NEW EQUIPMENT AND TECHNOLOGY FOR DEEP CORE DRILLING IN COLD GLACIERS

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ABSTRACT

A new electro-thermal drill, ETB-5 was developed from the model ETB-3, for the purpose of coring in glaciers which contain ice colder than -33°C. The unit and its functioning principles is described.

INTRODUCTION

The powerful and reliable electro-thermal drill, ETB-3 (Morev *et. al.*, 1981) is used for drilling in ice when the temperature is not lower than -33°C. The upper layers of the central east Antarctic ice sheet have temperatures as cold as -57°C. The attempted deployment of ETB-3 under these conditions would require a considerable increase in core barrel diameter, and, accordingly, excessive quantities of electrical power and liquid fillers. Instead, for optimum dimensions of core and hole, using reasonable power levels, the ETB-5 drill was developed.

THE DRILL UNIT

Figure 1 is a schematic diagram of the ETB-5 drill unit. It consists of a drill heater shoe attached to two concentric barrels, the inner one of which serves as the core barrel. Above the shoe, are the three core grippers. A lower piston moves within the confines of the core barrel. Above, there is another set of concentric barrels, the inner one of which contains the upper piston which is connected to the first by a connecting rod. There are two sets of fluid filling nozzles, one set for each chamber and a set of inlet ball valves.

At the top end there is an end cap assembly and a spring loaded cable termination.

The drill is suspended in the hole by a single cored armored cable (KG-1-40-180) with a diameter of 8.6 mm. Power applied to the drill heaters, varies from 3 to 4 kW. Energy losses in a 4 km long cable amount to 3 to 4 kW. The maximum power consumption would therefore be up to 8 kW (supplied at 600 to 800 V).

The core barrel may be made 1.5 m to 3 m long, as is the case with the ETB-3 drill to which it is analogous in principle.

WORKING PRINCIPLE OF THE DRILL

The first step is to fill the upper tank and the core barrel with anti-freeze solution of the required concentration, the pistons being set at their lowest position. After lowering the drill to the base of the hole and switching on the power, the melting process at the annular drill face commences. During this process, the core lifts the pistons, as a result of which, the solution is expelled from the core barrel and travels down the space between the concentric barrels to the lower drill hole area, where, after mixing with the melt water, it produces the first solution. (If the core barrel is filled with 96 % alcohol, then the resulting lower solution has a strength of about 50 % alcohol).

As it is expelled by the rising

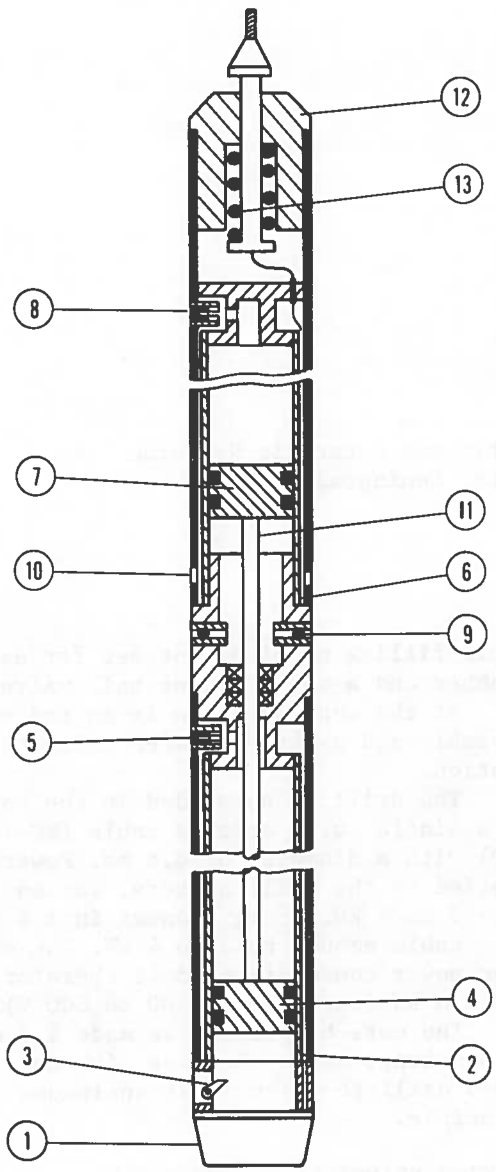

Figure 1. Schematic diagram of the ETB-5 electro-thermal core drill. (1) Heater shoe. (2) Lower double tubes. (3) Core grippers. (4) Piston with rings. (5) Lower fluid filling inlets. (6) Upper double tubes. (7) Upper piston with rings. (8) Upper fluid filling inlets. (9) Inlet pressure valves. (10) Fluid discharge openings. (11) Connecting rod. (12) End cap assembly. (13) Spring and cable termination assembly.

upper piston, the upper fluid is forced through the space between the barrels and out the openings (10) shown in Fig. 1. By means of the inlet valves (9), the original, lower solution is now extracted from the hole by suction and collected in the lower end of the upper chamber.

In this way, an anti-freeze solution of the required concentration is distributed more evenly along the length of the barrel. As a result, un-necessary excess melting of the bore hole walls and the subsequent dilution of the anti-freeze solution is minimized. Excessive dilution and cooling of the solution could lead to shuga (slush) formation.

FIELD TESTING OF THE UNIT

The drill was tested on a glacier of Severnaya Zemlya. It is now being tested at Komsomolskaya Station in east Antarctica, where the near surface temperature is -53°C. The drill equipment sent to Komsomolskaya includes a heated shelter, mounted on a steel transport sled. The total weight of the equipment including the sled is about 18,000 kg. The shelter contains a 16 kW diesel power unit, a cable winch with a drum capacity of about 5 km of cable and an electric drive with a power of 7 kW. Above these units there is a tower 9 m high. Other items include a control panel, and a dynamometer. Hot water heating is by excess heat from the diesel generator and there is natural and artificial ventilation.

After its extraction from the hole the drill is placed on a table and the core removed. The chambers are then refilled with anti-freeze solution. These procedures are carried out in a special unheated cabin where the core examination and analysis is also performed. The dimensions of the drill shelter are 3.5 m x 8 m and of the unheated cabin 2.5 m x 5 m.

To provide vertical holes, the cable is kept under tension. This is controlled by partially activating the spring in the end cap of the drill. The tension may be measured using the dynamometer or using sensors installed in the spring assembly. Due to the lower weight of cable in fluid, it is possible to control the cable tension entirely using surface equipment down to a depth of at least 2.5 km. Tensometers may be used when the sensitivity of surface instrumentation is inadequate.

REFERENCE

Morev, V.A., V.A. Pukhov and A.G. Nikiforov (1981) Equipment for deep core thermo-drilling in ice. *Authors Certificate No.* 794178. *Bulletin of Inventions No.* 1.