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APPARATUS AND METHOD FOR LOCATING PIPES

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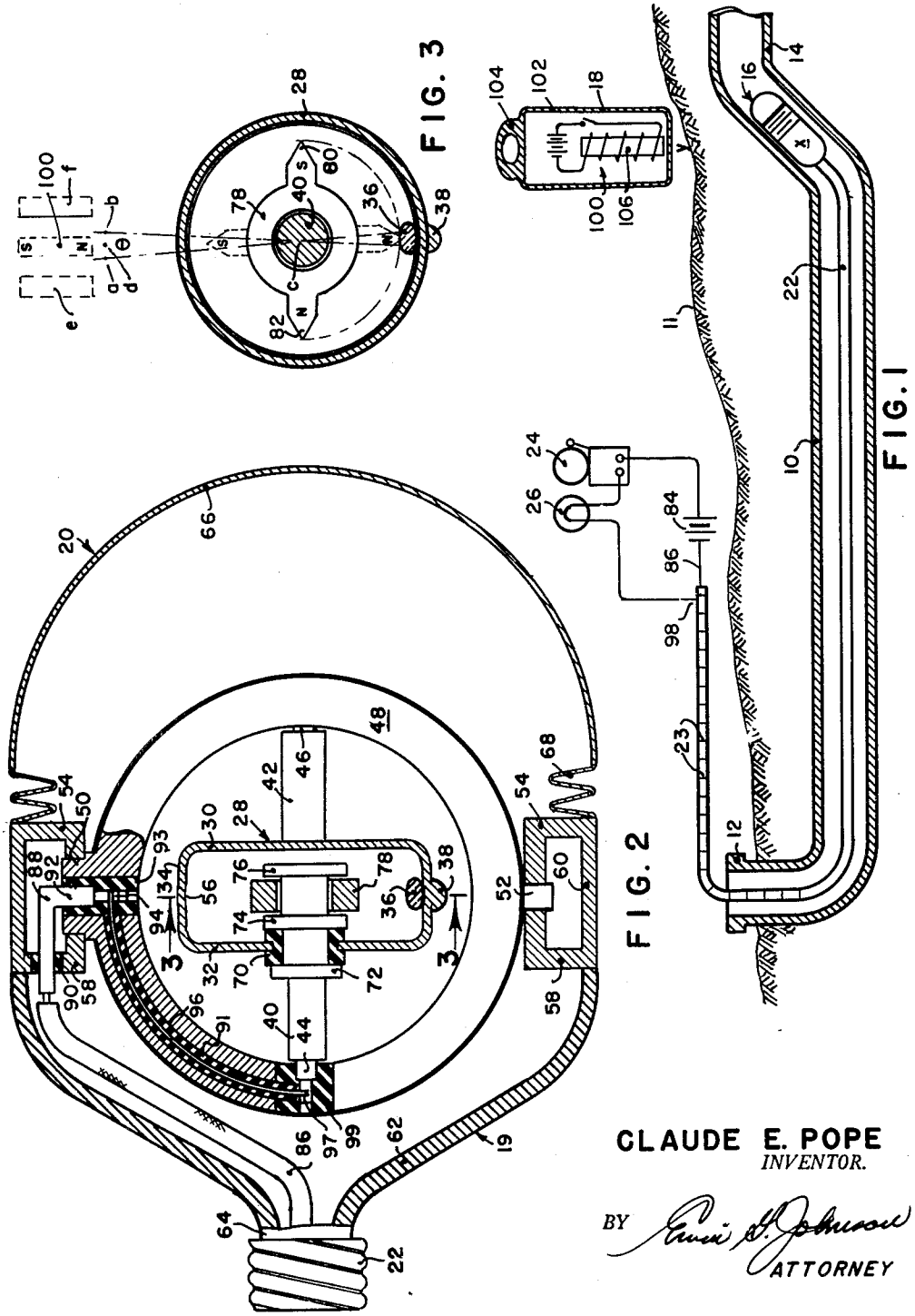

FIG. 1

FIG. 2

FIG. 3

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APPARATUS AND METHOD FOR LOCATING PIPES

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This invention is for locating and mapping the course of conduits and pipes which are for the most part hidden under floors, behind walls, or under soil, concrete, water, or pavements, and inaccessible to a person for the purpose of making a map, or locating the position of the pipe from a point outside the pipe.

It is one of the principal objects of my invention to provide a pipe locating method which gives the location of a pipe accurately.

It is another object of my invention to provide apparatus which is practical, and which provides for an adequately precise determination of the depth of a pipe.

It is another object of my invention to enable one to measure the distance along a pipe from a point where it is exposed to a point where the pipe is hidden from view.

Other objects of my invention will be evident from a consideration of the following specification and accompanying drawing, in which:

Fig. 1 is a sectional elevation of an underground pipe with the apparatus of this invention shown as employed in use of the invention;

Fig. 2 is a view, largely in section, of the exploring head much enlarged from that shown in Fig. 1; and

Fig. 3 is a partial section at plane 3—3 of Fig. 2, and in part a diagram illustrating certain functions and steps in the use of the apparatus.

Referring to the drawings, it is supposed that a pipe 10 is buried beneath surface 11 of the earth with only outlet 12 exposed and accessible. The location of the portion of pipe 14 remote from outlet 12 is unknown, both as to direction from outlet 12 in a horizontal plane, and as to depth below the surface of the ground at x, that is, the vertical distance xy corresponding to the direction of gravitational force, is unknown. The two problems are: (1) to determine where y is such that x is directly below y and (2) to determine the length of xy.

It is often important in electrical wiring and cable running to be able quickly to locate the point x from the point y just above it. For example, it would possibly be of interest for a wireman to know precisely where, in the vicinity of y, he must cut away concrete or soil in order to open pipe 10, tap a conduit vertically therefrom and extend wire from 12 to y. This invention determines exactly where y, a point directly over x, is; determines how far along the inside of the pipe it is from outlet 12 to x; and also how deep x is below y.

In general the apparatus comprises two coacting exploring devices 16 and 18, one of which, 16, traverses the inside of pipe 10, and the other of which, 18, is moved above the surface 11 of the ground or pavement. So long as the two exploring devices 16 and 18 have a certain relationship, a fixed electrical circuit condition is maintained, affecting a signalling device or devices. When that certain relationship ceases to exist, the circuit condition is also altered to change the signal. The changing of the signal is sensible to the operator so that he knows whether or not the device 18 occupies the certain relationship to device 16.

The apparatus will now be described in greater detail. The exploring device 16 comprises a protective casing 20 within which there is mounted a switch. The casing 20 is connected to one end of a flexible pushing rod, or tube, 22, sometimes known as a "fish" tube. Tube 22 is formed of flexible conduit well known in the electrical wiring trades. The device 16 is pushed into pipe 10 from the outlet 12.

The switch within casing 20 is connected in, and for, controlling a circuit for energizing signalling devices 24 and/or 26, which devices 24 and 26 are above the ground and visible or audible to the operator. The switch within casing 20 is responsive to the presence and absence of device 18; in the certain relationship the switch maintains a fixed circuit condition; when that relationship ceases to exist, the fixed circuit condition also ceases and establishes another circuit condition.

That certain relationship and those circuit conditions referred to above are determined, in the preferred embodiment of this invention, by the particular constructions to be described.

The switch includes a housing 28 which is aluminum or other non-magnetizable but electroconductive metal. Housing 28 has two flat parallel disc shaped walls 30 and 32 joined by a generally cylindrical wall portion 34. These wall portions form a sealed container having an axial opening through wall 32. Within the container there is placed a globule of mercury 36, and the wall 34 is preferably weighted by a small mass of metal 38 placed on wall 34. As will be made clear, the mass 38 always remains lowermost due to the pull of gravity.

The switch 28 is provided with axial shaft members 40 and 42 axially secured thereto which are journalled in bearings 44 and 46 provided by a pivoted supporting member 48. The supporting member 48 is also, in turn, journalled in bearings 50 and 52 carried by frame 54. The com-

mon axis of bearings 50 and 52 is perpendicular to and intersects the axis of bearings 44 and 46. This plural bearing support and structure insure that the side walls 30 and 32 of the switch 28 always remain in vertical planes parallel to the direction of gravitational force, under the influence of mass 38 or its equivalent, and that the axes of shafts 40 and 42 remain horizontal. The wall 34 of the switch is provided with a slight peripheral internal groove 56 to insure the positioning of the mercury globule 36 at a fixed location between the side walls 30 and 32.

The frame 54 provides bearing brackets 58 secured to a rigid ring 60 which is in turn suitably fastened to a bell section 62 of the casing 20. Bell section 62 is provided with a neck 64 which is fitted within flexible tubing 22. A nose portion 66 of the casing 20 is suitably secured to the ring 60 by means of a section of flexible tubing 68 to provide a liquid sealed enclosure for the switch parts, and to enable the device 16 to more readily pass around bends and obstructions in the pipe 10.

The shaft 40 passes through wall 32 of the switch 28 and is electrically insulated therefrom by a grommet 70 of rubber secured in position by a gland nut 72 and a shoulder flange 74. The shaft 42 is of metal secured in any suitable manner to wall 30.

A second flange 76 is provided on the end of shaft 40 within housing 28 to provide a shaft bearing for a movable contact arm 78. Arm 78 is formed of highly and permanently magnetized steel, constituting a magnetic vane having pointed tips 80 and 82. The magnetic vane 78 normally takes a position coinciding with the nearly horizontal earth magnetic field, the shaft 40 being always horizontal. The tips 80 and 82 are equally distant from the shaft center "c," and extend so as to only contact the globule of mercury through a vertical angle θ as shown in Fig. 3. The depth xy of the pipe is determinable because of the existence of the angle θ, as will be pointed out.

Current is conducted from a battery 84 through an insulated conductor 86 extending through tube 22 into shell 20 where it is attached to a terminal 88. Terminal 88 is mounted in insulation 90 of bracket 58 and is extended to provide a stationary brush 92 co-axial with bearing 50. A second brush 94 carried by pivoted support 48 is in continuous axial contact with brush 92 and is electrically connected through a conductor 96 and a suitable brush 97 to contact the end of shaft 40. Shaft 40 bears in insulating bearing 99, and the conductor 96, with brushes 94 and 97, are insulated as at 91 and 93.

Electrical signal devices 24 and 26 have their terminii connected in circuit to the other terminal of battery 84 and to the tube 22 as at 98. The tube 22 is provided with a scale 23 by means of which the length of it within pipe 10 may be determined.

When vane 78 contacts the globule of mercury a circuit is completed from battery 84 through conductor 86, brushes 92 and 94, conductor 96, brush 97, shaft 40, vane 78 to the globule of mercury 36, thence through the walls of switch 28 to shaft 42 and thence to support 48 from which it passes through bearings 52 and 54 to bell 19, then to and through the flexible tube 22 back to battery 84 through the signal devices 24 and 26.

It will be clear that the switch 28 closes this circuit only when the vane 78 is in a position within the limits of angle θ, that is, when the vane 78 is near or at vertical. This condition can exist when a strong unidirectional magnetic field is produced with its resultant axis of flux lying within angle θ. Device 18 effects this function by providing an electromagnet 100 the magnetic axis of which is vertical. Device 18 comprises a case 102 with a handle 104. A magnet core 106 is fixed in casing 102 so that when the casing 104 is suspended by the hand, the field of magnet 100 is about vertical. Magnet 100 is either a permanent magnet, or a direct current excited magnet which produces north and south excited poles.

Assuming that the lower end of magnet 100 is a north pole, it will be understood that the south pole of vane 78 takes the top position when the magnet 100 is vertically above device 16; or, more precisely stated, when the center of action of the pole N of magnet 100 lies within the angle θ above the shaft center c, the s pole of vane 78 also lies within angle θ.

One way to easily find point x is to start device 16 from outlet 12 with the device 18 moving over it, keeping the signal energized by shifting 18 as the device 16 is forced into pipe 10. Of course, the larger the angle θ is, the easier it is to get a signal.

The depth of the shaft 40 below the lower pole of magnet 100 was stated to be determinable because of the existence of the angle θ. The angle θ is determined by the distance on the arc between the opposite points on the globule 36 of mercury where the contact is made with the points 80 and 82. This arc is fixed in any particular switch 28 because of the integrity of the globule of mercury as to shape. Referring to Fig. 3, the points a and b represent two horizontally spaced points on the sides of angle θ. The distance from a or b to the center c of shaft 40 is proportional to the distance between a and b, or the length of the line ab. The ratio of ab to ac is determined by a preliminary calibration where ac is known and ab is measured as the distance between two points corresponding to a and b at which the circuit makes and breaks when the magnet pole N of magnet 100 is moved horizontally in and out of angle θ.

When this ratio is once determined, it is employed in the following equation, in which a', b' and c' represent new positions of the corresponding points a, b, and c:

$$a'c' \text{ equals } b'c' \text{ equals } (a'b')\frac{(ab)}{(ac)}$$

Thus the depth of the pipe is measured with a practical degree of accuracy. The position of point y, vertically above x, is, evidently, on the bisector of angle θ, or at the midpoint of ab.

In Fig. 3, e and f represent positions of magnet 100 at which the signal circuit is open.

It is not essential that the contact 36 be of mercury. It may be of solid metal fixed in switch casing 28. When contact 36 is made of solid metal it is clear that the vane 78 cannot pass the contact 36. It is not necessary that it do so. It will be noted that, by simply reversing the position of poles S and N of magnet 100, the N pole or the S pole of vane 78 rotates through about 180 degrees of angle and contacts 36 from the other side. Therefore the position of the pole N of magnet 100 on one side of the angle θ and of pole S of magnet 100 on the other side of angle θ corresponding to the positions a and b or a' and b' at which the circuit makes and breaks, serves the same purpose of determining depth of c below a' and b'.

It should be observed that the farther the exploring device 18 is away from device 16, the greater is the distance $a'b'$, and the reverse proposition is also true. Therefore, as the earth is dug away to approach pipe 10, the device 18 gives more critical indications of the pipe position and facilitates the more direct approach to the pipe.

I claim:

1. Apparatus for determining the location of a hidden pipe comprising in combination: a flexible rod, a switch secured to one end of said rod, a signalling device, and an electrical circuit including said switch and signaling device, said circuit including conductors extending from the switch and along the rod to the signaling device; and a separate magnet for actuating the switch to control the circuit.

2. The method of determining the location of a pipe which includes extending a circuit controlling member into the pipe and actuating the controlling member from points outside the pipe.

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No references cited.