

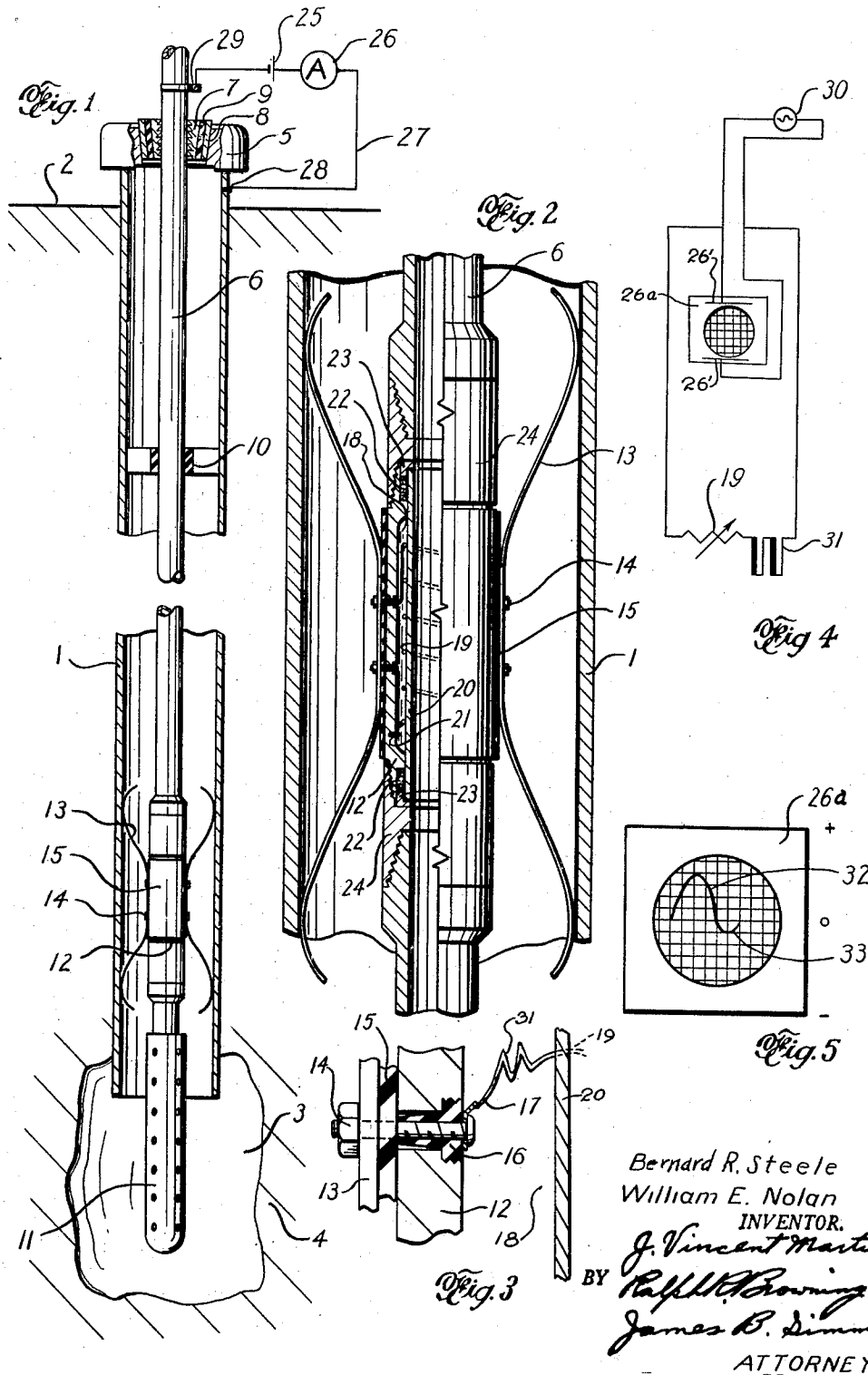
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DEVICE FOR INDICATING CONDITIONS IN WELL BORES

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DEVICE FOR INDICATING CONDITIONS
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This invention relates to devices for reading directly at the earth's surface various conditions which may exist in a well or the like at a substantial distance beneath the surface of the earth and has for its general object the provision of such a device which will involve the use of a minimum of special equipment and a maximum of reliability and durability.

Another object of this invention is to provide such a structure which will offer a minimum of interference with the normal functioning of a well and the use of various other devices in the well.

More specifically it is an object of this invention to provide a means for directly reading at the surface of the earth the bottom hole pressure of a well or bore hole or the pressure therein at a specified distance from the surface of the earth, and in addition to provide a continuous indication of such pressure within the range of pressure variations in the particular well at the point where readings are desired.

It is a further object of this invention to provide a pressure detecting apparatus of the character referred to which may be made much more sensitive than devices for this purpose heretofore employed.

It is a further object of this invention to provide a unitary assembly adapted to be inserted into and form a part of the tubing string of a well and capable of detecting variations in the conditions to be indicated at the surface and of transmitting to the surface information concerning such variations.

Another object of this invention is to provide a structure not requiring the use of independent or specially designed electrical conductors.

Another object is to provide such a structure in which readings may be simultaneously made which will indicate more than one bottom hole condition such as for example temperatures and pressures.

Other objects and advantages of this invention will become apparent from the following description taken in connection with the accompanying drawings wherein are set forth by way of illustration and example certain embodiments of the invention.

In the drawing:

Figure 1 is a view partly in longitudinal cross-section showing a well having disposed therein a detecting and information transmitting device constructed in accordance with this invention, the surface portion of such device being illustrated diagrammatically;

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Figure 2 is a view on an enlarged scale showing the detecting unit or assembly forming a part of such device and illustrating the manner in which the same is embodied into the tubing string as a part thereof;

Figure 3 is an enlarged fragmentary cross-section showing one of the securing end electrical conductor bolts which hold in place the contactor and centralizing springs forming a part of such assembly;

Figure 4 is a diagrammatic illustration of a slightly modified electrical circuit whereby information concerning more than one bottom hole condition may be transmitted to the surface of the earth simultaneously;

Figure 5 is a view showing an oscillograph of the current transmitted by the circuit illustrated in Figure 4.

In the drawing the well casing 1 is substantially identical with well casings customarily used in oil, gas and water wells and the same extends from the surface of the earth at 2 to the opening 3 within the producing formation 4 at the bottom of the well.

Mounted on the upper end of this casing is any suitable type of well head 5 and extending down through the casing to a point preferably adjacent the lower end thereof is a tubing 6 of conventional form which may be suspended within the casing head 5. The tubing 6 is illustrated as being of the type known as external upset, internal flush tubing and the suspending means therefor consists of slips 7 having air plates of suitable material 8 adapted to seat in a tapered seat within the head 5, the plates 8 being separated from the main bodies of the slips 7 by means of electrical insulating material 9. Intermediate its ends the tubing is supported at intervals in spaced relation with respect to the casing by means of the insulating spacers 10. At its lower end the tubing may be provided with the customary screen 11 adapted to admit oil, water or gas and exclude solid material such as sand.

Intermediate its ends and at such a point as it may be desired to determine the pressure, temperature or other characteristic of the conditions existing in the well there is interposed a body 12 which forms a part of the tubing and provides the basis for an assembly of apparatus which may be termed a detecting assembly. This detecting assembly is supported in a centrally located position with respect to the casing by means of contactor springs 13 secured to the body 12 by means of suitable bolts 14 or the like but spaced and insulated from the body 12 by

means of a layer of insulation 15 around the outside of such body. These bolts are further insulated from the body 12 by means of insulating bushings 16 extending through suitable openings in the body 12 and surrounding the bolts. One of the bolts serves at its inner end to provide binding posts whereby an electrical conductor 17 may be connected thereto and thus electrically connected to the contactor and centralizing springs 13.

The body 12 is hollowed out to provide an annular chamber 18 therein and the conductor 17 is located in this chamber and provides a connection with one end of a resistance winding 19 wound upon a flexible thin walled cylindrical member 20. The opposite end of the winding is connected to the body 12 by a connecting element 21. The member 20 is of such physical characteristics that it will expand by predetermined amounts upon the exertion of unequal pressures on its interior and exterior, respectively, and the resistance 19 is tightly wound on the outside of this member so that when the member expands under the influence of pressure on the inside it will stretch the resistance wire 19 and thus increase the overall resistance of this winding. The ends of the cylindrical diaphragm member 20 are of substantially the same external diameter as the openings through the ends of the member 12 and of substantially the same internal diameter as the internal diameter of the tubing 6. The annular space 18 is sealed at its ends by means of packing 22 inserted in suitable counterbores in the member 12 and compressed by glands or followers 23. These glands or followers are urged into and held in their active positions by means of collars 24 threaded onto the ends of the member 12 and provided with threads at their opposite ends suitable for receiving the externally upset ends of the adjacent sections of tubing 6.

Referring again to Figure 1, it will be seen that in this instance the power supply consists of a battery 25 which is connected in series with an ammeter 26 and the ammeter in turn is connected by a conductor 27 to the casing 1 at 28. The other terminal of the battery is connected to the tubing 6 by any suitable clamp such as 29.

It will be seen that when pressure is exerted within the tubing this pressure will likewise be exerted within the cylindrical diaphragm 20 which, being backed up by atmospheric pressure within the annular chamber 18 will expand, producing elongation of the winding 19 and hence increasing its resistance. Thus increase in pressure within the tubing will cause a decrease in the flow of current from the battery 25 through the ammeter 26, the conductor 27, the casing 1, the contactor springs 13, bolt 14, resistance 19, connecting element 21, body 12, tubing 6 and connector 29 back to the battery. Such decrease in current flow may readily be noted by reference to the ammeter 26, and this ammeter may, if desired, be calibrated in terms of pressure. It may also be of the recording type if desired.

With reference to Figure 4, the power in this case is supplied by means of an alternator 30 and instead of the ammeter 26 there is provided an oscilloscope 26a. In the same manner as above described, the increase in pressure will cause an increase in the resistance of the winding 19 which will decrease the current flowing due to the influence of the alternator 30 and this will be reflected on the oscilloscope. Of course any one means desired for measuring the amplitude of

this current may be employed. Where the oscilloscope is employed, the resistance 19 has its terminals connected to the vertical deflection plates 26' of the oscilloscope 26a so that changes in the value of the resistance will result in the increase or decrease in the peaks of the sine waves with respect to the center line of the oscilloscope screen.

In order that temperature might be measured simultaneously with pressure, the electrical diagram illustrated in Figure 4 is made to include a thermopile 31, and upon increases in temperature this thermopile will of course superimpose upon the alternating current in the circuit a direct current voltage. This last will be indicated on the oscilloscope by a vertical shifting of the entire curve due to the alternating current, this being in a manner well known to persons skilled in the art.

The thermopile 31 is electrically connected to the vertical deflection plates 26' of the oscilloscope 26a, and as is well known, a D. C. voltage is developed by the thermopile, such voltage being proportional to the temperature changes. Thus, the D. C. voltage is impressed upon the vertical deflection plates 26' and is in addition to the A. C. voltage which is controlled by pressure variations through the resistance 19. With this arrangement the pressure variations are indicated by the height of the sine wave curve and the variations in temperature are indicated by a displacement of the sine wave curve with respect to the center of the oscilloscope screen.

With reference to Figure 5, it will be seen that the oscillogram there shown has been influenced by a direct current such as would be provided by the thermopile 31, and that this has caused the upper lobe of the curve to be moved upwardly as shown at 32 and the lower lobe of the curve likewise moved upwardly as shown at 33, the amount of this upward movement being a measure of the temperature change in the well. A thermopile 31 may be and desirably is located within the annular space 18 where it will be protected from mechanical contact by the fluids and other material in the well so that it should have long life.

It will be seen from the foregoing that means have been provided whereby all of the objects and advantages of this invention may be accomplished.

Having described our invention, we claim:

1. A device for securing at the earth's surface information concerning conditions within a cased bore hole at a substantial distance below the earth's surface comprising in combination a housing having an annular chamber and a flow passage therethrough, a detector in said chamber having two poles and having electrical characteristics variable with changes in the condition concerning which information is desired at the earth's surface, a suspension for said housing including an electrically conductive conduit having a passageway therethrough substantially the same size as the flow passage through said housing and in communication with said flow passage, said conduit extending from said housing to the earth's surface and electrically connected to one pole of said detector, a sliding contactor carried by and insulated from said housing and connected to the other pole of said detector and extending laterally therefrom into sliding electrical contact with the casing in said bore hole, and insulators carried by said suspension means for maintaining said conductive

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conduit out of contact with the casing throughout its length.

2. A detector assembly comprising in combination a housing for use within a bore hole, said housing comprising spaced inner and outer shells having an annular chamber between them, the inner of said shells being open at both ends and providing a flow passage therethrough and being formed of a material flexible under pressure, means for sealing said shells to each other at the opposite ends of said chamber, means on the opposite ends of one of said shells for connecting the housing with adjacent sections of a tubular conduit, said shells being substantially concentric with said tubular conduit, the flow passage through the inner shell being of substantially the same diameter as the tubular conduit to form a continuous passage therewith and an electrically variable detector within said annular chamber responsive to flexing of said inner shell under pressure.

3. A detector assembly comprising in combination a housing for use within a bore hole, said housing comprising spaced inner and outer shells having an annular chamber between them, the inner of said shells being open at both ends and providing a flow passage therethrough and being formed of a material flexible under pressure, means for sealing said shells to each other at the opposite ends of said chamber, means on the opposite ends of one of said shells for connecting the housing with adjacent sections of a tubular conduit, said shells being substantially concentric with said tubular conduit, the flow passage through the inner shell being of substantially the same diameter as the tubular conduit to form a continuous passage therewith and an insulated electrical resistance tightly wound upon said inner shell within said annular chamber, whereby expansion of said inner shell under an increase of pressure within said inner shell will cause stretching and result in increase in the electrical resistance characteristics of said insulated resistance.

4. A detector assembly comprising in combination a housing for use within a bore hole, said housing comprising spaced inner and outer shells having an annular chamber between them, the inner of said shells providing a flow passage therethrough and being formed of a material flexible under pressure, means for sealing said shells to each other at the opposite ends of said chamber, means on the opposite ends of one of said shells for connecting the housing with adjacent sections of a tubular conduit, said shells having registering openings substantially concentric with said securing means, the flow passage through the inner shell being of substantially the same diameter as the tubular conduit to form a continuous passage therewith an insulated electrical resistance tightly wound upon said inner shell within said annular chamber, means for grounding one end of said resistance to the housing, a sliding electrical contactor connected with the other end of said resistance and carried on and extending laterally from said outer shell, and insulating means between said sliding contactor and said outer shell for electrically insulating them from each other.

5. A tubular pressure variation detector comprising a housing in the form of an outer shell having connections at its opposite ends for receiving the ends of adjacent sections of a well tubing and having an annular recess in its in-

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ner surface, a cylindrical diaphragm open at both ends within said housing and extending past the opposite ends of said recess to provide an annular chamber between said housing and the diaphragm, the bore of the diaphragm being of the same diameter as the bore of the well tubing to form a continuous passage therethrough a seal between said housing and said cylindrical diaphragm adjacent the opposite ends of said recess, and means within said recess for detecting variations in the external diameter of said cylindrical diaphragm.

6. A detector assembly adapted to be connected in a well tubing and lowered therewith in a well casing including, a tubular housing having means at its ends for connecting it in the well tubing string and having electrical connection with said tubing, the bore of said housing having an annular recess therein, a flexible tubular diaphragm member within the bore of the housing spanning the annular recess and adapted to undergo flexing in response to pressure changes within the member, a variable electrical means surrounding the diaphragm and variable in its electrical characteristics in accordance with flexing of the diaphragm, means for electrically connecting one side of the electrical means to the well tubing, a lateral extension on the well tubing string engageable with the well casing, said lateral extension being insulated from said well tubing, additional means for connecting the opposite side of the electrical means to the well casing through the well tubing extension, a source of electrical current connected with the tubing and casing whereby the variable electrical means is connected in the circuit, and means at the surface for indicating changes in the electrical characteristics of the variable means as caused by pressure changes within the tubular diaphragm member.

7. A detector assembly as set forth in claim 6, wherein the bore of the tubular diaphragm member is of the same diameter as the bore of the well tubing string to form a continuous passage of constant diameter throughout the length of the string.

8. A detector assembly as set forth in claim 6, wherein the variable electrical means is a resistance wire which is wound around and snugly engages the outer surface of the tubular diaphragm member.

9. A detector assembly as set forth in claim 6, wherein the lateral extension on the tubing string comprises curved metallic contact springs on the exterior of the housing and engaging the wall of the well casing, the means for electrically connecting one side of the electrical means to the well casing including said contact springs and also including an electrical conductor extending through the housing and insulated therefrom and having electrical connection with the variable electrical means.

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