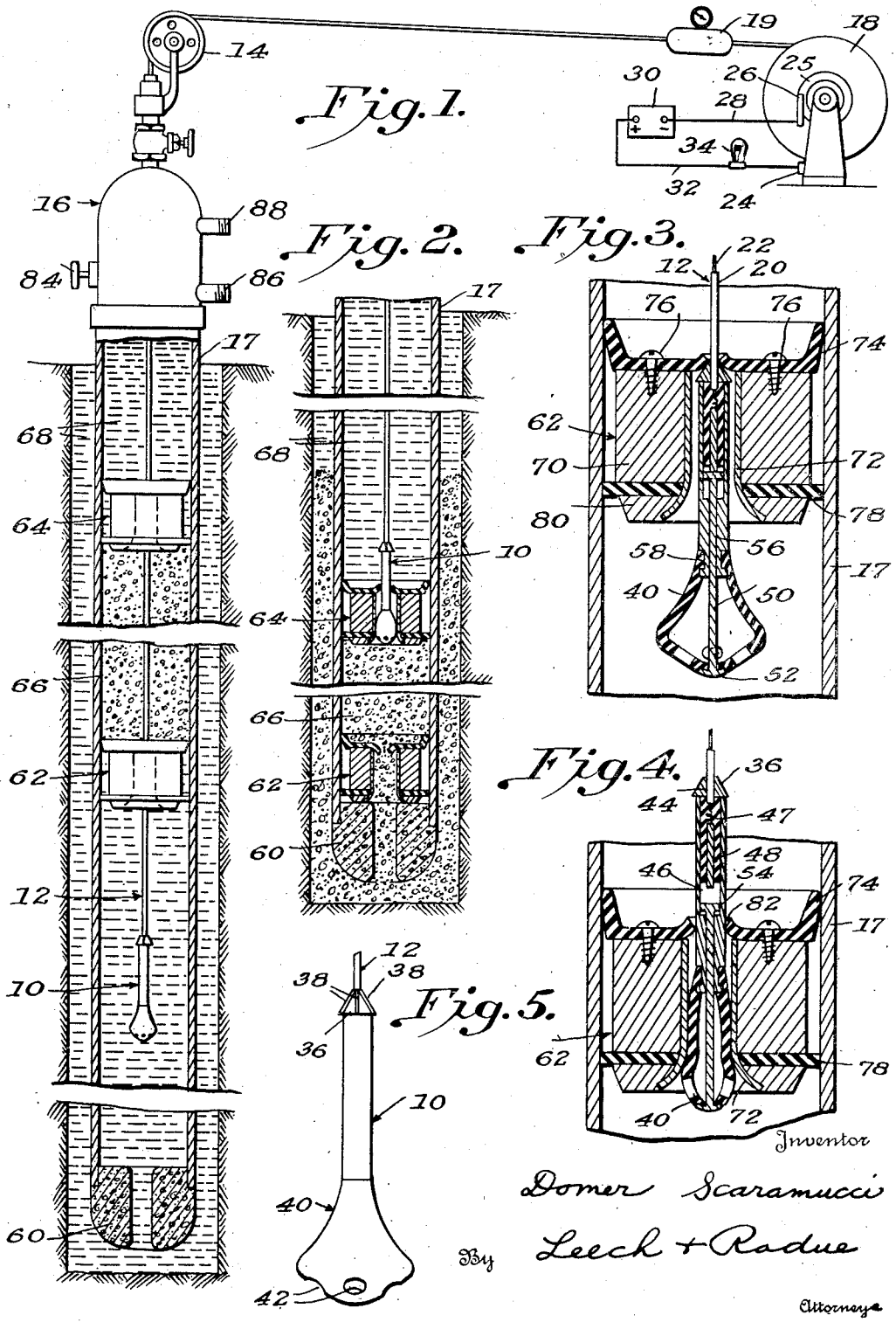
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APPARATUS FOR CEMENTING WELLS

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APPARATUS FOR CEMENTING WELLS

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This invention relates to an improved apparatus for cementing wells, and more particularly to the positioning of a cementing plug in an oil well and to means for facilitating such an operation.

In a co-pending application bearing Serial No. 281,976, and filed June 29, 1939, by this same applicant, an invention similar to the present one in its broader aspects has been described and claimed.

When an oil well is drilled, a casing is placed in the well hole so that there will be a small clearance between the outer side of the casing and the surrounding hole. Very often the hole will pass through strata containing considerable water before the oil bearing level is reached. In order to prevent such water from passing down the well outside of the casing to the oil bearing strata where it will mix in an objectionable manner with the oil, it is the practice to cement the well hole around the lower end of the casing. The cement extends sufficiently far above the lower end of the casing to prevent the downward passage of water. Owing to the depth of such wells, it has been a rather difficult problem to determine accurately the position of the cement therein. With the increase in depth of wells from several thousand feet up to fifteen thousand feet, the problem becomes more acute.

The practice hitherto has been to let a sounding weight and line down to the bottom of the well and to provide means for indicating when the cement slurry and the cementing plug, which is used to force it downwardly in the well, have arrived at a certain point. This has been determined either by the tension effect of the cement and plug as they pass over a determined part of the weight line, or by indicating and observing at the surface changes in the character of the well fluid at a certain point in the lower end of the well, and thus determining when the cement slurry has reached that point. The present invention, however, embodies distinct improvements in the practices which has been outlined.

Another method frequently used at present is to force the cement slurry into the well casing between two plug members and to follow the uppermost plug member with a sounding weight supported by a measuring line. The operator by alternately raising and lowering the weight on the uppermost plug is ordinarily able to detect the plug by the difference in apparent weight. Increase in the depth of wells and increase in the viscosity of the drilling mud have made this method of locating the plug quite haphazard. Furthermore, the length of the sounding weight line and the greater speed of pumping the cement into position also impair the accuracy of the method just outlined, depending as it does upon a measurement of the distance from the surface to the plug.

It is the principal object of this invention to provide a novel apparatus for accurately positioning a cementing plug with respect to the bottom or shoe of a well casing.

A further object of the invention is to provide a measuring line with novel means for signaling the arrival of a cementing plug to the position desired by the operator.

An additional object of the invention resides in the provision of apparatus which makes it unnecessary to follow the cementing plug with a measuring line, and thus enables the operator to pump the cement down the casing with maximum speed.

Among the specific objects of this invention, are the provision of a novel sounding weight provided with a cutting member and a contractible member for operating an electric switch, and a novel cementing plug construction having a portion shaped for cooperation with the cutting and switch-operating members.

The preceding and other features and advantages of the invention will be better understood and appreciated from a reading of the following detailed description of a specific embodiment in connection with the accompanying drawing, in which

Fig. 1 is a side elevation, partly in section, of an oil well and a casing therefor, which casing is provided with a shoe and a pair of cementing plugs spaced by a cement body; a measuring line and sounding weight together with means for handling the line are also shown in operative positions;

Fig. 2 is a partial longitudinal section similar to Fig. 1, but with the cementing plugs and cement in different positions relative to the casing and sounding weight;

Fig. 3 shows in enlarged, longitudinal section a cementing plug and its relation to the sounding weight and well casing;

Fig. 4 is similar to Fig. 3, except that the lower contractible end instead of the upper cutting end is within the weight; and

Fig. 5 is a side elevation of the weight itself.

As viewed in Fig. 1, the illustrative embodiment of the apparatus of this invention comprises an elongated sounding weight 10, the main body portion of which may be formed of brass or other

suitable material, a measuring or sounding line 12 supported by a guide pulley 14 mounted on a combined casing head and stuffing box 16, and a winding reel 18 for handling the line 12. A conventional form of linear measuring device 19 engages the line 12 just in advance of the reel 18, as shown.

The detailed section of Fig. 3 indicates the construction of the measuring line 12 and shows that it is composed of an outer metallic conductor 20, which makes contact with the metallic body portion of the weight 10, and a separate inner conductor 22, the cooperation of which with the weight 10 will be described.

The winding reel 18 is provided with a connector 24, and the outer conductor 20 is grounded through the reel to this connector. An insulated conductor ring 25 and connector 26 furnish an unbroken electrical path from the inner conductor 22 through a conducting lead 28 to a source of current 30, shown as a storage battery. The connector 24 is joined to the opposite side of the current source 30 by another conducting lead 32. An indicator of current flow in the circuit thus defined may be provided by inserting an electric lamp 34 in the line 32. Any suitable form of electric responsive indicator may be used at this point.

Referring to Fig. 5, it will be seen that the weight 10 has a conical top portion or cutting head member 36 through which the line 12 enters. A plurality of cutting edges 38 may be arranged circumferentially of the pointed head member 36 and extend as elements of the cone. At the lower end of the weight, a contractible member 40 is mounted and projects outwardly of said weight. As illustrated, the contractible and deformable member or portion 40 comprises a rubber bulb having a plurality of apertures 42 at its lower face in order to facilitate free contraction and expansion thereof under suitable pressure.

In the detailed sections of Figs. 3 and 4, it will be observed that the line 12 passes through a bore 44 in the conical head 36 so that the outer conductor 20 will make contact with the metallic body of the weight 10, through the head 36 which is also of brass or other suitable metal for the purpose. The upper end of the weight 10 is provided with a cylindrical chamber 46 into which is fitted a plug 47 of hard rubber insulating material having a centrally imbedded contact member 48 extending somewhat below its lower end and into the chamber 46. A metallic rod 50, having a head 52 securely connected to the bottom of the bulb member 40, extends centrally through the body portion of weight 10 and into the lower end of the chamber 46. The rod 50 has an integral head 54, of a diameter corresponding to the chamber 46, which engages the exposed end of the contact member 48 when the bulb 40 is in the uncontracted position of Fig. 3. Contraction of the bulb 40, in the manner of Fig. 4, pulls the rod 50 downwardly and separates its head 54 from the contact member 48, which is shown connected with the innermost conductor 22 of the line 12. It will be obvious, therefore, that the rod 50 sliding in engagement with a bore 56 formed in the lower part of the metallic body portion of the weight 10 will connect the inner and outer conductors 22 and 20 when its head engages the contact member 48. In this way, the rod 50 and contact member 48 provide a switch for bridging the conductors of the line 12. The lower end of the body portion of weight 10 has a circumferential groove 58 into which the upper end of the rubber bulb 40 is closely fitted.

Reverting to Figs. 1 and 2, note is now taken of the apertured shoe member 60 at the bottom end of the well casing 17. Above the shoe member 60, a lower cementing plug 62 and an upper cementing plug 64 are spaced from each other by the body of cement 66. In these two figures, 68 has been used to indicate water or drilling fluid which surrounds the casing 17 and is above and below the cementing plugs in the positions shown in Fig. 1.

The details of construction of the cementing plug 62 are illustrated in Figs. 3 and 4. Since the plug 64 is identical with plug 62, only the latter will be described. A cylindrical body member 70, preferably of wood, is provided with a longitudinal bore defined by a metallic lining 72 having a flared mouth on the lower side of the plug. The cylindrical body member 70 will be made somewhat smaller in diameter than the inside of the casing 17. On the top side of the plug body member 70, an upturned, skirted rubber washer 74 extends as a diaphragm over the plug bore and is secured in place by screw means 76, 76, which extend into the body member 70. A lower plug seal is provided in the form of a second rubber washer 78, which is held in place between the body member 70 and a thin block 80 of similar material, the sleeve 72 passing through the center of washer 78 and block 80. Attention is now called to a small, central aperture 82 in the upper washer 74 through which the line 12 is originally threaded. Fig. 4 shows the same aperture 82 in a much enlarged condition. It should be noted that all of the weight 10 except the outwardly projecting, contractible member 40 will slide loosely in the bores of the cementing plugs 62 and 64.

The operation of the novel apparatus which has been described will now be explained. As a preliminary to the cementing of the well which has been illustrated, the ordinary casing head will be removed and the combined stuffing box and casing head 16 will be installed in the manner shown in Fig. 1. Before the head 16 is attached to the casing 17, however, the upper cementing plug 64 will be threaded on the measuring line 12 which has been passed through the upper end of the said head, and the lower cementing plug 62 will also be similarly threaded. After this, the weight 10 will be secured to the free end of the line 12 with the outer conductor 20 in contact with the metal body portion of the weight and the inner conductor connected to the contact member 48. Next, the weight 10 will be lowered into the well casing 17 until it has reached the bottom thereof. The weight 10 will then be raised a predetermined and measured distance from the bottom or shoe 60 to the position illustrated in Figs. 1 and 2. The lower plug 62 is then let down the line 12 below the casing head, the upper plug 64 being releasably retained in any well known manner within the casing head 16, which is now attached. A rod 84, which is reciprocable transversely of the head 16, is indicated in Fig. 1 for this purpose. By means of an inlet pipe 86 near the bottom of the head 16, cement slurry in a desired amount, may now be pumped into the casing between plugs 62 and 64. After the desired amount of cement has been thus pumped, the upper cementing plug 64 will be released so as to engage the top of the cement body, and hydraulic pressure will be ap-

plied thereto by means of another inlet pipe 88 in an upper portion of the casing head 16.

As fluid is forced into the casing 17 through the inlet 88, the upper plug 64 will be forced downwardly in the casing, together with the cement body 66 and the lower plug 62. This downward movement will force any fluid below the plug 62, out through the shoe 60, and up into the space between the casing and the well. When the lower plug 62 arrives at the vertically stationary weight 10, it will be guided into the bore thereof by the flared mouth of the plug sleeve 40, and upon continued relative movement, the cutting head 36 will be drawn through the aperture 82 of the frangible diaphragm washer 44 so as to produce the enlargement, shown in Figs. 2 and 4. A very definite indication of the entrance of the bulb member 40 into the sleeve of the lower plug 62 will be obtained when the plug 40 has been contracted or deformed sufficiently to separate the head 54 from the contact member 48 and break the circuit of the lamp 34, which is at the surface. This indication or signal will be repeated when the upper cementing plug 28 passes over the stationary weight 10 in its downward journey and deforms bulb 40. When the operator receives the first signal, he will know the exact position of the cement body 66 and will be ready to stop the pumping of pressure fluid above the plug 64, as soon as that plug has reached its desired position. Up until the time the first signal is received, the cement slurry can be forced down the casing with maximum speed, so as to avoid initial setting, which would impair its final strength. The rupturing of the diaphragm washer 74 permits the weight 10 to pass through the plugs and opens the bottom plug for the passage of cement through the apertured shoe member 60 and up the outside of the casing into the required cementing position, indicated in Fig. 2.

It will be appreciated that the cement which is left in the casing, the shoe 60, and the plugs 62 and 64 will be drilled out after the cement has finally set.

With the present procedure, the only measurement which must be taken with the line 12 is the distance the weight is to be located above the bottom of the casing. While the distance of the weight from the top of the casing could be measured, considerations of accuracy and simplicity make the other measurement preferable.

The foregoing description of the preferred form of apparatus is illustrative, since it will be apparent to those familiar with this art, that variations and modifications can be made which will come within the scope of the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. Apparatus for cementing oil wells comprising, in combination, a measuring line, said line including a pair of electrical conductors, a weight having a cutting top portion and a contractible bottom portion attached to the end of the line, a switch within the weight and arranged to connect and disconnect the weight ends of the conductors, a plug having a longitudinal bore for receiving the measuring line and weight, said bore being of a diameter which will contract the bottom portion of the weight as it passes therethrough, and a frangible diaphragm attached to an end of the plug over the bore and provided with a small aperture for receiving the measuring line, and adapted to be enlarged by the cutting top portion of the weight as the plug passes thereover, said switch being connected to the contractible portion of the weight and arranged to be operated by the contraction and expansion thereof.

2. Apparatus for cementing oil wells comprising, in combination, a measuring line, said line including a pair of electrical conductors, a weight having a cutting top portion and a contractible bottom portion in the form of a rubber bulb attached to the end of the line, a switch within the weight and arranged to connect and disconnect the weight ends of the conductors, a plug having a longitudinal bore for receiving the measuring line and weight, said bore being of a diameter which will contract the bulb portion of the weight as it passes therethrough, and a frangible diaphragm attached to an end of the plug over the bore and provided with a small aperture for receiving the measuring line, and adapted to be enlarged by the cutting top portion of the weight as the plug passes thereover, said switch being connected to the bulb portion of the weight and arranged to be operated by the contraction and expansion thereof.

3. Apparatus for cementing oil wells comprising, in combination, a measuring line, said line including a pair of electrical conductors, a weight having a cutting top portion and an outwardly projecting, contractible bottom portion attached to the end of the line, a switch within the weight and arranged to connect and disconnect the weight ends of the conductors, a plug having a longitudinal bore with a flared mouth on the underside of the plug for receiving the measuring line and weight, said bore being of a diameter which will contract the bottom portion of the weight as it passes therethrough, and a rubber plug washer and diaphragm attached to an end of the plug over the bore and provided with a small aperture for receiving the measuring line, and adapted to be enlarged by the cutting top portion of the weight as the plug passes thereover, said switch being connected to the contractible portion of the weight so as to be operated by the contraction and expansion thereof.

4. Apparatus for cementing oil wells comprising, in combination, a measuring line, said line including a pair of electrical conductors, a weight having a cutting top portion and an outwardly projecting, contractible bottom portion in the form of an apertured rubber bulb attached to the end of the line, a switch within the weight and arranged to connect and disconnect the weight ends of the conductors, a pair of plugs each having a longitudinal bore with a flared mouth on the underside of the plug for receiving the measuring line and weight, said bores being of a diameter which will contract the bulb portion of the weight as it passes therethrough, and a diaphragm attached to an end of each plug over its bore and provided with a small aperture for receiving the measuring line, and adapted to be enlarged by the cutting top portion of the weight as the plug passes thereover, said switch being connected to the bulb portion of the weight and arranged to be operated by the contraction and expansion thereof.

5. Apparatus for cementing oil wells which comprises plug means for forcing cementing material downwardly of the well casing, a measuring line including a pair of separate electrical conductors, a weight secured to the line and provided with a resilient portion which is adapted

to be contracted when the plug means comes into engagement with it, and a switch associated with the weight and connected to the resilient portion so as to be operated by contraction of said portion.

6. Apparatus for cementing oil wells which comprises plug means for forcing cementing material downwardly of the well casing, a measuring line including a pair of separate electrical conductors, a weight secured to the line and provided with a resilient bulb portion which is adapted to be contracted when the plug means comes into engagement with it, and a switch associated with the weight and connected to the resilient portion so as to be operated by contraction of said bulb portion.

7. Apparatus for cementing oil wells which comprises plug means for forcing cementing material downwardly of the well casing, a measuring line including a pair of separate electrical conductors, a weight secured to the line and provided with an apertured rubber bulb portion which is adapted to be contracted when the plug means comes into engagement with it, and a switch across the conductors and associated with the weight, said switch being connected to the resilient portion so as to be operated by contraction of said bulb portion.

8. Apparatus for cementing oil wells which comprises plug means for forcing cementing material downwardly of the well casing, a measuring line including a pair of separate electrical conductors, a metallic weight secured to the line and provided with a resilient portion which is adapted to be contracted when the plug means comes into engagement with it, and a switch associated with the weight so as to bridge the conductors and connected to the resilient portion so as to be operated by contraction thereof.

9. The combination comprising a line, an elongated metallic weight attached to an end of the line so as to hang vertically, said weight having a contractible, outwardly projecting member adjacent its bottom end, said contractible member being a hollow bulb of resilient maaterial, and an electric switch carried by the weight, said switch being connected to the projecting member and arranged to be operated by contraction thereof.

10. The combination comprising a line, an elongated weight attached to an end of the line so as to hang vertically, a contractible, outwardly projecting member secured to the bottom end of said weight, said contractible member being a hollow bulb of resilient material having apertures therein, and an electric switch carried by the weight, said switch being connected to the projecting member and arranged to be operated by contraction thereof.

11. A measuring line weight of elongated form and having a pointed top portion provided with cutting means, an outwardly projecting portion of resilient material secured to the weight below its top portion, and switch means carried by the weight and arranged to be operated by deformation of the resilient projecting portion.

12. The combination comprising a line, an elongated metallic weight attached to an end of the line so as to hang vertically, a contractible, outwardly projecting member secured to the bottom end of said weight, said contractible member being a hollow bulb of resilient material, and an electric switch carried by the weight, said switch including a sliding member connected to the projecting member and arranged to operate the switch in response to contraction of said projecting member.

13. The combination comprising a line which includes a pair of separate conductors, an elongated metallic weight having a chamber therein attached to an end of the line so as to hang vertically and make electrical contact with one conductor, a contractible, outwardly projecting member secured to the bottom end of said weight, said contractible member being a hollow bulb of resilient material, and an electric switch within the chamber of the weight, said switch including a contact member which is connected to the other of the conductors but insulated from the weight and a sliding metal rod aligned with the contact member and in contact with the weight and connected to the contractible projecting member for making and breaking a circuit through the contact member as the projecting member is permitted to expand or caused to contract.

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