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NOTE ON A NEW INSTRUMENT FOR SURVEYING DEEP BORE HOLES.

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(Read before the Mining Section, 30th November, 1905.)

It is a well-known fact that deep borings are seldom true, and although artesian wells seldom depart very much from the vertical owing to the method of drilling them, yet diamond drill holes and other borings with rotary apparatus very frequently drift very far out of line. So long as the hole is not deep this drifting is not a serious matter, but on holes of say 1,000 feet, the departure from line sometimes exceeds ten per cent. In extreme cases such as certain very deep recent borings near Johannesburg, holes which were intended to be vertical have drifted more than 2,500 feet to one side of their aim.

In view of the great cost of these deep borings it is extremely desirable that the exact location of cores brought to the surface should be determinable, and a number of devices have been introduced within the last few years for the purpose of surveying holes. Most of these devices are comparatively crude and their use involves a great deal of labor.

The apparatus most generally used of late years has been a cylinder of glass, partially filled with hydrofluoric acid. This cylinder, usually less than one inch diameter, is enclosed in a brass case and attached to the end of a string of screwed rods and lowered into the hole to a known depth where it is left for some hours and then withdrawn. The inclination of the hole can easily be read from the glass vessel, as the upper surface of the hydrofluoric acid etches the glass quite distinctly, but the direction of the hole can only be determined by marking the orientation of the top rod while the etching is taking place, marking each joint when the rods are taken apart and finally screwing them together again on the surface in order to compare the orientation marks with the etching on the glass tube. By surveying points at distances of say 300 or even 500 feet, the general course of a bore hole can be determined by the method above described, but the method is laborious and costly and owing to almost unavoidable twisting of the rods the results have seldom proved very satisfactory.

Another method of surveying involves the use of plummets and compasses immersed in a solution of gelatine which slowly hardens after the apparatus has been sent down the hole. This device, although very ingenious, has proved very difficult in use and has not met with much success, especially in deep holes. A very recent form of the apparatus uses paraffine in place of gelatine. The instrument contains an electric resistance and is connected with a dynamo on the surface by double insulated cables. The compass and plummet remain fixed in the solid paraffine while the instrument is lowered to the station in the hole. Current is then sent through the cable and the paraffine melted. The current is then shut off and after sufficient time has elapsed for the paraffine to solidify the instrument is reeled in and its records read. The apparatus should give accurate results, but the long line of insulated cable is costly and liable to injury. (Marriott—Trans. Inst. Min. and Met., Feb., 1905.)

A few months ago an instrument maker in Johannesburg designed a very ingenious apparatus containing compass, plummet, small cameras and electric light, the whole connected with a small adjustable clock so that the light could be turned on for a given period after the apparatus had been lowered into the hole. This apparatus was described by its inventor, Wm. Helme, at a meeting of the Institute of Mining Surveyors of the Transvaal on May 27th, 1905. It has since been used in surveying a number of holes and has proven extremely satisfactory.

A prominent mining engineer of the author's acquaintance states that he has had the machine tested by surveying several holes twice and has found the readings to agree so closely in all cases that he scarcely considers it necessary to take check readings unless the first set show some unusual change of direction in the hole. The apparatus, instead of requiring rods, the use of which involves a great expenditure of time and labor, and the use of a derrick and a power hoist, can be lowered on the end of a piece of flexible wire from a large reel and thus several observations per day may be taken by two men.

The writer has not had an opportunity to use the instrument in actual surveying, but has taken a number of observations with it on the surface and has found its records interesting and apparently exact. He therefore feels justified in submitting the following brief description of the instrument taken from the original paper by its inventor.

GENERAL DESCRIPTION.

Briefly described, this instrument is one in which both dip and deviation are recorded by means of photographs of the positions of both a plumb-bob and a magnetic needle at any desired point in a borehole. The photographs are taken by means of two small electric lamps lit by a "time contact."

DETAILED DESCRIPTION.

The instrument comprises a brass cylinder 20 to 30 inches long; both length and diameter are varied to suit the particular requirements. The cylinder is made in two portions, which screw together quite flush shoulder to shoulder. The top and bottom are closed by means of tightly-fitting screwed plugs. To the top plug is attached a brass swivel with an eye piece, by which the instrnment is suspended. The swivel is fitted to the plug with ball bearings. The object of this swivel is to prevent the wire, which is used in lowering the instrument, from twisting; also, to minimise risk of the instrument kicking against the sides of the borehole when being lowered or raised. Inside the cylinder, immediately beneath the top plug, is a spring resting on a pad, which keeps firmly in position a small watch or timepiece. Below the watch is a dry battery. Below this again is arranged a tiny electric lamp, and below the lamp is a glass plate, from the centre of which hangs a small plumb-bob. Below the plumb-bob is a circular brass plate supported on gimbal bearings, so that it always remains in a horizontal position. On this plate is placed a small disc of sensitised paper. Below this is another electric lamp, and below this again is a compass, which is also supported on gimbal bearings. On the dial plate of the compass is placed another disc of sensitised paper; each disc is pierced by a pin-prick in the centre, and another on one side, and both discs are fixed in exactly the same relative position, one above the other, when in the instrument. The whole is kept firmly in position from below by another spring placed under the little cup holding the magnetic needle, and resting on the bottom screwed plug. When the hand of the watch is passing the 12 o'clock point on the dial, it makes contact for about 15 seconds with a small projecting spring made of copper foil, which is connected with one line from the battery. The hand of the watch is connected with the other line; and so, when in contact with the spring, the circuit is completed; both electric lamps are lighted; and photographs are taken of the positions of the plumb-bob and the magnetic needle. It is only necessary to set the watch so that the hand will only pass the 12 o'clock point after sufficient time has elapsed to allow for the instrument being lowered to the required depth, and also to allow for the plumb-bob and magnetic needle having come to rest. In practice, it is usual to take readings at, say, every 200 feet to 300 feet, and two readings should invariably be taken in each instance. When once the photographs have been obtained, the rest of the work is easy; for, the height of the point of suspension of the plumb-bob above the centre of the disc being known, and the distance of the lower end of the plumb-bob from the centre of the disc having been obtained by accurately measuring the distance between the centre of the photograph of the plumb-bob and the centre of the disc, the angle of dip can be calculated. The direction is also easily obtained by placing the two discs in the same relative positions which they occupied while in the instrument, which can at once be done by means of the two pin-pricks on each. The direction of the line joining the centre with the image of the plumb-bob on the one disc will then (unless it happens to fall in the magnetic meridian) make an angle with the photograph of the magnetic needle on the other disc, and from this angle the magnetic direction of the path of the borehole at that particular point is determined. In surveying a borehole, say 4,000 feet in length, two sets of readings should first be obtained at regular intervals, which should not exceed 250 feet in length. When these have been obtained, the dip and deviation must be calculated for each point, and then sufficient data are available to plot, in plan and section, the true path taken by the borehole. (Proc. Institute of Mine Surveyors, Transvaal, May 27, 1905.)

DIAGRAM OF INSTRUMENT