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WELL SOUNDING MICROPHONE

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Fig. 1.

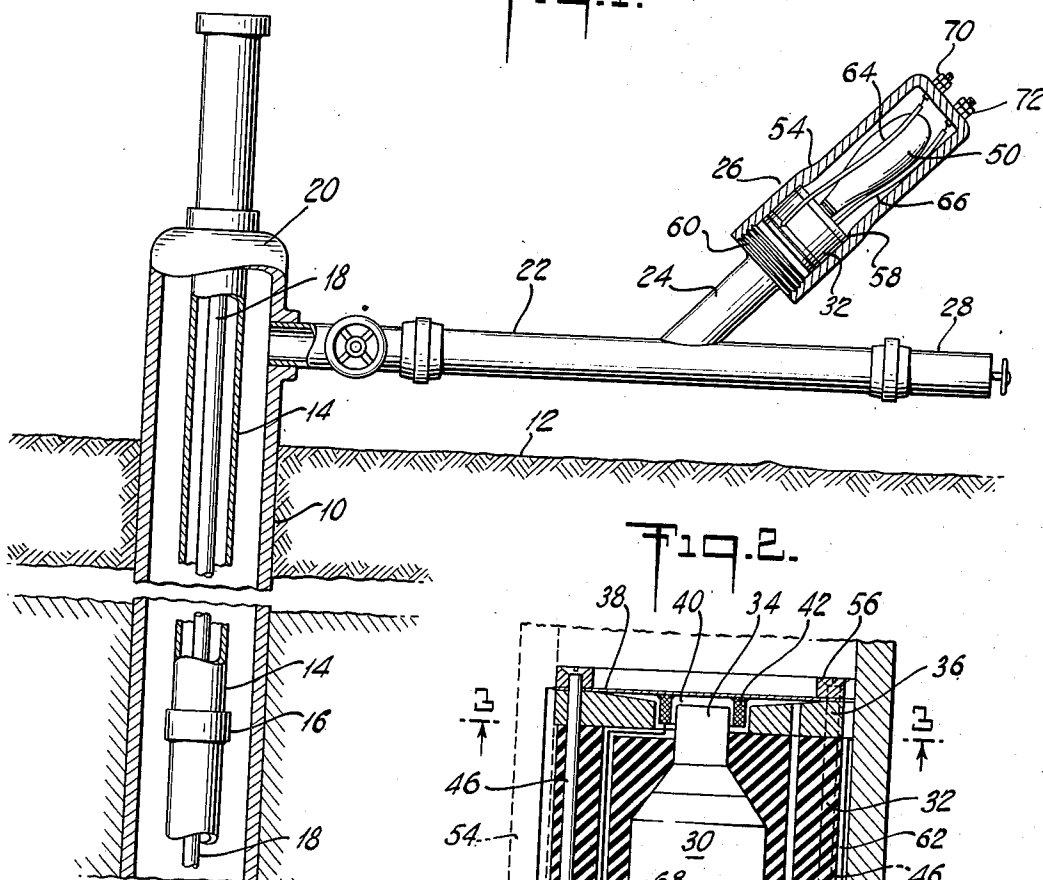


Fig. 2.

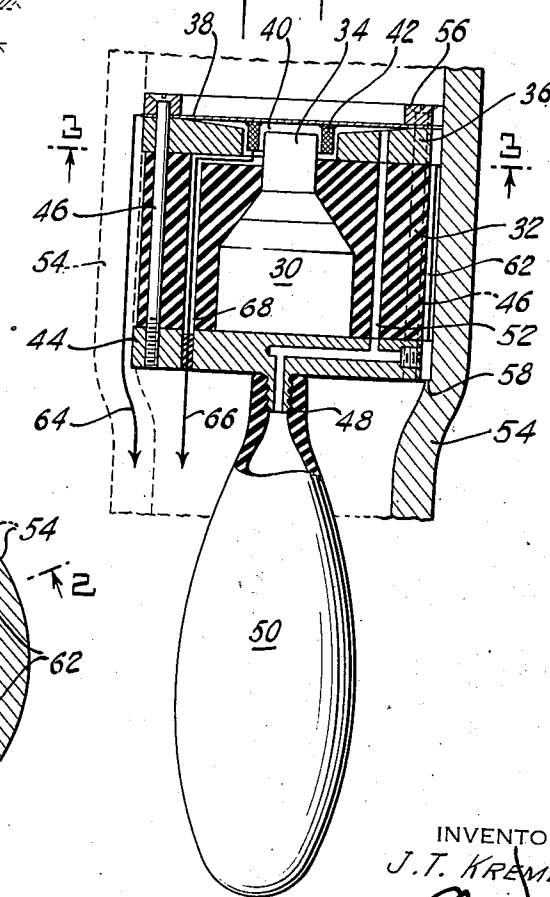
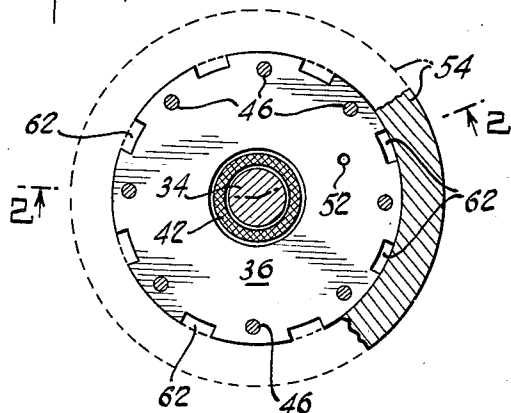


Fig. 3.



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WELL SOUNDING MICROPHONE

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2 Claims. (Cl. 177—352)

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This invention relates to apparatus for measuring the location or depth below the ground surface of the liquid level in a deep well, whether the liquid therein be oil, water, or a mixture of water and mud and particularly to an apparatus for receiving and recording pressure impulses which have been directed into a well and are reflected from the surface of the liquid in the well, as well as those reflected from tubing collars and other obstructions.

More specifically, the present invention relates to an apparatus of the type wherein pressure waves are employed, preferably those produced by a sharp explosion such as that caused by the firing of a blank cartridge in a suitable firing device. The pressure waves thus produced traverse the length of the well casing, a portion of them being reflected back from the tubing collars or casing joints and the remainder being reflected back from the surface of the liquid in the well. The receiver or microphone in which the reflected pressure impulses are picked up and recorded must necessarily be extremely sensitive to very minute variations in pressure, while at the same time it must be capable of withstanding the static pressure of the well gases without damage to the instrument. The interior of the receiver must be sealed from the well gases so that the sensitive parts will not be exposed to the corrosive action of the gas.

One of the objects of the present invention is to provide a device such as a microphone for receiving and recording pressure impulses reflected from the surface of liquid in a well, which device is not only sensitive to slight variations in pressure but also capable of withstanding static pressure without damage to the delicate internal mechanism. Another object is to provide a microphone wherein the static pressure to which the diaphragm is exposed is equalized on both faces, regardless of the pressure encountered.

Other objects, features, and advantages of the invention will readily appear as the description thereof progresses, particularly when read in connection with the accompanying drawing in which,

Figure 1 is a diagrammatic view showing in cross section a conventional type of well assembly, together with the apparatus for determining the liquid level in the well, the impulse receiving device being shown in cross section;

Figure 2 is an enlarged and partially sectional view of the impulse receiving device, and

Figure 3 is a sectional view of the impulses

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receiving device taken on line 3—3 of Figure 2.

In Figure 1 there is illustrated a conventional type of oil well having a relatively large casing 10 composed of a plurality of sections which extend from above the ground level 12 downwardly into the well. The several sections comprising the casing are secured together in any desired manner. A second pipe or tubing string 14 which also is composed of a plurality of sections secured together by means of collars 16 extends downwardly to a point below the level of fluid in the well and at its lower end the pipe 14 carries a pump of any desired character (not shown). The pump ordinarily is operated by means of a string of sucker rods 18, which extend through the uppermost section of the casing which is capped by a casinghead 20, the uppermost rod being connected to the usual pumping mechanism (not shown). A pipe 22 connects at one end with the upper end of the casing 10 and its opposite end terminates in a Y fitting providing a branch pipe 24 to the end of which the impulse receiving device or microphone 26 is secured. The firing device 28 which produces the pressure waves is attached to the free end of the pipe 22.

From the foregoing it will be seen that when the firing device 28 is operated to produce a sharp explosion by the firing of a blank cartridge or the like, the pressure impulses resulting from the explosion will traverse the length of the pipe 22 and the casing 10 until they reach the surface of the liquid in the well from which they are reflected and pass upwardly through the casing 10 and outwardly through the pipe 22 and into the branch pipe 24 until they contact the microphone 26. It is also apparent that a certain portion of the pressure impulses will be reflected backwardly upon contact with any obstacles in the casing 10, such as the collars 16 on the flow-pipe 14, and these impulses, though of lesser strength than those reflected by the surface of the liquid in the well, likewise reach the microphone 26 through the pipe 22 and branch pipe 24.

The microphone 26 is of the dynamic, pressure sensitive type and is provided with a high pressure equalizing device or compensator which is employed for the purpose of excluding the well gas and powder fumes from the delicate microphone mechanism. By referring to Figure 2 it will be seen that the microphone consists of a permanent magnet 30 which is embedded in a block or block-like member 32 composed of non-magnetic material such as Bakelite or a suit-

able non-magnetic metal such as brass. The neck 34 of the magnet extends beyond the upper surface of the block 32 and into a slightly larger centrally disposed hole in a soft iron disc 36 which is placed directly on top of the block, an annular air gap being provided between the neck 34 and the disc 36. The upper face of the disc 36 is beveled slightly towards the centrally disposed hole so that when a bronze diaphragm 38 is positioned on top of the disc, a restricted air chamber 40 is formed between the disc and the diaphragm. A light pick-up coil 42 is secured to the inner face of the diaphragm 38 in such a position that it extends into the gap between the neck 34 of the magnet and the inner edge of the hole in the disc 36, one end of the coil 42 being electrically connected to the diaphragm 38.

A second soft iron disc 44 is positioned against the bottom face of the block 32 and the two discs 36 and 44 are maintained in position by means of a plurality of screws or rods 46 which extend through holes provided for the purpose in the block 32. One end of a screw 48 is secured in the bottom disc 44 with one end projecting from the disc so that a pressure equalizer in the form of a small compressible rubber bulb 50 can be screwed thereon. The bulb 50 should fit the back of the microphone tightly enough to maintain a seal, as any slow leak in the microphone which would permit the entrance of well gas will cause permanent damage to the unit.

The two discs 36 and 44 as well as the block 32 and screw 48 are each drilled to provide relatively small ducts which, when these elements are assembled in operative position, together form a continuous air duct 52 through which air can pass slowly between the air chamber 40 and the pressure equalizing bulb 50 to permit equalization of static pressure or pressure applied at a slow rate. The microphone unit is enclosed within a tubular container or housing 54 which is made of steel or other magnetic metal and the inner wall of which contacts both of the soft iron discs 36 and 44 to complete the magnetic circuit. A brass ring 56 is placed on the periphery of the diaphragm 38 to protect the latter against damage, the ring being secured in position by the screws or rods 46.

The housing 54 is open at one end and is so formed that its inner chambered portion is composed of sections of two different diameters thus providing a shoulder 58 on which the microphone unit seats when the unit is assembled, with the bulb 50 disposed in the closed and smaller chambered section of the housing. A ring or plug 60 which is threaded externally and internally is screwed into the open end of the housing 54 to maintain the unit in operating position. Finally, the complete assembly is screwed onto the end of the branch pipe 24 with the diaphragm 38 exposed to the open end of the pipe.

Means are provided for equalizing the pressure on the opposite faces of the diaphragm 38 and for this purpose slots or apertures are formed in the peripheral surfaces of the ring 56, discs 36 and 44, and, if necessary, in the non-magnetic block 32. These slots, when aligned, form elongated ducts 62 or apertures through which the well gases can readily pass to the rear closed portion of the housing 54 to act upon the bulb 50. Consequently, well gases under pressure acting upon the diaphragm 38 will likewise act upon the bulb 50 and compress it to slowly force air within the bulb outwardly through the duct 52 into the air chamber 40 with the result that the pres-

sure upon both faces of the diaphragm is equalized. The air capacity of the bulb 50 should be such that when the bulb is fully compressed the pressure on the inner face of the diaphragm will equal the maximum external pressure exerted on the outer face. In other words, the ratio of bulb volume to that of the space behind the diaphragm must be at least as large as the maximum external pressure in atmospheres likely to be encountered. In the event that for some reason the well pressure should be sub-atmospheric the bulb 50 could not expand, and in this event it would be necessary to remove the bulb, partially compress it, and then replace it. It should be understood that a gaseous medium other than air can be employed in the compressible member 50 to act upon the inner face of the diaphragm 38.

The electrical connections are completed by attaching lead wires 64 and 66 to the diaphragm 38 and to the pick-up coil 42, respectively, and running them through suitable insulating bushings (not shown) in the discs 36 and 44, and through a duct or ducts 68 in the block 32 to terminal posts 70 and 72 mounted in the closed end of the housing 54 from which posts wires lead to the recording device.

From the foregoing it will be seen that when a shotgun blank is exploded in the gun cartridge chamber of the firing device 28, the pressure impulses created by the explosion traverse the length of pipe 22 and pass into the well casing 10. The impulses reflected by obstructions in the casing together with those reflected from the surface of the liquid in the well return through the casing, pipe 22 and branch pipe 24 on the end of which the microphone 26 is positioned. Upon coming in contact with the diaphragm 38 of the microphone, they cause the diaphragm to fluctuate in accordance with the strength of the impulses, the stronger impulses creating a more violent fluctuation of the diaphragm. This movement of the diaphragm produces a corresponding movement of the pick-up coil 42 in the air gap between the neck 34 of the magnet and the inner wall of the hole in the disc 36, and this movement creates in the coil energization of varying degree, which energization is transmitted to the recording device and there recorded in a well-known manner.

During this period the outer face of the diaphragm 38 is exposed to the well gases which it is necessary to exclude from the interior of the microphone unit to prevent damage to the delicate mechanism which might result because of the ordinarily corrosive nature of such gases. By reason of the fact that the duct 52 is of small size, rapid fluctuations in pressure which constitute the reflections from the various obstacles in the well, are not equalized, and it is this lack of equalization for sharp pulses which makes the diaphragm 38 responsive to them. In fact, the size of the duct 52 in relation to the volume of the bulb 50 and the air chamber 40 behind the diaphragm is critical in regard to the lowest frequency to which the entire device will respond.

Obviously, many modifications and variations may be made in the invention as herein set forth without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. A microphone adapted to respond to pressure waves passing through a gaseous medium in a conduit under relatively high pressure, com-

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prising a tubular housing closed at one end and connected at its open end to said conduit, a body member, a pair of discs at opposite sides of said body member, a diaphragm secured to the outer face of one of said discs to provide an air-tight chamber between the diaphragm and disc, a compressible member mounted at the rear of the other disc, a duct connecting the interior of said compressible member with said chamber, said body member and discs being mounted in said housing so that the peripheries of the discs fit snugly against the inner surface of said housing with the diaphragm facing said conduit and the peripheries of said discs being provided with apertures to permit said gaseous medium to surround and compress said compressible member to force air therefrom through said duct to said chamber so as to equalize pressure on opposite sides of said diaphragm.

2. In combination with a tubular member communicating with a well casing, a well sounding microphone unit comprising a cylindrical metallic housing closed at one end and adapted to have its open end secured to the free end of the tubular member, a non-magnetic block-like member for

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supporting a magnet disposed within said cylindrical housing, metallic discs at opposite ends of said block-like member, said discs being adapted to engage the inner surface of said housing and the peripheral surfaces of said discs and said block-like member being formed with aligned longitudinally disposed apertures, a diaphragm mounted in spaced parallel relation to the disc adjacent the open end of the housing to provide an air-tight chamber therebetween from which chamber well gases are to be excluded, a compressible chambered member secured to the other metallic disc and extending towards the rear closed end of the housing, a duct connecting the interior of said compressible member with the interior of said air-tight chamber so that well gases under pressure acting on the diaphragm can likewise pass through the peripheral apertures in the discs and block-like member to reach the rear of the housing and compress the compressible member to force some of the gaseous contents therefrom to the air-tight chamber to equalize the pressure on the opposite faces of the diaphragm.

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