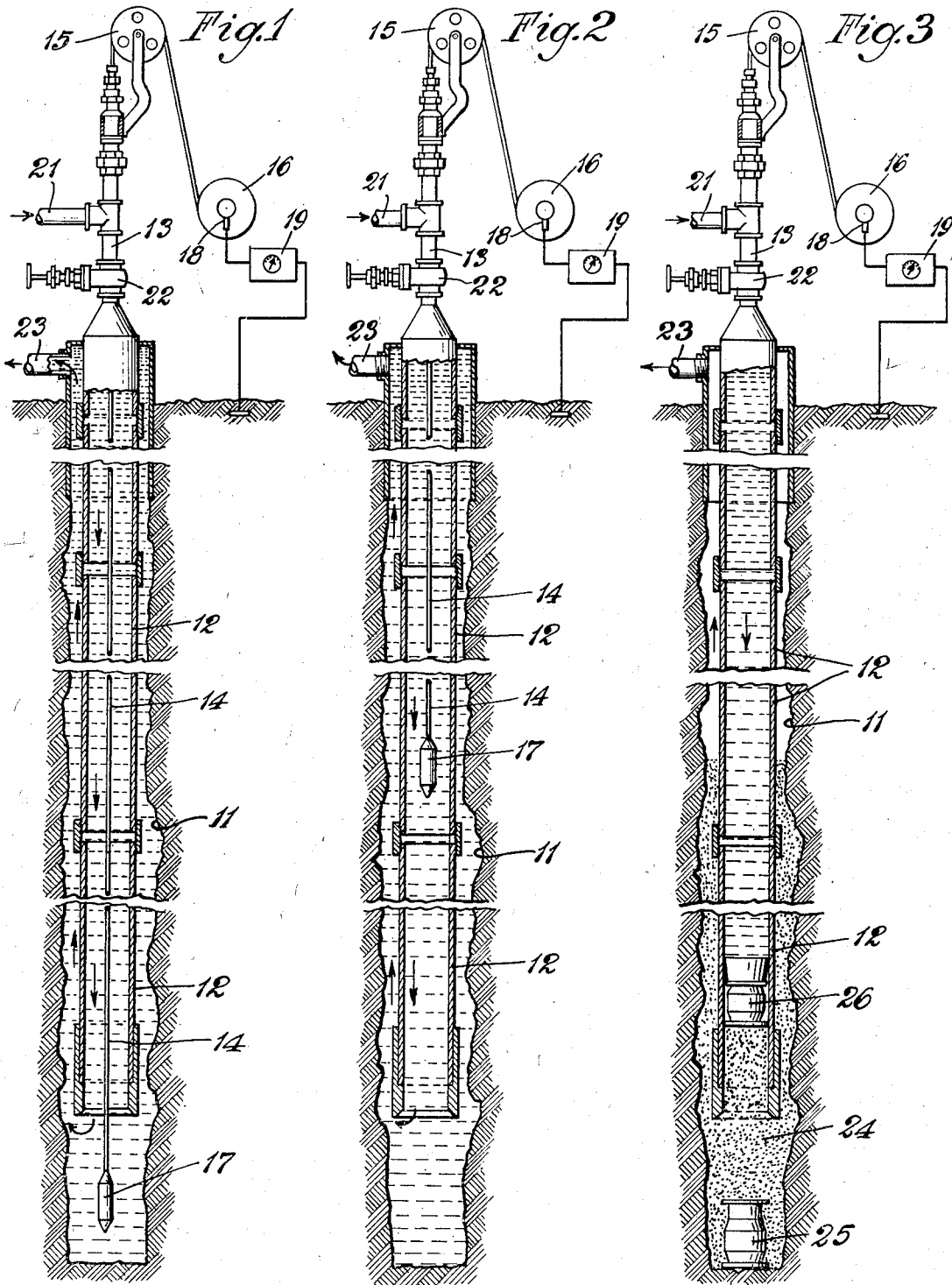


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METHOD OF DETERMINING THE VOLUME OF THE ANNULAR SPACE
BETWEEN THE CASING AND WALL OF BORE HOLES
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METHOD OF DETERMINING THE VOLUME
OF THE ANNULAR SPACE BETWEEN THE
CASING AND WALL OF BOREHOLESErle P. Halliburton, Los Angeles, Calif., assignor
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1 Claim. (Cl. 73—51)

This invention relates to a method for cementing wells and more particularly to a method for determining accurately the volume of cement slurry required to be pumped into a well to fill the annular space between the casing and the wall of the bore hole up to a desired level.

It is common practice to cement casing in oil wells by pumping slurry down through the inside of the casing and up through the annular space between the casing and the wall of the hole. The use of cementing plugs in such an operation is described in the patent to Perkins, et al., No. 1,011,484 granted December 12, 1911, for "Method of cementing oil wells." In carrying on operations of this type the annular space between the casing and wall of the bore hole is often not filled with slurry to the desired level because the operator does not know exactly what the volume of this annular space is. Heretofore, calculations have usually been based upon the assumption that the bore hole is of substantially uniform diameter, but this is seldom the case.

In accordance with the present invention a method is provided for determining accurately the volume of the annular space between the casing and wall of the bore hole between two selected depths in the well. The method is carried out by determining the amount of fluid pumped into the well which is sufficient to move a body of fluid of a different temperature than that normally prevailing in the well from one depth to another, movement of the fluid of abnormal temperature being detected by the use of a telemetric thermometer.

Accordingly, it is one object of the invention to devise a new and novel method for determining movement of fluid in an oil well, so as to measure the volume of fluid in a confined space therein.

It is another object of the invention to devise a novel method for filling the annular space between the casing and wall of a bore hole with cement slurry without placing more than the amount necessary to fill the space.

Other objects and advantages reside in certain novel features of the method, as will be apparent from the following description taken in connection with the accompanying drawing in which:

Figure 1 is a vertical cross sectional view of an oil well provided with casing and with apparatus shown therein for determining the temperature at the bottom of the well.

Figure 2 is a vertical cross sectional view of an oil well the same as Figure 1, but illustrating the thermometer moved to a point up the well from the bottom so as to be located at the level where

it is desired that cement slurry shall come up around the casing; and

Figure 3 is a view similar to Figures 1 and 2, but illustrating the condition of the well as the placing of the cement slurry therein is being completed.

Referring to the drawing in detail, it will be seen that a well bore is there illustrated at 11. The casing 12 is shown in the well in position to be cemented. The top of the casing is provided with a suitable stuffing box and staff arrangement 13 through which an electric cable 14 is passed into the well, the cable extending over a swivelled sheave 15 and on to a drum 16.

A thermal responsive element 17 (such as a resistor having a high temperature coefficient) is mounted on the lower end of the cable 14 and connected to the insulated conductor thereof. By means of a slip ring connection 18 on the drum 16 which makes connection to the conductor of the cable 14, the thermal responsive element 17 is connected to an indicating device 19 so that it is possible to observe at the surface of the well, variations in temperature at the element 17. Telemetric thermometers of this type are well known to those skilled in the art, and need not be shown or described here in detail. (See, for example, "A Text-book of Physics"—Duff 4th ed. 1916, pages 210 and 395.)

It will be observed that the thermal element 17 may be raised and lowered in the well as desired and that fluid may be pumped into the casing through the connection 21 and valve 22, circulating down through the casing and up through the annular space between it and the wall of the bore hole and out through the connection 23, without removing the element 17 from the well.

One way of proceeding to carry out the method of the invention is as follows:

The element 17 is lowered to the shoe of the casing as shown in Figure 1. At this time the well will normally be filled with fluid such as drilling mud, which will be approximately at the temperature normally prevailing in the well. With the element 17 located at the shoe of the casing a quantity of mud or other fluid of a different temperature than that of the fluid in the well is pumped into the casing and circulated in the direction shown by the arrows. This quantity of fluid may be at a temperature either above or below that of the fluid in the well. The quantity must be sufficient to maintain a measurable temperature differential long enough to be circulated as described below.

When the quantity of fluid of abnormal temperature reaches the shoe of the casing its position will be indicated by the instrument 19. The element 17 of the thermometer is then raised up the casing to the level shown in Figure 2, which level is that to which it is desired that cement slurry shall be pumped up in the annular space between the casing and the wall of the bore hole. The circulation of the fluid of normal temperature may then be continued in the direction shown by the arrows until the fluid of abnormal temperature reaches the new level of the element 17. This position is indicated by the instrument 19, due to conduction of heat, through the casing and fluid around the element 17.

During the circulation of the fluid of abnormal temperature from one position in the annular space to the other, the quantity of fluid of normal temperature pumped into the inlet 21 is accurately measured. This quantity will be equal to the volume of the annular space between the initial position of the element 17 at the shoe of the casing to the position shown in Figure 2.

After thus determining the volume of the space which is to be filled with cement slurry the cable 14 and element 17 may be removed from the well or pulled up into the stuffing box and staff assembly. A quantity of cement slurry equal to that of the volume measured is then pumped into the well in accordance with the usual practice. This operation is illustrated in Figure 3, which shows the slurry 24 being pumped into the well between a bottom plug 25 (shown at the bottom of the well), and a top plug 26.

It is obvious that the determination of volume and the placing of the required amount of cement in a well in accordance with the above described method can be applied to other conditions than those illustrated. For example, in multiple stage cementing operations the volume of the annular space for a specified distance above the multiple cementing unit may be determined. Various other modifications may be made without departing from the spirit of the invention or the scope of the annexed claim.

I claim:

The method of determining the volume of an annular space between two levels in an oil well which consists in placing the thermal responsive element of a telemetric thermometer in a pipe in the well at one of said levels, circulating fluid through the annular space and through said pipe in opposite directions, placing a quantity of fluid in said circulating fluid of a temperature different from that normally prevailing in the well and continuing the circulation until the fluid of abnormal temperature reaches the level at which the thermal responsive element is located, as indicated by the thermometer, moving the thermal responsive element to the other level, continuing the circulation until the fluid of abnormal temperature reaches the other level, as indicated by the thermometer, and measuring the quantity of fluid pumped into the well in forcing the fluid of abnormal temperature from one level to the other.

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