

INSTRUMENTS AND METHODS

THE PICO LIGHTWEIGHT CORING AUGER

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ABSTRACT. A new lightweight hand-operated coring auger for use in firn or ice is described. Extensive use of glass-epoxy composites contributes to a drill weight of approximately 1 kg/m in 20 m and 50 m configurations.

RÉSUMÉ. Le carottier léger PICO. On décrit un nouveau carottier manuel léger pour le névé et la glace. L'utilisation de composés verre-résine permet

d'obtenir un poids de l'ordre de 1 kg m^{-1} pour des carottiers de 20 m et 50 m.

ZUSAMMENFASSUNG. Der leichte PICO-Kernbohrer. Ein neuer leichter Handkernbohrer für Firn oder Eis wird beschrieben. Weitgehende Verwendung von Epoxy-Glas-Teilen vermindert das Gewicht des Bohrers auf etwa 1 kg/m in 20-m- und 50-m-Ausführungen.

INTRODUCTION

The Polar Ice Coring Office (PICO) has completed field tests of a new lightweight hand-operated coring auger capable of collecting firn or ice core to 50 m using a tripod to assist in raising the drill string, or to 30 m without the use of a tripod. The drill barrel and extension components are made primarily of glass-epoxy composites, with aluminum used for the drill heads and adapters. The drill weighs approximately 1 kg/m, and is designed for backpacking and core drilling in high-alpine, remote locations.

The use of composite materials, with their favorable strength, has increased hand-augering depth capability to the 50 m range. Traditional SIPRE auger cutting heads and bits have been redesigned to include core dogs which enhance core-catching capability. This drill system has been used with an electric motor and solar voltaics as a power source to decrease drilling time, while avoiding contamination of the snow surface otherwise associated with gasoline-powered generators.

The concept of using glass-reinforced composites in drills and extensions is neither new nor unique in glaciological applications. However, the unique properties of composite materials and current mass-production practices have made it desirable from structural and economical viewpoints to use these materials in drilling applications.

Tests conducted in Greenland, Antarctica, Alaska, and the Peruvian Andes to depths of 40-45 m have demonstrated the effectiveness of this drill design. The tests were conducted by PICO engineers and principal investigators from other universities in field situations over the period 1980-82.

DRILL DESCRIPTION

The core barrel, available in either 1 m or 2 m lengths, is a piece of 7.5 cm diameter composite pipe, wrapped with two ultra-high molecular weight polyethylene spirals cut from sewer pipe and riveted to the barrel. An aluminum adapter, held in place by pins, is used to connect the core barrel to the extensions.

The extensions are 5 cm diameter composite pipes, cut to either 1 m or 2 m lengths, which weigh 1 kg and 1.5 kg per extension, respectively. Since it was recognized that nearly all the strength benefits of composites are lost when the glass fibers are cut, a design problem was encountered in determining the method to be used in joining the extensions. Screw threads were decided upon as being the least expensive alternative, since other attachment methods involved more intricate mechanisms and heavier components. The screw threads used are modified ACME threads

which are used commercially to join lengths of composite water piper (Fig. 1). The strength of the joints and pipe used in the auger is thus more than adequate for this application. Another advantage in using screw threads is that nothing sticks out beyond the outer diameter of the extension pipes, as quick-release pins would, thereby eliminating the problem of chips being scraped off the hole wall onto the barrel. As a result, the core length capability per run is not decreased due to the barrel filling up with chips from the hole wall. The extensions can be easily detached in 1-12 m increments (Fig. 2).

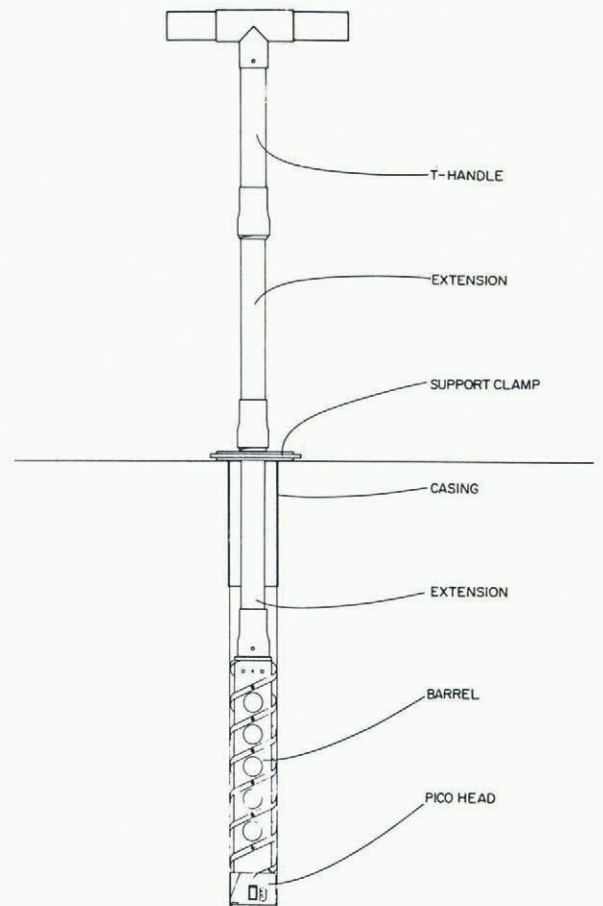


Fig. 1. Lightweight hand auger with hole casing.



Fig. 2. PICO driller with 9 m of extensions and 2 m auger barrel.

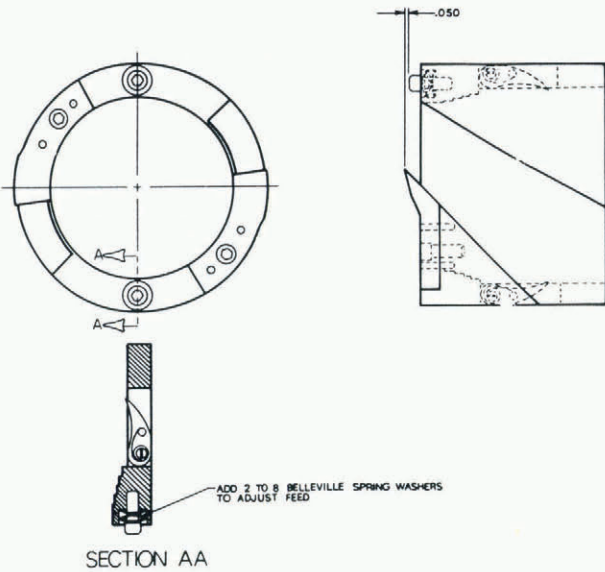


Fig. 3. Cutting head showing adjusting screws and core dogs.

A new cutting head has been designed to incorporate both a tapered annulus and core dogs to insure positive catching of the core after each run. Additionally, the leading angle of the cutters has been made more shallow (45°) for easier cutting. Adjustment screws are necessary to control the rate of penetration and to avoid jamming the drill head in the hole (Fig. 3).

By using the 2 m core barrel, cores in the range of 0.8-1.2 m can be retrieved in each run. As a result, 20 m holes can be drilled in four hours, 30 m holes in ten hours, and 40 m holes in fifteen hours drilling time. Depths beyond 40 m require the use of a tripod and a strong desire to go deeper.

ACCESSORIES

The use of a tripod in lowering and lifting the drill string increases the depth capability of this system to 50 m. A block and tackle is used to multiply the lifting force by four. By using a casing around the top of the hole and clips which rest on the casing, the drill string can be suspended while extensions are removed, further relieving the burden of raising and lowering the drill (Fig. 4).

The use of solar voltaics to power an electric motor attached to the topmost extensions was demonstrated in Greenland and Antarctica during 1981-82

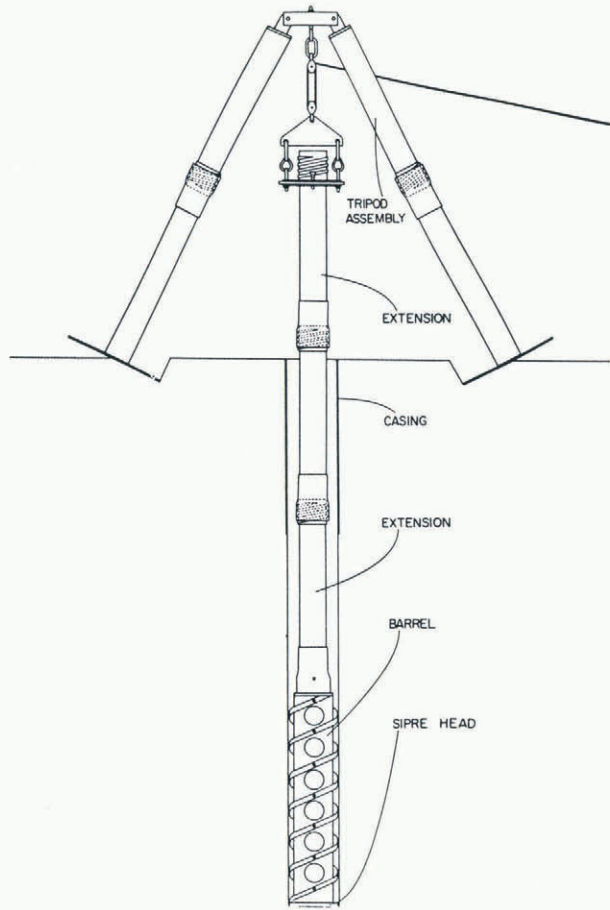


Fig. 4. Tripod assembly with lightweight auger.

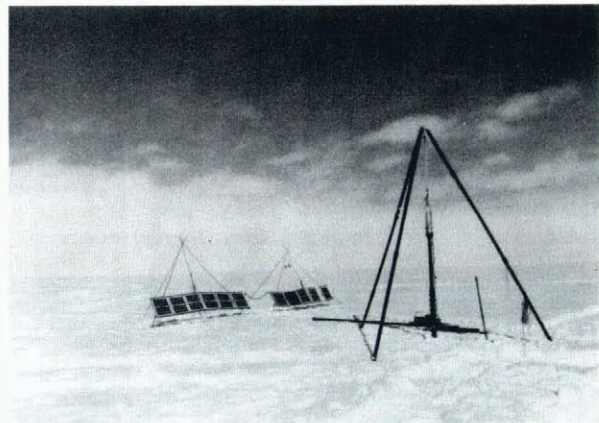


Fig. 5. Lightweight auger with solar-generated power.

(Fig. 5). Since only 250W are required to drive this drill, the motor package is neither large nor heavy. Penetration rates of 1 cm/s were achieved in firn at 40 m depth on a sunny day at Dye 3, Greenland, with the rate being reduced by half on a cloudy day.

ACKNOWLEDGEMENT

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