June 5, 1945. M. M. KINLEY 2,377,501

FLUID INFLUX INDICATOR

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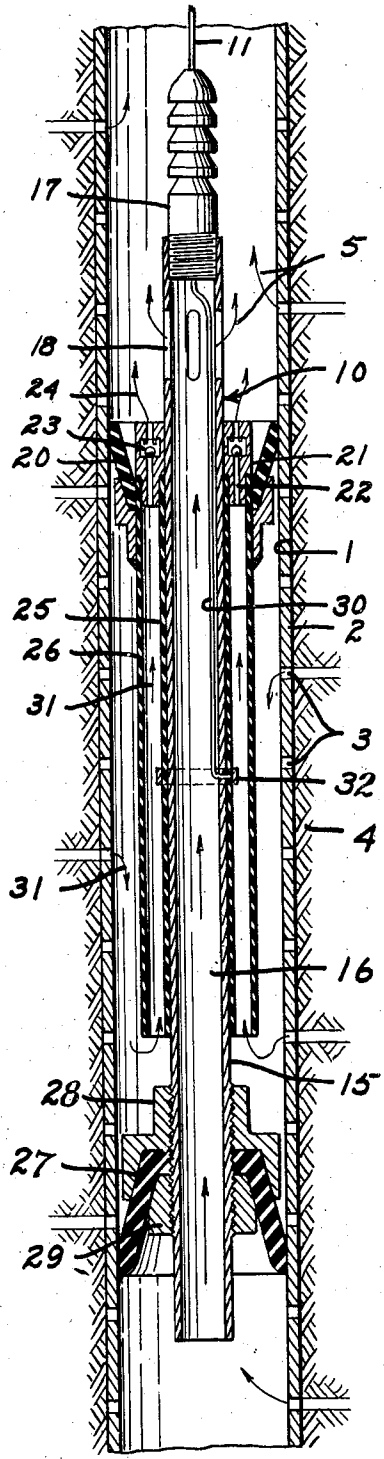



Fig. 1.

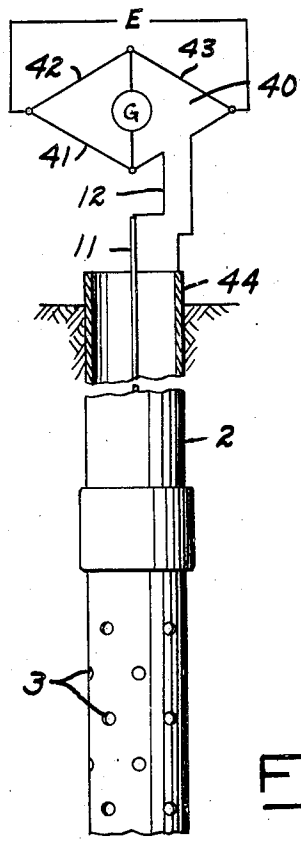



Fig. 2.

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## FLUID INFLUX INDICATOR

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3 Claims. (Cl. 175—182)

This invention relates to apparatus for locating the area or areas of fluid influx to wells and the nature of such influx at the different levels within such area or areas.

In deep wells production is usually effected by use of a screen or perforated casing so that formation fluids may enter the well bore and flow therefrom under formation pressures or by virtue of suitable pumping mechanism lowered within the well. Often the screen or perforated section is of considerable axial extent or there may be relatively widely spaced perforated or screen sections for production from a single stratum or a plurality of strata.

Frequently encroaching or unwanted fluids enter the well bore, as for example where salt water enters and is produced with the oil. In such cases it is necessary to separate the salt water from the oil and to dispose of such salt water in any suitable manner. Similarly, in event a supply of fresh water is desired, the influx of salt water may contaminate the fresh water entering the well bore. In either event it is desirable to ascertain the exact location and the nature of the fluids entering the well so that necessary steps such as squeeze cementing, pack offs, etc. may be taken to control the influx of undesired formation fluids. At the same time, it is desirable that the method and apparatus used for locating the level of influx of the various fluids shall not impede the flow of the fluids in the well bore.

It is the primary object of the present invention to determine the location of influx to the various fluids in a well bore and the nature of the fluids entering the wells at various levels throughout the area of influx.

Another object is to segregate an area within a well and to determine the nature of fluids entering the well through such area.

A more specific object is to provide an assembly which will segregate an area and obtain an indication of the nature of the fluids entering such area but which device will at the same time permit continued flow of fluids longitudinally of the well including those fluids which enter through the segregated area.

Still another object is to provide novel apparatus for determining at different levels in a well the nature of entering fluids by determining an electrical characteristic of the fluids entering at such levels.

The foregoing objects, together with additional objects, will be more fully apparent from a consideration of the following description taken in connection with the accompanying drawing in which:

Fig. 1 is a sectional view through a portion of a well in which there is positioned a device embodying the invention;

Fig. 2 is a diagrammatic view showing a manner of obtaining the desired electrical measurements.

In Fig. 1 of the drawing the device embodying the invention is positioned within a well bore 1 provided with a screen 2 having a plurality of openings 3 to permit fluids from the surrounding formation 4 to enter and to rise within the well as indicated by the arrows 5. The fluids entering the well bore may include mixed gaseous and liquid constituents and frequently it is desired to ascertain the exact point or points of entry of the respective fluids so that, as already indicated, necessary steps may be taken to enhance economy of production and conservation of the desired fluids. To this end the invention comprehends an assembly 10 to be lowered on a conductor cable 11 containing one or more insulated conductors 12 so that desired electrical measurements can be made in the manner and for the purposes appearing hereinafter.

The assembly 10 comprises an elongated hollow or tubular body member 15 having a longitudinal bore 16 which is closed at its upper end by means of a plug or head member 17 to which the lowering cable is secured. Closely adjacent the plug 17 are a plurality of openings 18 in the member 15 so that fluids entering the well below the assembly 10 can rise freely within the well bore regardless of the presence of the assembly 10 therein.

Below the openings 18 there is provided a packer assembly 20 about the member 15, such packer serving to provide a seal between the member and the walls of the surrounding screen 2. This packer has an inner collar portion 21 filling the annular space between the packer 20 and the member 15 and such collar is provided with a plurality of passages 22, each of which is provided with an upwardly opening ball valve 23. Such passages serve for the conduction of fluid upwardly about the member 15 as indicated by the arrows 24.

The collar 21 is reduced both interiorly and exteriorly at its lower end and has attached thereto a pair of spaced concentric tubes 25 and 26. Such tubes may be of any suitable material but are preferably an insulating material so as to more efficiently serve a purpose to be further described.

Spaced below the lower ends of the tubes 25

and 26 is a second packer assembly 27 which includes an outer cup member 28 and an inner cup member 29 which are threadably attached to the member 15 so that the packer 28 is held thereon to form a lower seal between the member 15 and the surrounding screen 2.

A conductor within the lowering cable 11 extends downwardly as indicated at 30 and terminates in a ring or electrode 32 which surrounds the tubular member 25 whereby such electrode is located within the stream of fluid moving upwardly between the tubular members 25 and 26 as indicated by the arrows 31.

It is to be noted that the spaced packers 20 and 27 serve to segregate an area of the walls of the well so that fluid entering through such segregated area will flow in the manner indicated by the arrows 31. Attention will now be directed to Fig. 2 which indicates the manner of obtaining a measurement of an electrical characteristic of such fluid as an indication of the nature of the fluid entering between the packers when the assembly is located at a desired level within the well.

The conductor cable 12 is connected to a measuring device such as a bridge 40 having arms 41, 42 and 43 which, as is well known, may contain any suitable resistance and/or impedances so that a balance of the bridge or a galvanometer deflection may be obtained. The fourth arm of the bridge comprises the conductors 12 and 11, the electrode 32, the casing and screen 44 and 2 and the fluid passing through the screen 2 adjacent to and flowing upwardly between the tubular members 25 and 26. Since the respective elements of this arm of the bridge remain constant except the fluid flowing along the path 31, it seems apparent that the measurement or indication obtained by the bridge 40 constitutes an indication of the nature of the fluids which enter the well intermediate the packers 20 and 27.

As indicated above measurements are made of the fluid which is segregated and is located between the tubular members 25 and 26. If the well is flowing under pressures exerted within the earth formations measurements may be made of such flowing fluids. If, however, a static condition exists in a well such condition can be overcome by producing an unbalanced condition by removal of liquid from the well whereupon formation liquids enter the well and measurements thereof can be made in the manner already set forth. Th technique of the invention includes such step of unbalancing where conditions are such that this feature is necessary.

It seems apparent that the desired measurements may be made at any level within the well and such measurements may be either intermittent or continuous. It also seems apparent that the assembly 10 may remain stationary during the making of measurements or, if desired, such assembly may be raised or lowered by means of cable 11 during the measuring operations.

Broadly the invention comprehends a method and apparatus for locating the area or areas of fluid influx to wells and the nature of the influx at different levels within such area or areas.

What is claimed is:

1. An apparatus to detect the electrical characteristics of a liquid entering a well through the well casing comprising a body, an upper packer on said body, a pair of spaced tubes of insulating material on said packer and body so as to provide an annular passage therebetween, a lower packer on said body disposed below said tubes, said annular passage being open at the bottom for the entry of liquid, an outlet through said upper packer from said passage, and an electrical circuit including a bridge having one leg that includes the casing and an electrode well within said annular passage whereby fluid present between the casing and the electrode constitutes the unknown impedance in said leg, and means to indicate unbalancing of said bridge as caused by variation in the electrical characteristics of the liquid passing through said passage.

2. An apparatus to detect the electrical characteristics of a liquid entering a well through the well casing comprising a body, an upper packer on said body, a pair of spaced tubes of insulating material on said packer and body so as to provide an annular passage therebetween, a lower packer on said body disposed below said tubes, said annular passage being open at the bottom for the entry of liquid, an outlet through said upper packer from said passage, and an electrical circuit including a bridge having one leg that includes the casing and an electrode well within said annular passage whereby fluid present between the casing and the electrode constitutes the unknown impedance in said leg, and means to indicate unbalancing of said bridge as caused by variation in the electrical characteristics of the liquid passing through said passage, said body having a passage throughout its length for the flow of well fluid from below the apparatus so as to avoid closing of the well during use of the apparatus.

3. A device for detecting the nature and location of fluid entering a well bore casing, having a passage throughout its length and carrying a packer near each end, an insulating sleeve encircling and spaced from the pipe and extending downwardly from said upper packer with its only radially outward opening adjustment said lower packer, an outlet from said sleeve through the upper packer, and means including an electrical circuit connnected to the casing and having an electrode insulatingly carried by said pipe within the sleeve and spaced from said outward opening to detect a characteristic of fluid flowing from the formation between said packers and through said sleeve as an indication of the nature thereof.

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