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WATER INTRUSION LOCATION IN OIL WELLS

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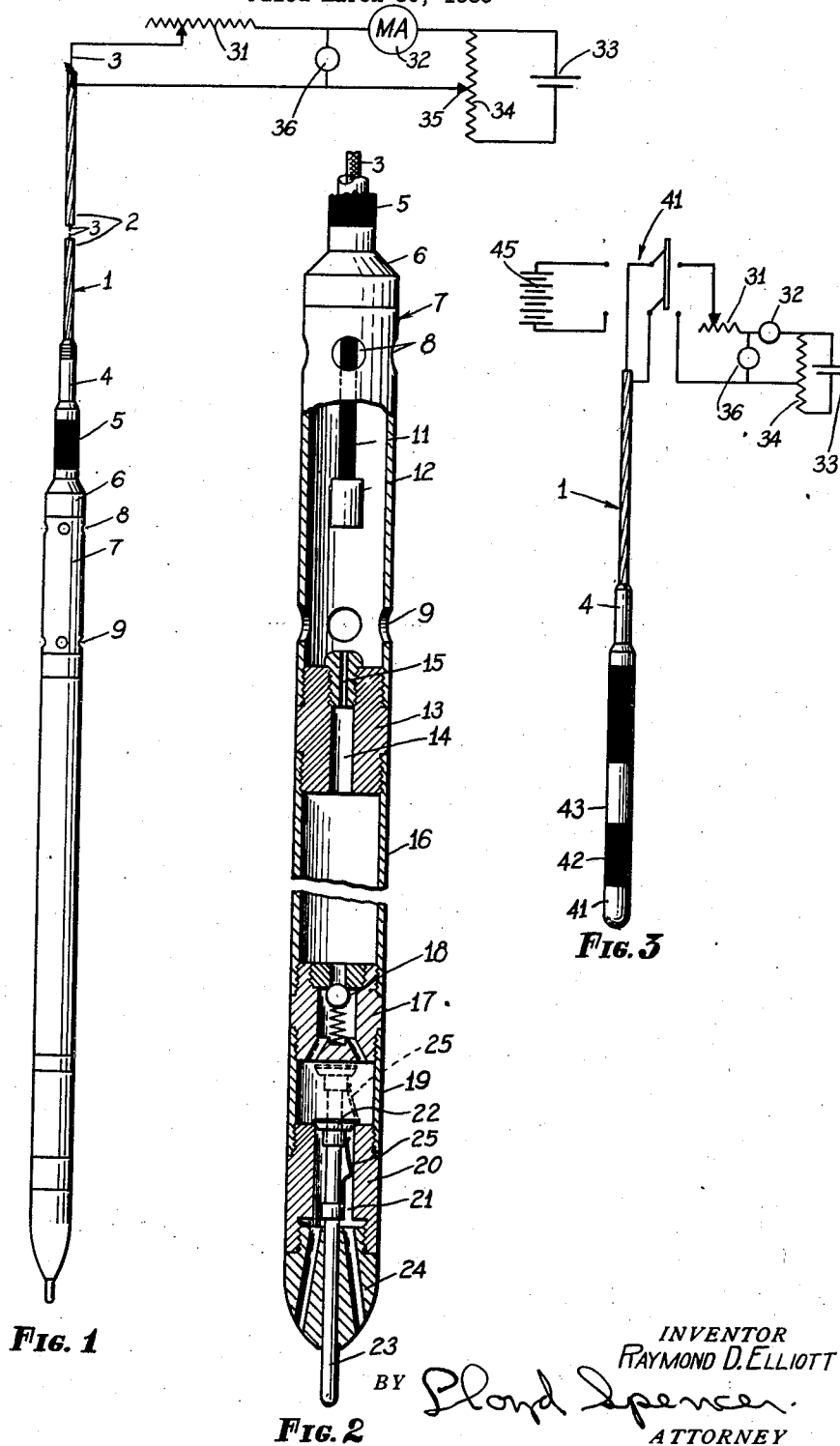


FIG. 1

FIG. 2

FIG. 3

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WATER INTRUSION LOCATION IN OIL
WELLS

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My invention relates to water intrusion loca-
tion in oil wells, that is, to a method and ap-
paratus for locating the point at which water is
entering oil wells so that steps may be taken
to correct or stop the intrusion of water. Among
the objects of my invention are:

First, to provide a method and apparatus of
this character which may be employed while the
well is flowing, or under any condition, either
in a flowing or non-flowing well, in which the
formation pressure of the water-bearing strata
in question at the time of testing is greater than
the hydrostatic head within the well-bore.

Second, to provide a method and apparatus of
this character which eliminates extensive and
time-consuming preliminary operations formerly
required to condition a well in order to
make a test of water intrusion;

Third, to provide a method of this character
wherein only a small quantity of conditioning
material applied only in the zone in question
need be introduced into the well fluid, the quan-
tity of conditioning material being sufficiently
small that it may be contained in a baller or
other suitable device attached to the measur-
ing electrode and lowered therewith on an elec-
tric cable into the zone to be investigated;

Fourth, to provide a method and apparatus
of this character wherein only one round-trip of
the apparatus need be made, that is, it is merely
necessary to lower the electrodes and condition-
ing material into the zone to be treated, move
the electrode assembly through said zone only
a few times to obtain several records for check,
one against the other, then withdraw the appa-
ratus from the well;

Fifth, to provide a method and apparatus of
this character wherein, if desired, several tests
may be run in sequence, either to investigate
the same or different sections of the well-bore,
without reconditioning or otherwise re-treating
the well between tests; and

Sixth, to provide a method of this character
which employs to an advantage certain condi-
tions heretofore existing as a detriment in the
former methods of investigating or detecting
points of water entry into an oil well.

With the above and other objects in view, as
will appear hereinafter, reference is made to the
accompanying drawing, in which:

Figure 1 is essentially a diagrammatical view
of the apparatus employed;

Figure 2 is an enlarged fragmentary longitu-
dinal sectional view of the apparatus lowered

within the well-bore taken substantially through
2-2 of Figure 1; and

Figure 3 is a diagrammatical view of a modi-
fied form of the apparatus.

The apparatus employed in my invention in-
cludes a cable 1 preferably comprising a weight-
supporting sheath 2 and a single conductor 3.
The lower end of the cable is provided with a
cable head 4 connected through a link 5 (prefer-
ably covered with insulation) to a fitting 6. The
fitting 6 is screwthreaded to one end of a
sleeve 7 of uniform diameter and having circu-
lation ports 8 and 9 at its upper and lower ends
respectively.

Supported within the sleeve, on an insulated
stem 11, is an electrode 12, preferably centrally
disposed with respect to the ends of the sleeve 7
and electrically associated with the conductor 3
of the cable. The sleeve 7 is electrically asso-
ciated with the sheath 2 of the cable.

The lower end of the sleeve 7 is attached to
a nipple 13 having a bore 14 therein controlled
by a suitable valve 15 having an aperture of
predetermined area. The lower end of the nipple
13 is screwthreaded into a shell 16 which, in
turn, is secured to a check valve housing 17
which carries a check valve 18 adapted to permit
downward flow of fluid through the shell 16, but
to prevent upward flow therethrough. The check
valve housing 17 is connected by a coupling 19
to a trip valve housing 20 which is provided with
a bore 21 therethrough, controlled by a trip
valve 22 normally tending to prevent downward
flow of fluid through the bore 21. The trip valve
22 is provided with a stem 23 which extends
through and protrudes beyond a nose piece 24
attached to the lower end of the valve housing
20. The stem 23 is provided with suitable latch
means 25 so that when forced upwardly a pre-
determined distance the latch means prevents
return movement of the valve 22, as shown by
dotted lines in Figure 2.

The conductor 3 is connected, through a vari-
able resistance 31 and milliammeter 32, to the
negative side of a battery 33. The battery 33
is bridged by a resistor 34 having an adjustable
tap 35 connected with the sheath 2 of the cable.
A voltmeter 36 is connected across the conductor
3 and sheath 2, preferably beyond the resistor
31. The milliammeter is preferably associated
in a conventional manner with a recording me-
chanism so as to measure variations in the cur-
rent flowing between the electrode 12 and sheath
7, and associated metal parts 6 and 13.

My method of locating water intrusion is as

follows: First, if the well is not flowing, fluid is removed from the well by bailing, or otherwise, to create a lower hydrostatic head in the well than exists in water-producing stratum. The shell 16 is filled with a suitable oxidizing agent, such as ferric chloride, potassium permanganate or sodium hypochlorite. It is preferred not to have too active an oxidizing agent, but one which exhibits a low oxidation potential under the temperatures of operation, it being borne in mind that the well temperatures may reach as high as the boiling point of water. The apparatus, as shown in Figure 1, is lowered to a point opposite the region under investigation, usually to the bottom of the well. When the apparatus is set on bottom the stem 23 is forced upwardly, opening the valve 22 so that as the apparatus is drawn upwardly the ferric chloride, or other oxidizing agent, may drain out at a predetermined rate from the shell 16, it being noted that the check valve 18 is responsive to the slight differential pressure. Ferric chloride has a melting point at approximately 98° Fahrenheit; it may, therefore, be introduced as a solid and permitted to dissolve or mix with the water as it enters. After the region in question has been treated with the oxidizing agent, by reason of its discharge into the well fluid through openings in the end plug 24, the apparatus is again lowered. Any movement of the apparatus, of course, causes flow of fluid through the interior of the sleeve 7 around the electrode 12. The electrode 12 is connected to the negative side of the circuit; consequently there is a tendency for particles of hydrogen gas to collect on its surface, causing what is known as a polarizing effect which, as the effective surface is diminished by reason of the presence of the hydrogen bubbles, increases the resistance of the circuit. The presence of the oxidizing agent in the well fluid, however, tends to prevent the accumulation of the hydrogen bubbles, that is, tends to depolarize the electrode 12. However, the treated region of the well is being continually diluted by the intrusion of the water to be detected. By reason of such dilution, the oxidizing agent is less effective opposite the point of water entry, and this decreasing effect is readily ascertained by change in the current flowing in the circuit. Several runs past the area so affected by water intrusion may be made.

It is preferred to use stainless steel or other non-corroding material for the electrode 12. It is not necessary that the fitting 6, sleeve 7 or nipple 13 be connected to the return side of the circuit; a second electrode positioned above the insulated section 5 may be used, or the cable sheath itself may suffice. Still further, the return side may be the casing lining the well-bore. The electrode 12 is preferably quite small in area; an area of approximately two square inches has been found satisfactory. Also, it is preferred to use quite low voltages to avoid excessive decomposition of the electrolyte in the water column; voltages below 1.7 are preferred. Also, a very low current is preferably employed, 30 to 400 microamperes being found satisfactory. A comparatively small quantity of oxidizing agent is sufficient to treat a relatively long section of casing; for example, about 5 pounds of ferric chloride (solid) is sufficient to treat 200 feet of 6 5/8" casing.

In some instances it is not necessary to carry a quantity of electrolyte in the apparatus associated with the electrode; if sodium chloride is

present in the well-bore, it may be decomposed electrically to liberate a chlorine oxidizing agent suitable for the purposes of my method. An arrangement to accomplish this is shown in Figure 3. In this arrangement a large graphite negative electrode 41 corresponding to electrode 12 is provided, separated by insulation 42 from a positive electrode 43, both suspended from the cable 1, the negative electrode 41 being connected to the conductor 3, while the positive electrode 43 is connected to the sheath 2. At the surface a circuit such as shown in Figure 1 is provided, except that there is interposed between the cable and such circuit a double pole, double throw-switch 44 which may be connected to a direct current source 45 of greater potential. In operation, the electrode assembly is moved through the region to be investigated while the switch 44 is connected to the source of high direct current, so that the electrolyte, such as salt water, within the well-bore, is decomposed and an oxidizing agent, namely, free chlorine, is released. The switch 44 is then connected to the measuring circuit and while the chlorine is active the test is made. Of course, in such event there will be a drift, or gradual over-all decrease in its effectiveness as the free chlorine re-combines, nevertheless superposed on such change will be that change due to the inflow of water.

In other words, the oxidizing agent may be either carried down with the electrodes or generated in situ; in either case the oxidizing agent is established in the fluid just prior to making the test. By reason of the fact that there is always present in the oil well material with which the oxidizing agent will combine, a time interval varying from a few minutes to a few hours, depending on the oxidizing agent employed, may be sufficient for the oxidizing agent to combine and restore conditions as they existed before the test. Consequently, repeated tests may be made without special preparation between tests.

Various changes and alternate arrangements may be made within the scope of the appended claims, in which it is my intention to claim all novelty inherent in the invention as broadly as the prior art permits.

I claim:

1. A method of detecting the point of intrusion of a fluid into a well-bore, characterized by: providing an oxidizing agent in the well fluids throughout the region to be tested; moving an electrode through said region while applying direct current thereto; and measuring polarization effects on said electrode as said oxidizing agent becomes diluted with incoming fluids.

2. A method of detecting the point of entry into a well, of liquids having electrolytic properties, characterized by: providing throughout the region to be tested, an oxidizing agent in the liquids contained in the well; moving an electrode through said region while applying a negative potential thereto; and measuring the changes in polarization at said electrode as the oxidizing agent becomes diluted with incoming liquid.

3. A method of detecting the point of entry into a flowing well, of liquids having electrolytic properties, characterized by: establishing a distribution of an oxidizing agent throughout the region to be tested; immediately, during the active period of said oxidizing agent, moving an electrode through said region while applying a negative potential thereto; and measuring the polarization effect on said electrode as changed

by dilution of said oxidizing agent by the liquids entering the well.

4. A method of detecting the point of entry of a fluid into a well wherein the liquid within the well exhibits electrolytic properties, characterized by: conditioning the well liquid throughout the region to be tested with an oxidizing agent capable of inhibiting polarization of an electrode subject to a negative potential; moving such electrode through said region while subjected to a negative potential; and measuring changes in an electrical circuit incorporating said electrode as induced by changes in polarization of said electrode due to dilution of the oxidizing agent by incoming liquids.

5. A method, as set forth in claim 4, wherein the oxidizing agent is lowered simultaneously with said electrode to the region to be tested, distributed throughout said region, and said electrode immediately employed while said oxidizing agent is active.

6. A method, as set forth in claim 4, wherein said oxidizing agent is generated by electrolysis of the well fluid caused by application of substantial direct current thereto, and said electrode is employed immediately following such application of direct current and during the active period of said oxidizing agent.

7. A method of detecting water intrusion in an oil well, characterized by: conditioning the region to be investigated with an oxidizing agent; moving an electrode subject to a negative potential through said region during the active period of said oxidizing agent with such potential below 1.7 volts; and measuring changes in the circuit associated with said electrode caused by changes in polarization of said electrode as said oxidizing agent is diluted by incoming water.

8. A method, as set forth in claim 7, wherein said region is conditioned by an oxidizing chemical lowered into said region simultaneously with said electrode and distributed therein immediately prior to conducting the test.

9. A method, as set forth in claim 7, wherein the electrolyte within the well-bore is subjected to active electrolysis to generate an oxidizing agent in said region immediately prior to conducting said test.

10. An apparatus for locating the point of water entry into a well-bore, comprising: a distributing bailer and an electrode suspended from a cable; means for operating said bailer to distribute its contents along a predetermined region of said well-bore; an electrical circuit for said electrode to establish a negative potential; and means in said circuit for measuring variations in said circuit caused by changes in polarization of said electrode.

11. An apparatus for locating the point of water entry into a well-bore, comprising: an electrode assembly; a cable for lowering said assembly into a well; a charging circuit associated with said electrode assembly adapted to generate by electrolysis an oxidizing agent from the electrolyte within the well-bore as said electrode assembly is moved along the region to be investigated; and a measuring circuit adapted to be employed immediately following generation of said oxidizing agent, for detecting changes in the polarization effect on said electrode.

12. A method of detecting the point of entry into a well, of liquids having electrolytic properties, characterized by: introducing into the region to be tested an initially solid oxidizing agent having a melting point below the temperature of said region; distributing said agent through said region as it melts; and thereafter during the active period of said oxidizing agent, moving an electrode through said region while subjected to a negative potential; and measuring the polarizing effect on said electrode as incoming liquids dilute said oxidizing agent.

13. A method of detecting the point of entry into a well, of liquids having electrolytic properties, characterized by: introducing into the region to be tested a solid oxidizing agent soluble in the fluids present in said region; distributing said agent through said region as it dissolves; and thereafter during the active period of said oxidizing agent, moving an electrode through said region while subjected to a negative potential; and measuring the polarizing effect on said electrode as incoming liquids dilute said oxidizing agent.

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