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WELL CASING PROTECTED AGAINST ELECTROLYTIC ACTION

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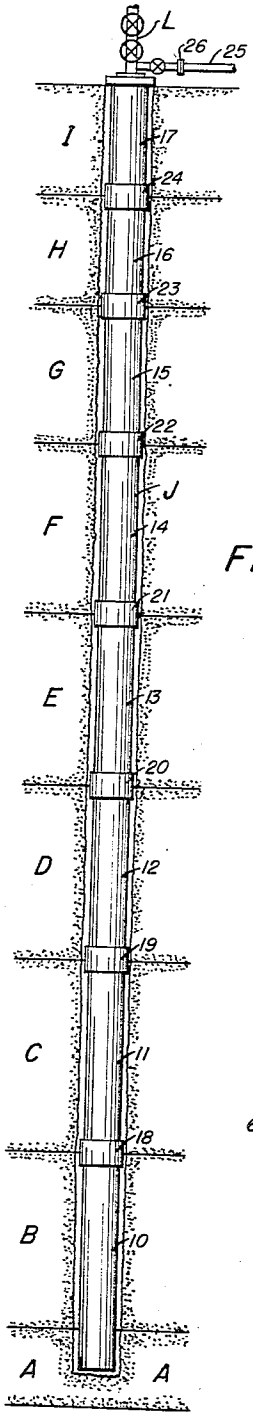


FIG. 1.

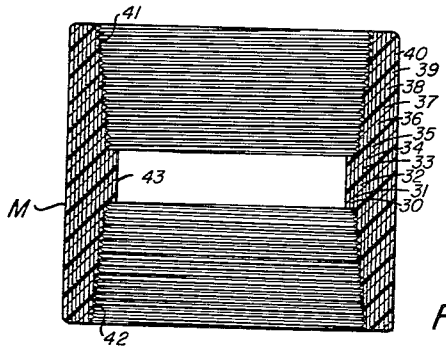


FIG. 2.

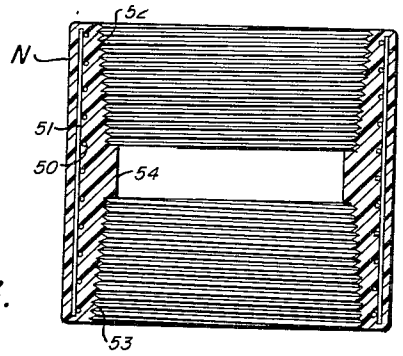


FIG. 3.

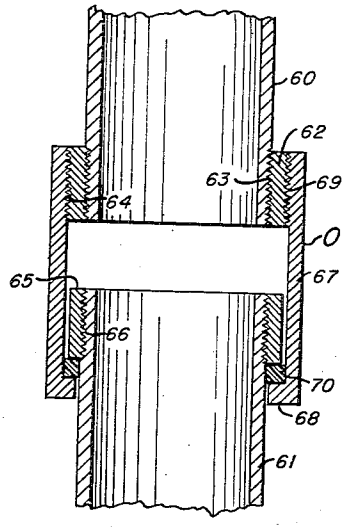


FIG. 4.

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WELL CASING PROTECTED AGAINST ELECTROLYTIC ACTION

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10 Claims. (Cl. 166—46)

The present invention is directed to a well casing protected against electrolytic corrosion.

In the production of fluids from subsurface formations such as the production of oil or gas, it is conventional to line the borehole with a string of pipe generally termed the casing which is permanently anchored into position, as by cementing and remains in the hole during the life of the well. Stray electrical currents when leaving the metal casing through conductive soil or other means cause a dissolution of the metal at a rate which is directly proportional to the quantity of electrical current leaving the conductor. In the well these currents may be subsurface currents which cannot be detected at the surface and yet which may cause electrolytic corrosion at a rapid rate. For example, in a deep well the current may pass from the formation to the casing at a depth of 5000 feet and may leave it at a depth of 3000 feet, this action causing rapid corrosion of the casing and the fact that such action is going on not detected at the surface until the casing actually develops a leak.

The present invention is directed to a method for casing a well to reduce substantially or eliminate electrolytic corrosion.

In accordance with the present invention, the metal pipe, almost universally steel, used for casing the well is made up in sections each consisting of a number of joints of the metal pipe with the joints secured together with the usual like metal couplings. These sections are made up in the desired lengths, these lengths preferably corresponding to the sections of formation between which are differences in potential. The ends of adjacent sections are secured together by the use of insulating couplings which join the sections into a complete fluid-tight casing and at the same time electrically insulate the adjacent sections from each other.

As is well known, the sedimentary formations through which the borehole penetrates in making a well may indicate differences of potential when passing from one formation to another. Sections of like formations, such as shale or sand stone or lime stone, may be of considerable depth such as in the range of 100 feet to 1000 feet and the character of the formation may then change. The differences in the potential when passing from one formation to another may be determined by electrically logging the borehole. In a field where there as a number of adjacent wells, correlations can be made from one well to another so that if the differences in potential are known for one or more typical wells, it is not necessary to log electrically every well in order to be able to predict the depth at which a change in potential may be expected to take place. In any event, the sections of pipe made up of lengths of metal pipe secured together by the usual like metal couplings may be made in lengths to correspond quite precisely to the sections of formation of substantially constant potential with insulating couplings securing together the ends of adjacent sections while insulating electrically said sections being located at the point where the natural differences of potential in the borehole exist. In many instances good results are obtained if instead of locating precisely points where the differences of potential exist the insulating couplings are used at selected uniform intervals to connect together the sections of metal pipe made up of joints of pipe secured together by metal couplings. For example, if the well has a depth of 7000 feet, the complete casing may be formed from sections 500 feet long with adjacent ends of sections secured together by insulating couplings which electrically insulate the sections from each other and the electrolytic corrosion in the casing substantially reduced.

The invention will now be described more fully in conjunction with the drawing in which

Fig. 1 is in the form of an elevation, partly in section, illustrating a completed well in accordance with the present invention;

Fig. 2 is in the form of an elevation, partly in section, showing a coupling of the type which may be used in the well shown by Fig. 1;

Fig. 3 is in the form of an elevation, partly in section, showing another design of coupling which may be used in the well of Fig. 1; and,

Fig. 4 is still another embodiment, partly in section, of a coupling which may be used in the well as shown in Fig. 1.

Turning specifically to the drawing and first to Fig. 1, this figure is in the form of an elevation, partly in cross section, showing a well penetrating to a producing formation A. The earth formations above the producing formation A between which differences of natural potential have been determined to exist, as by electrical logging of the borehole are shown as formations B, C, D, E, F, G, H, and I. The well is cased by a string of casing J surmounted at the top by a wellhead L.

The string of casing J is made up of sections 10, 11, 12, 13, 14, 15, 16, and 17, the ends of the adjacent sections being secured together respectively by insulating couplings 18, 19, 20, 21, 22, 23, and 24. In accordance with the usual practice, the wellhead L may be connected to a string of flow line 25. Flow line 25 may be connected to the wellhead through an insulating conductor 26 in order to reduce or eliminate electrolytic corrosion caused by surface currents. It is to be understood, however, that the use of insulating coupling 26 would not suppress electrolytic corrosion by underground currents which would not be indicated at the surface and that the insulating couplings 18 through 24 as described are for the purpose of reducing or eliminating electrolytic corrosion caused by such underground currents.

Figs. 2 and 3 are in the form of elevations, partly in section, illustrating forms of high strength insulating couplings which may be used to secure together the sections of pipe, said sections of pipe being made up of lengths of metal pipe secured together by metal couplings. In the embodiment shown in Fig. 2, coupling M is reinforced by cross laminations of fiber glass 30, 31, 32, 33, 34, 35, 36, 37, 38, 39 and 40. The remainder of the coupling may be a high strength insulating material such as a polyester plastic, the coupling being machined to provide screw threads 41 and 42 at the ends thereof for engaging corresponding screw threads at the upper and lower ends respectively of the sections of pipe held together by coupling M. Between threads 41 and 42 coupling M is provided with an inwardly projecting circular shoulder 43 which insures positively that the adjacent ends of sections of pipe connected together by coupling M are electrically insulated.

In Fig. 3 coupling N is provided with reinforcements 50 and 51 in the form of square mesh wire, the remainder of the coupling being a high tensile strength plastic and provided with threads 52 and 53 at its upper and lower ends respectively to engage with the upper and lower ends of sections of pipe made up of metal joints of pipe with their ends secured together by metal couplings. As seen, threads 52 and 53 are separated by ring 54 which assures positively that the ends of the sections of pipe connected by coupling N are electrically insulated from each other.

Another arrangement for securing together sections of casing is shown in Fig. 4. In this embodiment the upper and lower ends respectively of sections of the casing are shown and designated 60 and 61. It will be understood that end 60 represents the lower end of a section made up of a number of joints of metallic pipe with the ends fastened together by screwed couplings and similarly 61 represents the upper end of a section of casing made up of a number of joints with the adjacent joints secured together by screwed metal couplings. The assembly 0 which physically connects the sections 60 and 61 while insulating them electrically consists of a ring member 62 provided with inner threads 63 and outer threads 64, the threads 63 engaging with corresponding threads at the lower end of section 60. A ring 65 having its inner surface provided with threads 66 is secured to the threads at the upper end of section 61. A ring member 67 has its lower end provided with an inwardly projecting circular shoulder 68 and the inner surface of its upper end provided with screw threads 69 engaging with the corresponding screw threads of ring member 62. Between inwardly projecting circular shoulder 68 and ring member 65 is arranged a ring 70 of insulating material.

The assembly of Fig. 4 may be readily secured to a section of pipe by first slipping member 67 and ring 70 over the end of section 61 so that the screw thread 66 remains exposed, then screwing ring 65 on to section 61 and ring 62 on to section 60 and finally screwing the upper end of member 67 to ring 62. It is an advantage that the insulating material remains under compression, since, in general, the insulating materials commonly available have considerably greater resistance to compression loads than to tensile loads. The embodiment of Fig. 4 takes advantage of this characteristic.

While Figs. 2, 3, and 4 show specific examples of insulating couplings, it is to be understood that any suitable insulating coupling which serves to connect mechanically the ends of adjacent sections of pipe and while electrically insulating these connected sections may be employed. As specific examples of suitable insulating materials may be mentioned reinforced polyester plastics. When these polyester plastics are laminated with fiber, they may be produced with tensile strength equivalent to that of the common steels and of adequate structural strength for casing boreholes.

The expression polyester plastic has been accepted by the plastics industry to describe a group of thermosetting alkyd resins dissolved in a polymerizable vehicle, such as styrene. These resins are characterized by the presence of unsaturated carbon to carbon bonds and are capable of undergoing polymerization during cure without the liberation of water. These resins involve the action of a polyhydroxy alcohol with a polybasic acid. The polybasic acids most frequently used are maleic, fumaric, itaconic, and phthalic and the alcohols most frequently used are allyl alcohol, ethylene glycol and diethylene glycol, while the polymerizable vehicle usually is styrene or cyclopentadiene. These plastics may be readily reinforced by the use of paper, nylon, cordage fibers, asbestos and fibrous glass and by lamination or reinforcement with such materials. Insulating couplings may be obtained with the requisite high strength physical characteristics required.

While specific examples have been given to illustrate the practice of the present invention, it is to be understood that these examples are given by way of illustration only and not by way of limitation.

The invention claimed is:

1. A method for casing a borehole, penetrating through a plurality of subsurface formations which comprises the steps of logging said borehole to determine points where a difference of potential exists between adjacent formations, making up sections of casing consisting of lengths of metal pipe with the ends of the pipe secured together by metal couplings, securing together adjacent ends of sections of pipe by electrically insulated couplings which mechanically secure adjacent ends of sections while electrically insulating said sections, lowering into the well the complete casing made up of the sections of pipe with ends connected together by insulating couplings, positioning and permanently anchoring said complete casing in the well with the insulating couplings at said points between formations where said difference of potential exists.

2. For use in a completed well in which a substantially vertical bore-hole penetrates through a plurality of formations with differences in potential from one formation to another, a well casing permanently anchored within said borehole, said complete casing being made up of sections of casing under tension, each section consisting of a number of lengths of steel pipe with ends secured together by steel couplings with the ends of sections mechanically secured together by insulating couplings consisting essentially of high tensile strength plastic which electrically insulate said sections of pipe between points where there are differences of potential between formations penetrated by the borehole and which have a tensile strength equivalent to that of said steel such that the structural strengh of said casing is adequate.

3. A well casing in accordance with claim 2 in which the insulating couplings are internally reinforced.

4. A well casing in accordance with claim 2 in which the insulating couplings are internally reinforced with fiber glass.

5. A well casing in accordance with claim 2 in which the insulating couplings are internally reinforced with wire.

6. An electrically insulating coupling for use in joining vertical lengths of steel pipe together which consists essentially of a high tensile strength plastic coupling member having internal spaced apart screw threads and provided with an inwardly projecting shoulder between the spaced part screw threads for maintaining adjacent ends of lengths of said pipe joined together with said coupling member in spaced apart and electrically insulated relationship, said coupling member having a tensile strength equivalent to that of said steel.

7. A coupling in accordance with claim 6 in which the coupling member is internally reinforced.

8. A coupling in accordance with claim 2 in which the coupling member is internally reinforced with fiber glass.

9. A coupling in accordance with claim 2 in which the coupling member is internally reinforced with wire.

10. An electrically insulating coupling for use in joining vertical lengths of steel pipe together which consists essentially of a high tensile strength plastic coupling member having internal spaced apart screw threads and provided with an inwardly projecting shoulder between the spaced apart screw threads for maintaining adjacent ends of lengths of said pipe joined together with said coupling member in spaced apart and electrically insulated relationship, said coupling member being internally reinforced with laminations of fiber glass, said coupling member having a tensile strength equivalent to that of said steel.

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