Feb. 20, 1940. L. B. SLICHTER 2,191,121

GEOLOGICAL SURVEYING APPARATUS

Original Filed March 2, 1935 2 Sheets-Sheet 1

Fig. 1

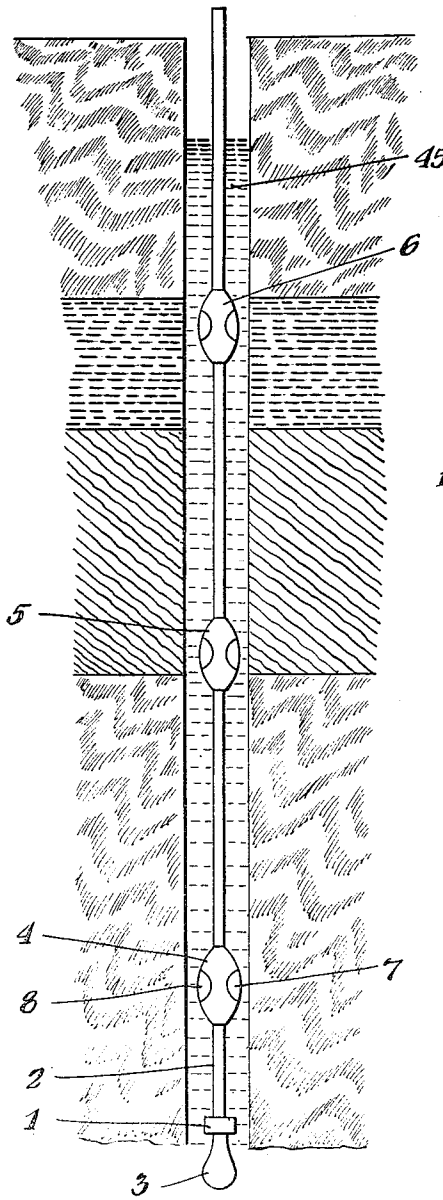
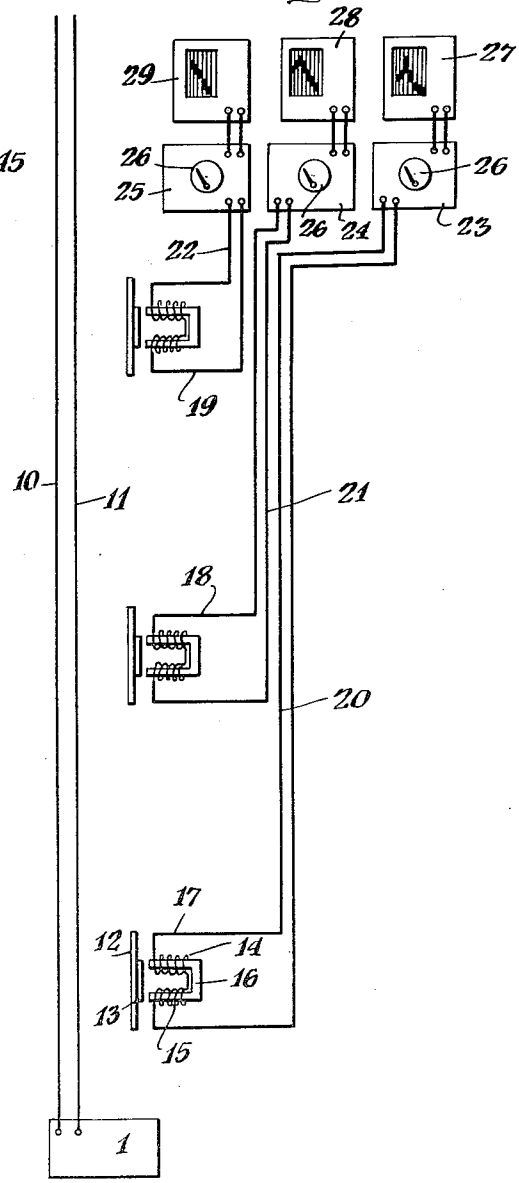


Fig. 2



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Fig. 5

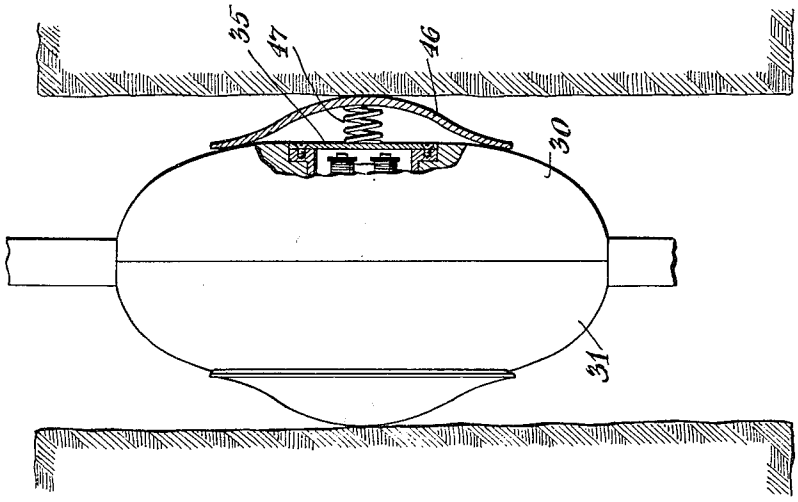


Fig. 4

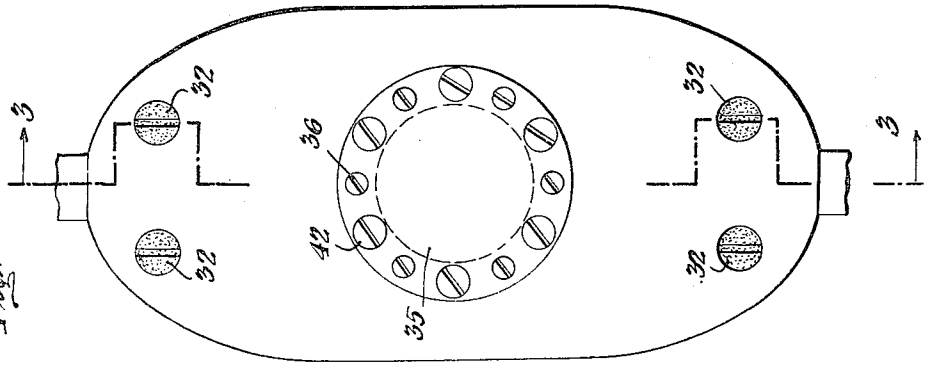
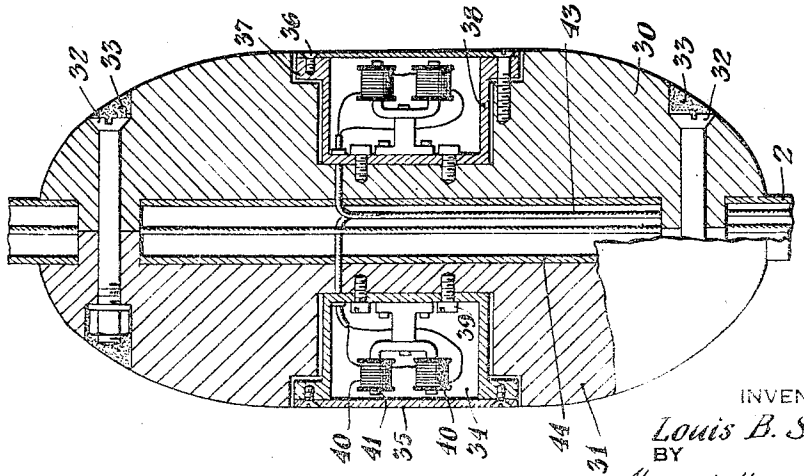


Fig. 3



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UNITED STATES PATENT OFFICE

2,191,121

GEOLOGICAL SURVEYING APPARATUS

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Original application March 2, 1935, Serial No. 9,046. Divided and this application January 5, 1940, Serial No. 312,609.

3 Claims. (Cl. 181—0.5)

The present invention relates to the exploration of drill holes and, more particularly, to the determination of the properties and characteristics of the various strata traversed by a drill hole by the use of compressional wave energy.

More specifically, the invention relates to new and improved wave receiving means for obtaining indications of compressional wave energy in a bore hole in a simple and highly effective manner.

In my copending application Serial No. 9,046, of which this application is a division, there is described a method of exploring bore holes in which compressional wave energy is generated in a bore hole and compressional waves transmitted through the surrounding formations are picked up by suitable wave receiving means. By studying the characteristics of the compressional waves picked up, valuable information about the formations surrounding the bore hole may be obtained.

An object of the present invention is to provide new and improved compressional wave receiving means for picking up waves in a bore hole, which may be secured to a cable in a simple and highly effective manner.

Another object of the invention is to provide new and improved compressional wave receiving means of the above character which may be moved with a minimum of effort through a bore hole containing a fluid.

A further object of the invention is to provide a compressional wave receiver which is adapted to make contact with the walls of a bore hole whereby an efficient transfer of energy from the surrounding formations to the receiver may be achieved.

According to the invention the receiver comprises a streamlined casing made in several parts which are somewhat oval in shape and which when assembled provide a central opening through which the cable may pass. The respective parts are adapted to be secured together about the cable in any suitable manner to form a streamlined body thereon.

In another embodiment of the invention means is provided for acoustically coupling the wall of the drill hole with the receiver. This modification is adapted to be used particularly in bore holes which do not contain a good sound propagating medium.

The invention may be better understood from the following detailed description of several embodiments taken in connection with the accompanying drawings, in which:

Figure 1 illustrates schematically an investigation system in a drill hole;

Figure 2 shows schematically a wiring diagram for connecting the various units in the system of Figure 1;

Figure 3 is a view in section of a receiving unit constructed according to the invention and attached to a cable in a drill hole;

Figure 4 is a view in plan of the receiver shown in Figure 3; and

Figure 5 is a view in partial section of a receiver adapted to be used in dry holes.

In the system shown in Figure 1, a sound generator or oscillator 1 may be provided towards the lower part of the well, or in any other desired position. The generator 1 may be supplied by energy transmitted through the cable 2, which cable may also act as a support for the generator 1. The generator 1 may be of any suitable type and preferably is of the so called oscillator type used generally for sub-aqueous signalling. The generator 1 may act as a weight for the cable, or additional weight may be provided as shown by the weight 3 attached thereto.

At various points along the cable 2, there are provided receiving units 4, 5 and 6, there being three shown in Figure 1, but it is understood that one or more units may be used if desired, and that two units may suffice. These units are individually connected through conductors forming a part of the cable. A pair of conductors may be used for each unit or in fact a single conductor may be used with a ground or with common wire return.

Each receiving unit 4, 5 and 6 may be provided with two separate receivers, if desired, as indicated by 7 and 8, and the receiving unit itself may be made streamline as shown in Figures 3 and 4, which will be described later.

In Figure 2 there is shown a diagrammatic representation of the system set forth in Figure 1. In this case an oscillator 1 is supplied by energy through the conductors 10 and 11 which may be twisted and shielded to prevent induction or disturbances of the receiving conductors which also may be twisted and shielded within the cable 2. The units 7 and 8 may be of the magnetophone type, as indicated in Figure 2, in which the diaphragm 12 has an armature 13 inducing current in the windings 14 and 15 placed over the core 16. Each unit, such as 17, 18 and 19, is connected respectively by the conductors 20, 21 and 22 to its respective amplifier and indicator 23, 24 and 25, in which an indicating meter such as 26 may be provided. Any other suitable means

may be used such as a bridge with a phone or galvanometer.

If desired, each unit 23, 24 and 25 may be respectively connected to recorders 27, 28 and 29, so that a permanent record can be kept of the intensity of the signal received at each receiver, or preferably of the relative intensities of the signals received at each receiver. These intensities may be plotted as ordinates on a curve, the abscissae corresponding to the points at which the receivers are placed in the drill holes.

In Figure 3 there is shown in greater detail the structures of the units 4, 5 and 6. Such units each comprise a streamline case made of two parts 30 and 31 which are somewhat oval in shape, and have, when put together, a center opening or hole through which the cable 2 may pass. The two parts 30 and 31 which may be made of wood or other suitable material are held together in any suitable manner, as for instance by machine or wood bolts or nuts 32, 32, 32, 32, which as indicated in Figure 3 may be recessed in one half of the frame and covered by a cement filling as indicated by 33, 33.

When the half units are applied to the cable, the cable is firmly clamped within the unit and the unit gives an appearance somewhat of the shape of a football, the two parts being firmly held together by the clamping bolts. Each half unit 30 and 31 may be provided with a suitable receiver, as for instance a receiver 34 of the magnetophone type in which there is provided a diaphragm 35 held fast by bolts 36 to a flange 37 of the casing 38 of the magnetophone. The casing 38 may be held in the unit 30 by means of the bolts 39, a recess being formed within the unit 30 so that the casing will fit snugly into it.

Within the casing 38 there may be provided the two coils 40, forming with the U-shaped core 41 a magnet system which will set up or generate a current when the diaphragm 35 vibrates. The coils 40 may be polarized with direct current, or permanent magnets may be used. The diaphragm 35 may be made flush with the surface of the half 30, which unit itself is substantially streamlined about the conductor. The cable 2 may contain a supporting core to support the weight of the cable itself and the receivers that are down deeper in the drill hole, and similarly the cable 2 may be provided with groups of twisted leads for the various receiving units.

The half 30 and the half 31 may both be provided with sound receivers and while these may be individually connected with their indicators and recorders, nevertheless, it is preferable to operate both receivers in parallel or series and place them as indicated in Figure 1, on either side of the streamline unit. The receivers themselves may be held in the units by means of screw or machine bolts 42 and the leads to transmit the energy picked up by the vibrations of the diaphragm 35 may be connected to the cable 43 passing through the casing 38 and through the outer cable shield 44 of the cable itself.

A great part of the exploration is to be done in drill holes that are filled with water as indicated by 45 in Figure 1. In this case the water serves as the chief propagating medium for the transmission of the compressional waves in the well. However, the analogous procedure may be utilized in a dry hole. In this case the source communicates its vibrations to the air, and the receivers receive energy from the air. Furthermore, instead of transmitting the energy through the air in the hole or through water in the hole, the energy might be transmitted through the walls of the hole by impressing the vibrations upon the walls of the hole and receiving them from the walls of the hole.

For this purpose a contacting cap or convex plate 46, as indicated in Figure 5 may be provided, which element may be somewhat resilient and be supported against the diaphragm 35 by means of a spring support 47 or in any other suitable manner. The spring 47 may be held in any way to the resilient cap 46 and the diaphragm 35 such as by welding or by some mechanical attachment. The cap 46 should be made of sufficient height so that as the receiver is lowered down into the drill hole, the cap 46 will press against the side walls of the drill hole and make a good acoustic connection between the walls of the drill hole and the diaphragm 35. By providing caps to both diaphragms sound energy may be picked up quickly on both.

In the operation of the system it should be noted that while the sound waves may travel uniformly through the water in the drill holes, nevertheless, due to the character of the sides of the hole, the observation of the sound travelling down the sides of the hole, will vary, dependent to a great extent upon the character or porosity of the earth at the sides of the hole. The observation of the sound energy at a given distance down in the hole depends upon the character of the sound energy, particularly the frequency and ultimately upon the porosity of the material forming the walls of the hole.

The porosity of the wall rock of a drill hole is of importance practically in the determination of the flow of oil from the oil rock or sand or the flow of water into the hole and may be measured by the comparative or absolute intensities of the sound waves picked up by the various receiving units.

Since the absorption per unit length will be greater at the audible frequencies than in the range of sub-audible frequencies or seismic vibrations, it will readily be seen that the use of audible vibrations has a distinct advantage in the present invention. This is particularly true where there is good transmission in the drill hole, because the absorption is small and more difficult to measure.

Where the well is dry, the modification shown in Figure 5 may be used, in which case the cap 46 is placed against the side of the drill hole through the spring 47 and the sound energy is conveyed to the receiver by the contact of the plate 46, the spring 47 operating against the diaphragm 35. Other means may be provided for acoustically coupling the side of the drill holes with the receiver, but in each case it should be remembered that the units must not be held so tightly against the side walls of the drill hole that the cable cannot be lowered.

Observations may be taken with the cable part way or all the way down in the drill hole. It is preferable in making such observations to keep the distance of the receiving units at a constant spacing one from the other and from the source, and this is possible by clamping the units as indicated in Figure 1, directly to the cable itself.

It will be evident from the foregoing that the invention provides compressional wave receiving means for use in bore holes which may be assembled in any desired position upon the cable with great ease. Furthermore, by reason of the streamlined shape of the receiver casing, the

receiving means may be moved through a bore hole containing a fluid with a minimum of effort.

While several specific embodiments have been described above, the invention is not intended to be in any way limited thereby but is susceptible of numerous changes in form and detail within the scope of the appended claims.

I claim:

1. In a device of the type described, a cable, a streamline body composed in two parts, and adapted to fit over the cable, the cable passing centrally therethrough, means for clamping the streamline body together about the cable, and means providing a sound receiving device within the stream-line body having a diaphragm contained within the surface of the streamline body.

2. In a device of the type described, adapted to be lowered into a drill hole, a cable, a streamline body attached to said cable, and having a receiver contained therein, and a spring contact element projecting from the streamline body and making an elastic connection between the receiver and the wall of the hole.

3. In a device of the type described adapted to be lowered into a drill hole, a cable, a body attached to said cable having a receiver contained therein and means projecting from said receiver body for making contact with the wall of the drill hole and providing vibrational coupling means between the receiver and the wall of the drill hole.

LOUIS B. SLICHTER.