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National Water Research Institute

Institut National de Recherche sur les Eaux

THE DEVELOPMENT OF A THROUGH-THE-ICE WATER SAMPLER

by

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ABSTRACT

The design, manufacture and in-house development of a prototype through-the-ice biological water sampler was completed. This sampler has a capacity of 3.7 ℓ ; it has a minimum of external appendages to prevent ice formation; it is small in diameter to penetrate an ice auger hole of 20 cm, and is operable to 300 m depth in sea water.

RÉSUMÉ

La conception, la fabrication et la mise au point en usine d'un prototype d'un échantillonneur d'eau biologique utilisable au travers de la glace, sont terminées. Cet échantillonneur a une capacité de 3,7ℓ, il a un minimum d'accessoires extérieurs pour empêcher la formation de glace, il est de diamètre réduit de manière à pouvoir pénétrer dans un trou de foret à glace de 20 cm et il est utilisable jusqu'à 300 m de profondeur en mer.

MANAGEMENT PERSPECTIVE

The Department of Fisheries and Oceans are carrying out a long-term oceanographic program around the North West Passage in the Arctic. In this program water samples are to be obtained through small diameter holes cut in the ice. This new sampler provides an efficient method to obtain, store, and transport samples of water until the contents are removed for analysis. The same sampler could possibly be used for winter operations in ice-covered portions of lakes.

T. Milne Dick
Chief
Hydraulics Division

April 1982

PERSPECTIVE DE GESTION

Le ministère des Pêches et des océans poursuit un programme océanographique à long terme autour du Passage du Nord-ouest dans l'Arctique. Ce programme prévoit le prélèvement d'échantillons au travers de trous de petit diamètre pratiqués dans la glace. Le nouvel échantillonneur constitue un outil efficace pour l'obtention, le stockage et le transport d'échantillons d'eau jusqu'à ce que son contenu soit retiré pour analyse. Le même échantillonneur pourrait être utilisé pour les opérations hivernales dans les parties englacées des lacs.

T. Milne Dick
Chef
Division de l'hydraulique

Avril 1982

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ADDENDA

1.0 INTRODUCTION

A requirement by Department of Fisheries and Oceans Arctic field parties for a supply of biological water sampling bottles suitable for sampling through ice cover, and being transported by helicopter, fixed-wing aircraft or tracked vehicle was completed by the Equipment Research and Development Unit. The design, manufacture, and lab testing of one prototype sampler was initially completed, followed by the production of a further eleven units. Five bottles were field tested during the spring of 1981, and from this experience, design changes have been applied to the remaining seven bottles. These seven have undergone field tests in the spring of 1982 and have performed satisfactorily. The original five bottles will therefore be brought up to the new specificaion at a later date. This work was done for D.J. Brooks of OSS, DFO, under Study No. OA0-99.

2.0 DESIGN CRITERIA

The following specifications were laid out by the client:

1. Volume of water sample 3 to 6 litres.
2. Sampler to pass through an ice hole 23 cm in diameter.
3. No external mechanisms which would snag or collect ice.
4. Materials suitable for general biological use in salt or fresh water.
5. Uncontaminated sampling, actuated by a mechanical messenger.
6. Bottle to become its own, non-leaking, storage unit for transport to laboratory.
7. Bottles to be used singly on a wire.
8. Nominal operating depth of 300 metres.

3.0 DISCUSSION

A design concept for a through-the-ice biological water sampler was evolved which used an evacuated cylinder sealed at each end by a plug valve. The cylinder was to be evacuated at the laboratory in the field camp, sealed, opened at the proper depth by a standard messenger, resealed at the surface, and opened and drained at the field laboratory.

In the planning phase, it was decided to investigate commercially available cylinders which were no more than 20 cm in outside diameter, built of corrosion resistant material, and capable of resisting an external pressure in excess of 7 MPa. A number of cylinders were reviewed and/or tested including: (1) aluminum "Scuba" cylinders; (2) fiberglass hot water tanks; (3) stainless steel sample cylinders. A 'Whitey' 3785 cm^3 stainless steel cylinder was finally selected and purchased, along with a carrying handle and two Nupro P4T series, type 316 stainless steel valves.

Referring to Figures 1 and 2, the sampler consists of the bottle with attached carrying handle (9); a drain valve (14), and dispensing fitting (13) at the bottom; the inlet valve (7); the striker (3); valve control linkages (1,6); a mooring attachment fitting (2) at the top; and a protective cage (12). A lead ballast was also designed for use in high current areas.

The prototype sampler met the design criteria in that the bottle filled in less than one minute, had a capacity of 3785 cm^3, was rugged, did not leak, and could be submerged to a depth of at least 685 m of sea water, and was protected from premature triggering. Stock components were therefore ordered for a further eleven units, and a contract was let for the special parts to be manufactured. A total of five units were completed in time to be shipped to Resolute Bay in early February 1981 where they saw service. A short instructional note was prepared and delivered at this time.

The remaining units were assembled in late March when the remainder of the back-ordered parts arrived.

Initial field testing revealed a problem of apparent internal corrosion of the cylinders, causing the production of a flocculent iron oxide and discoloration of the water sample. The problem was subsequently traced to mill scale on the inside shoulders of the bottle caused by a hot swaging operation during manufacture. The manufacturer of the bottles recommended an acid etching to clean the bottles (see Schedule 1) and subsequently acid cleaned and internally glass shot blasted one bottle. Upon testing at CCIW with synthetic sea water, no further corrosion

products were formed. The remaining bottles were then similarly pickled, blasted, steam cleaned, and reassembled.

At the same time, some further modifications were made in light of field experience. Instead of single sampling on a wire, as required by Design Criteria No. 7, the client now wished to string several bottles on one line and to serially trigger them. Messenger hooks were therefore added to the valve actuating levers at the top of each bottle. Thus when each bottle is opened by a messenger arriving from above, it in turn drops a messenger hanging on the wire below it to trigger the next bottle.

Field experience had also shown that water currents under the ice were sufficiently low that the lead ballast weight was unnecessary. The cage could therefore be shortened by 140 mm to decrease weight and improve handling.

4.0 CONCLUSIONS

The sampling bottles meet all their specified requirements and have proven to work well in the 1982 field season. Provided that reasonable care is taken in cleaning and maintenance, they should give many years of good service.

5.0 RECOMMENDATIONS

Consideration should be given at some future time to building a clamp arrangement for the samplers to avoid having to cut and splice the lowering wire for serial sampling.

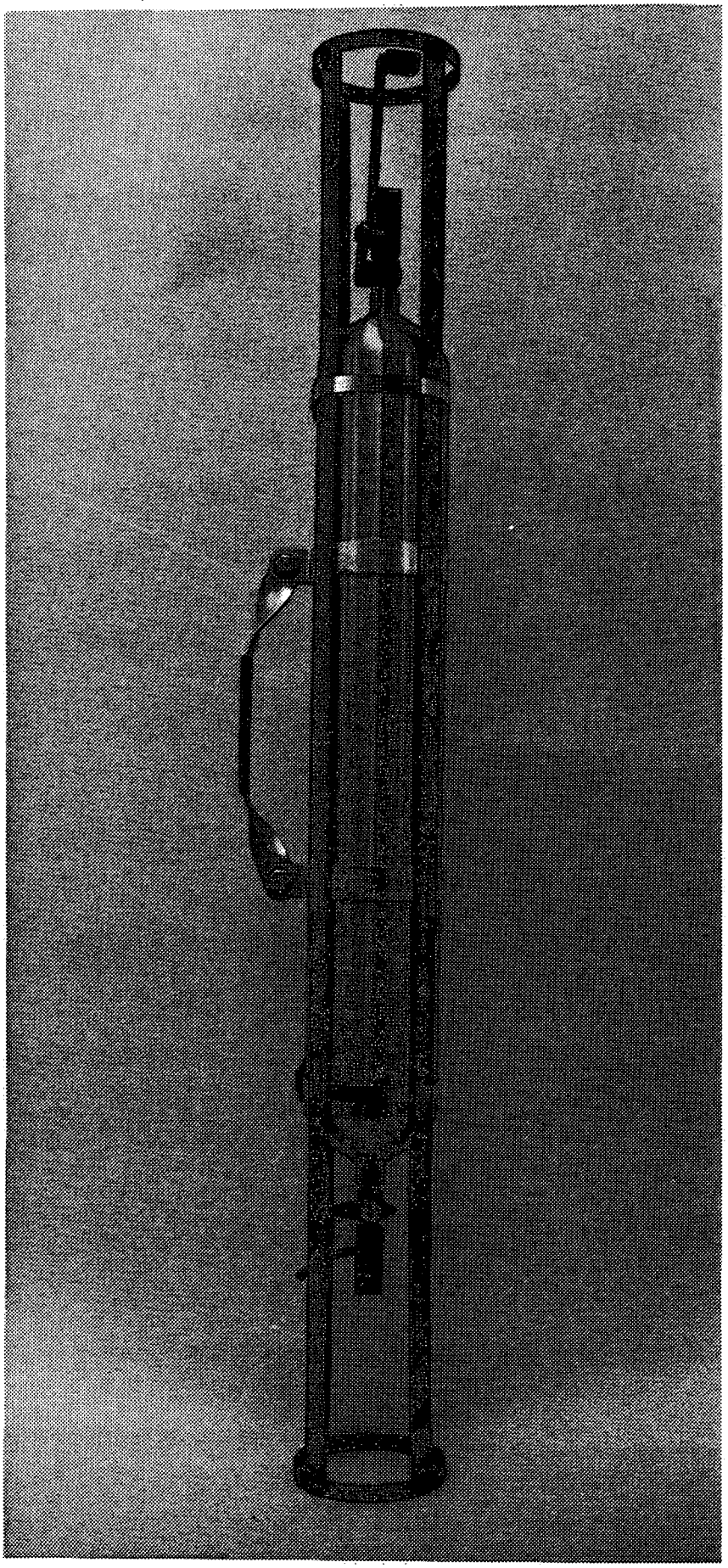

FIGURE 1. BOTTLE MK #1

PARTS LIST		
PART NO.	DESCRIPTION	QTY.
1	Valve Operator	1
2	Upper Attachment	1
3	Striker	1
4	Hex Head Capscrew	1
5	Hex Nylock Nut	1
6	Actuator Strap	1
7	Nupro Valve	2
8	Whitey Cylinder	1
9	Whitey Handle	1
10	Bandit and Buckle	2
11	End Ring	2
12	Side Bars	4
13	Spigot	1
14	Lower Attachment	1

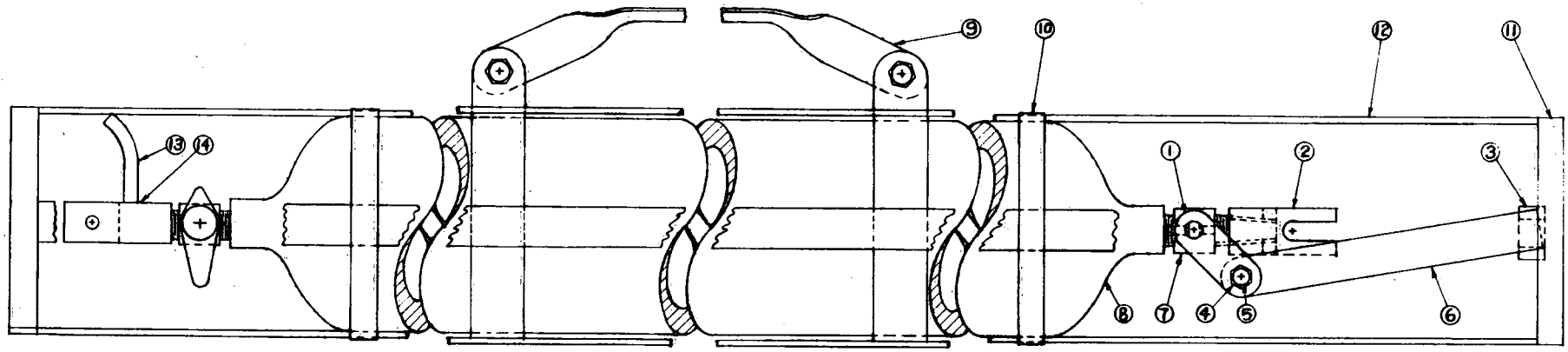

FIGURE 2

Figure 2

Environment Canada / Canada Centre for Inland Waters		Environnement Canada / Centre Canadien des Eaux Intérieures	
TITLE: Arctic Water Sampler Assembly and Parts List			
DESIGNED BY: RS	CHECKED BY: RS	APPROVED BY:	
DRAWN BY: SVV	CHECKED BY:	DRAWING NO.: ME 5112-5	
SCALE: 1:1	DATE: 81-5-25	SHEET OF	
		304 Stainless	

SCHEDULE 1

CLEANING, CYLINDERS, PICKLING

REVISION	REFERENCE	DATE	PREPARED BY	APPROVED BY
C	ECN 832	6-12-81	ABS	

1.0 SCOPE: Requirements for special cleaning, at the customer's request, for all sizes 304L and 316L Stainless Steel cylinders for use with water.

2.0 PROCEDURE:

2.1 Alkaline Clean	5 to 10 minutes
Concentration	8 oz:1 gal
Temperature	150°F
2.2 Cold running water rinse	
2.3 Activating hot sulfuric acid dip	10 minutes
Concentration (by volume)	10%
Temperature	150°F
2.4 Descaling hot acid dip	15 to 30 minutes
Concentration (by volume)	
Nitric acid	7%
Sulfuric acid	7%
Hydrofluoric acid	7%
Temperature	130°F
2.5 Cold running water rinse	
2.6 Hot running water rinse	
2.7 Centrifugal dryer	2 minutes

3.0 INSPECTION:

3.1 Inspect the inner surface with a probe type light such as the Titan "INTRA LITE" or the Welch Allyn "ILLUMINATOR".

3.2 The inner surface must be completely free from scale or rust, with a uniform matte appearance.

3.3 Overetching due to prolonged exposure to acid shall be a cause for rejection.

3.4 The outer surface may have a frosty finish caused by pickling.

4.0 MARKING: Add -161 after the stamped part number.

5.0 VENDOR: NIAGARA VALVE & FITTINGS LTD.
174 PARKDALE AVE. N.
HAMILTON, ONT. L8H 5X2

16040