Energy, Mines and Resources Canada

Énergie, Mines et Ressources Canada

# CANMET

Canada Centre for Mineral and Energy Technology

Centre canadien de la technologie des minéraux et de l'énergie

**Mining Research Laboratories**

**Laboratoires de recherche minière**

Canada

[redacted]

# THE REMOVAL OF CONES FROM TRICONE DRILL BITS USING EXPLOSIVES

D.L. Cox and D.L. Wilson
Canadian Explosives Research Laboratory

MRL 87-59 (TR)

FEBRUARY 1989

# THE REMOVAL OF CONES FROM TRICONE DRILL BITS USING EXPLOSIVES

by

D.L. Cox * and D.L. Wilson **

## ABSTRACT

This report describes the development and evaluation of an explosive system for the removal of cones from 75 mm tricone roller drill bits.

---

KEYWORDS: Drill bits, explosives, composition C-4, Detaprime P-3, annealed Acetal rod, phenolic tubing.

* Explosives Technologist, ** Mechanical Technologist, Canadian Explosives Research Laboratory, Mining Research Laboratories, CANMET, Energy, Mines and Resources, Ottawa, Canada.

# ENLÈVEMENT DES CÔNES DES TRÉPANS TRICÔNES AU MOYEN D'UNE CHARGE EXPLOSIVE

par

D.L. Cox* et D.L. Wilson**

## RÉSUMÉ

Le présent rapport comprend une description du développement et de l'évaluation d'un système de charges explosives pour enlever les cônes des trépans tricônes de 75 mm.

Mots clé : outils de forage; explosifs; composition C-4; Detaprime P-3; tige Acetal recuite; tiges phénoliques.

---

*Technicien des explosifs, ** Technologue mécanicien, Laboratoire canadien de recherche sur les explosifs, Laboratoires de recherche minière, CANMET, Énergie, Mines et Ressources, Ottawa, Canada.

## CONTENTS



## FIGURES

## INTRODUCTION

The Canadian Explosives Research Laboratory (C.E.R.L.) was requested to assist D.R. Boyle of the Geochemical Methodology and Research Section (G.M.R.S.) of the Geological Survey of Canada in a research project involving reverse circulation exploration drilling.

The project involves sampling ground water. The drill rod serves as the access to the hole for the ground water sampling equipment. C.E.R.L. was asked to develop and evaluate a system for removing the cones from the tricone roller bits (see Fig. 1). This system was intended as a labour saving device by removing the cones from the worn out bit rather than driving casing, pulling the drill rod, removing the bit and reinserting the drill rod. The drill rod is necessary to provide a smooth passage for the equipment and reinforcement to prevent the hole from caving.

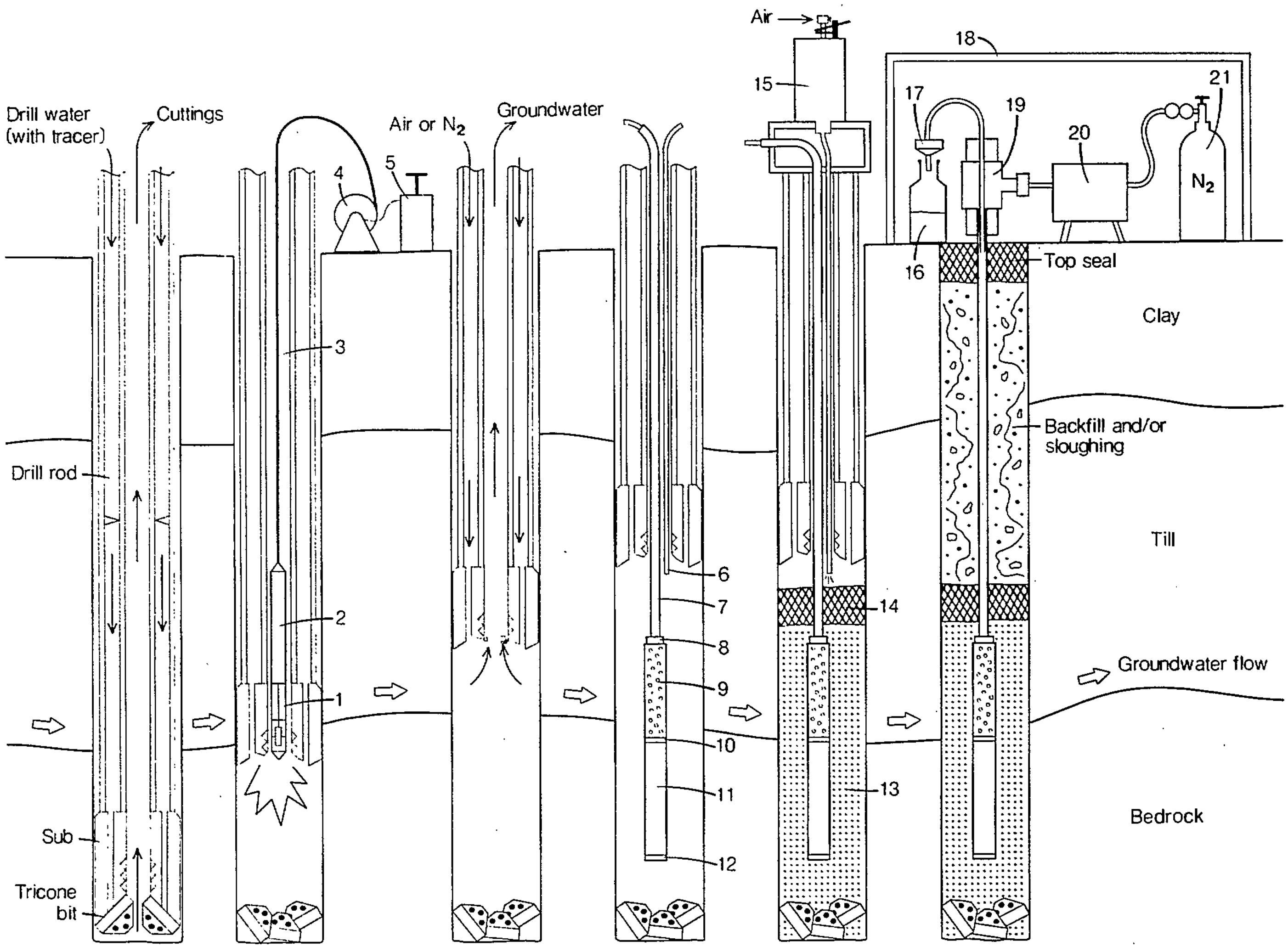
## A DESCRIPTION OF THE DRILL BITS AND CONDITIONS

The tricone roller bits involved are 75 mm bits with three intermeshed cones with tungsten-carbide button inserts. The mounts for the cones are cast into the body of the bit. There are three 8 mm holes for flushing water to enter the crushing area and a 28.5 mm central return hole. This centre hole opens from 28.5 mm to 55 mm over a distance of 25.5 mm to accommodate the cones.

The expected borehole depths will run from 15 to 120 metres. Blasting will take place approximately one metre into bedrock with the drill string pulled a short distance from the bottom of the hole. The holes will be wet with a water temperature of approximately 4°C [1].

## THE PRELIMINARY WORK

The combination of the environmental conditions and the limited




1) Tricone blasting assembly
2) Blasting delivery rod
3) Blasting cable
4) Blasting cable reel
5) Blasting box
6) Packing/sealing injection tube
7) Co axial tubing
8) Ball valve
9) Polypropylene filter
10) Reducing nipple
11) Fine sediment trap
12) End plug
13) Packing material
14) Seal
15) Packing/sealing injector
16) Sample bottle
17) Disposable filter
18) Insulated winter enclosure
19) Pneumatic sampling head
20) Pneumatic control unit
21) Compressed nitrogen

Fig. 1 - Ground water sampling system.

space available in the bit for an explosive charge led to the decision to experiment with the explosive Composition C-4.

C-4 consists of RDX and plasticizers, making it water resistant. It is easily shaped, retaining its plasticity between -29° and 77°C. It has a hand packed density of 1.60 g/cm$^3$ with a detonation velocity of 8.04 km/s [2].

The initial shot was performed with 20 g of C-4, a relatively heavy charge, hand pressed into a 22 mm diameter cardboard tube. The shot was placed in the centre of a 23 litre metal pail filled with sand. The bit was torn apart by the explosion, allowing an examination of the construction of the bit body and the cone mounts (see Figure 2). The second shot was set up like the first with the exception of the charge weight. A 10 g charge was used, with the result that two cones were blown off and the mount of the third cone was bent back. This demonstrated that the charge weight was roughly the required strength, however more directional control of the blast energy was required.

## THE EXPERIMENT

Initially, a mock-up of a borehole had to be constructed. This was accomplished by using a length of drill casing inserted into a 25 litre metal pail filled with sand and water.

Secondly, a charge holder had to be designed to contain the explosive. The factors considered in the design of the charge holder were: (1) the diameter of the centre flushing hole of the drill string (28.5 mm); (2) the working depth of the hole would be up to 120 metres; and (3) the presence of water in the hole. Additionally, the holder had to be small enough to allow loading through the flushing hole with enough play to permit displacement of the water. Therefore, a practical diameter of 22.5 mm (7/8") was chosen.

The first design consisted of a nylon holder 22.5 mm in diameter

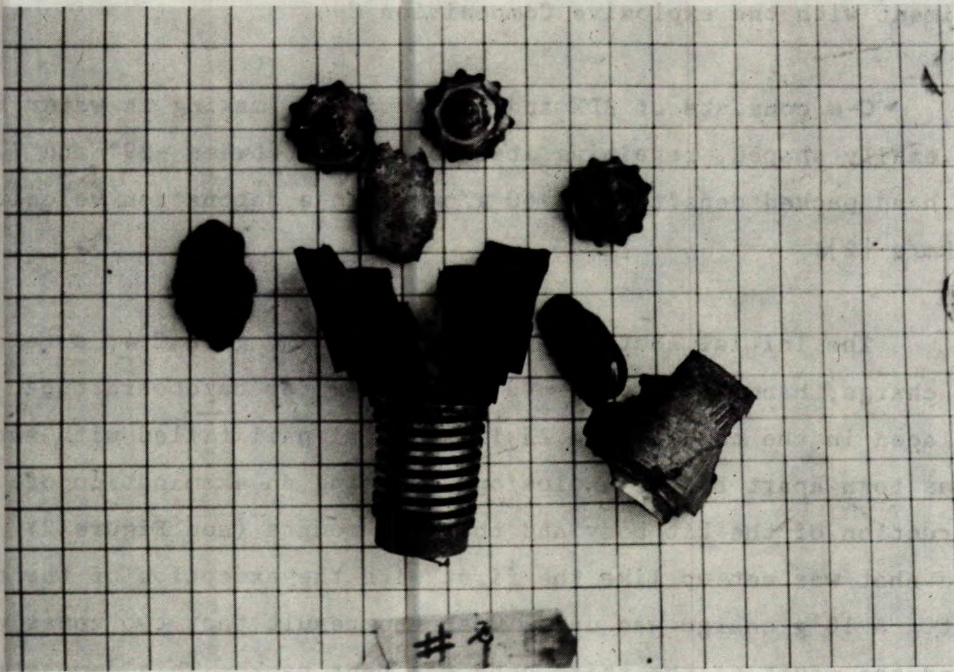


Fig. 2 - Tricone bit after shooting 20g of C-4.

and 190 mm in length, with one end machined to accommodate a detonator and 10 g of C-4. The other end was machined to accommodate a steel rod one metre long and 22.5 mm in diameter. The rod was to provide sufficient weight to sink the charge. One side of the holder was cut lengthwise to allow placement of the detonator and leg wires.

The above design and an identical one made from annealed Acetal rod produced the same results, ie: two cones were blown off. These results were considered to be unsatisfactory, but encouraging, and an increased degree of confinement of the explosive was deemed necessary. This was accomplished by using a 12.7 mm steel confinement ring, placed behind the charge, and a 6.35mm coned disk. Blasting with the confinement ring alone resulted in the removal of all three cones but with some peeling back of the cone mounts. The inclusion of the disk resulted in the removal of all three cones with no damage to the body of the bit (see Figure 3).

The next modification was to improve the charge holder by eliminating the band saw cut in the portion of the charge holder which contained the explosive. This was done by constructing a two piece charge holder (see Figure 5).

Three sizes of flat disks were tested in the two piece holder: 6.35 mm, 3.2 mm, 1.6 mm with no difference in results. The 6.35 mm disk was chosen for further tests.

## THE FIELD TRIAL

The first field trials were conducted at a site in Kingston in 3 m deep holes drilled a metre into the Limestone bedrock. Each hole held roughly a metre and a half of water.

The set-up used for these shots consisted of nominal 25 mm conduit, a modified drill sub machined to thread onto the conduit and a fabricated drill rod clamp to hold the bits up from the bottom of the hole. The conduit was used instead of drill rod because of its light

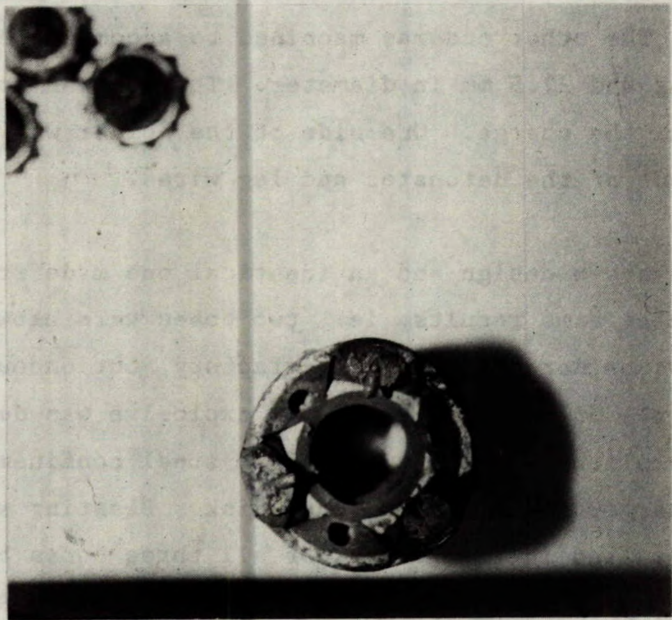


Fig. 3 - Successfully deconed bit.

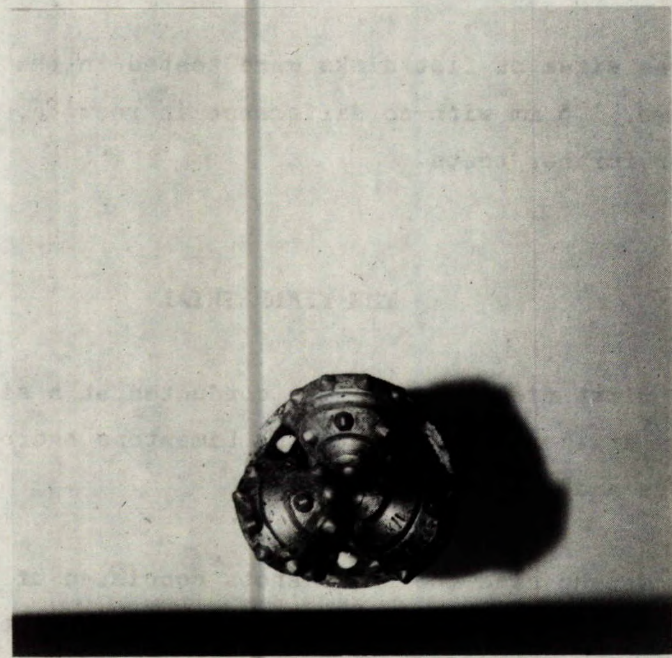


Fig. 4 - Intact bit.

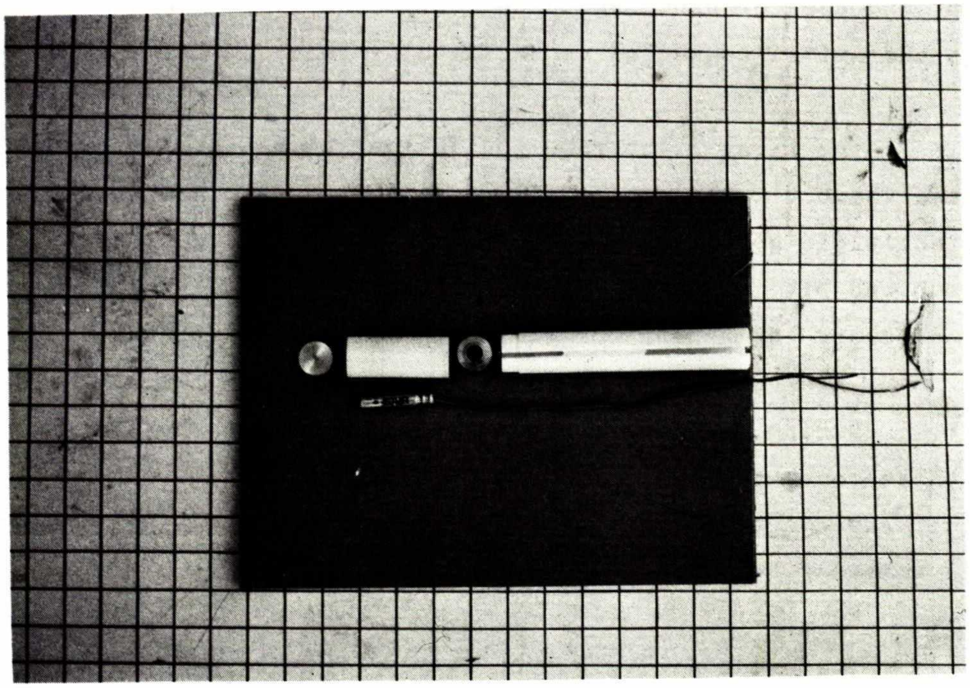


Fig. 5 - Experimental charge holder

weight and ease of handling. The charge and loading rod were lowered by cable and swivel connected to the loading rod.

The first blast resulted in the removal of two cones. However, because the bit could not be threaded tightly into the sub, the charge apparently did not seat on the cones, rather it hung up in the gap between the sub and bit, resulting in damage to the sub. Having lost the sub, it was necessary to machine the remaining bits to accept the conduit.

During the course of the remaining seven shots, three bits had all three cones removed, two bits were lost in the hole because of broken conduit and two bits were completely blown apart because they were shot while immersed in mud.

The crude delivery system presented the problem of surviving pieces of Acetal rod jamming the delivery rod in the conduit. The loading rod was freed by cutting the conduit and pounding out the rod.

## THE PROTOTYPE DEVELOPMENT

Having determined the suitability of the basic design, a prototype of a more commercially suitable device was developed.

The first consideration was the material used for the charge holder. The main disadvantates of the annealed Acetal rod are the labour involved in machining the charge holder and the possibility of material surviving the blast and jamming the flushing hole. Other considerations were the possibility of the charge not seating properly on the cones or hanging up above the bit as well as improving the delivery rod.

After meeting and discussing the changes with D.R. Boyle and R. Thibedeau, they provided us with a prototype charge holder. This design consisted of a glass tube 25.5 cm long and 22.5 mm in diameter, a steel cone, a steel detonator holder, a plastic confinement piece, a glass spacer with foam cushions and a steel disk to protect the delivery rod. A prototype delivery rod was also provided as shown in Figure 6.

C-4 was suitable for the experiment up to this point, however C-4 is a restricted explosive and cannot easily be used in a manufactured, commercial product. In place of the C-4, a PETN based, plasticized explosive manufactured by ETI called Detaprime P-3 was used. This explosive is manufactured in tubes with a 18.9 cm O-D and a 0.74 mm 1-D and can be easily cut into lengths weighing 10 g, which occupy approximately the same volume as 10 g of C-4. Detaprime has a high velocity of detonation similar to C-4's.

Trials with the prototype and the Detaprime P-3 produced ideal results in the laboratory set-up.

Modifications from this point consisted of using a one-piece stainless steel cap holder and confinement piece and substituting CEN grade Phenolic tubing, with a 22.5 cm O-D and a 19.0 cm 1-D, for the glass tubing for the main body at the holder. Glass was still used for the internal spacers.

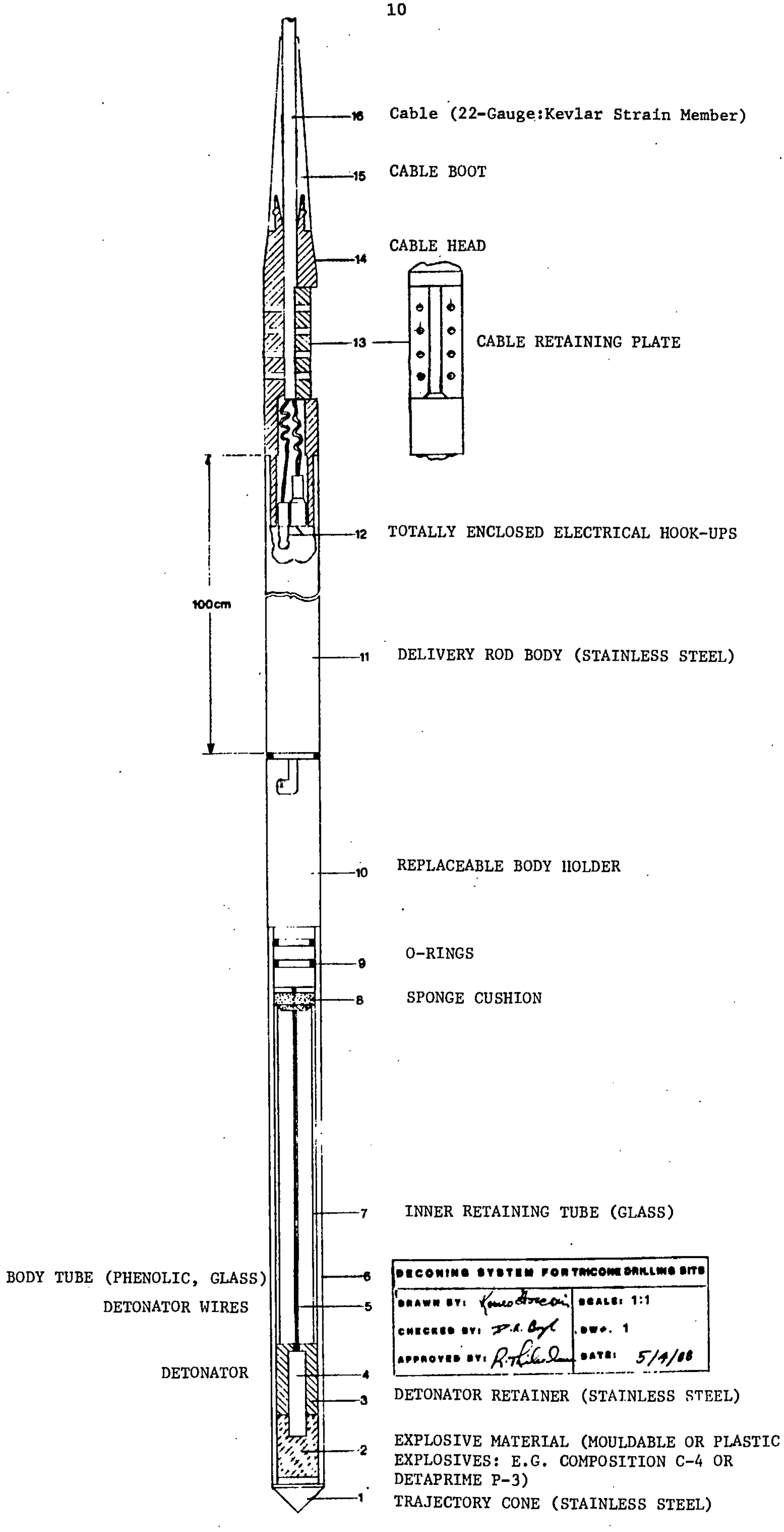
Trials with this version of the prototype gave excellent results and was considered ready for in-situ field trials.

## THE IN-SITU FIELD TRIALS

D.R. Boyle of G.S.C. carried out these test shots in Northwestern Quebec in conjunction with the field trials of the ground water sampling system.

Six shots were carried out, resulting in four successful shots, one shot had a cone jammed by surviving Phenolic and one failed shot probably because of dirt preventing the charge from resting on the cones.

Unfortunately, it was not possible to try any more than the six shots during this session.



16 Cable (22-Gauge:Kevlar Strain Member)
15 CABLE BOOT
CABLE HEAD
14
13 CABLE RETAINING PLATE
12 TOTALLY ENCLOSED ELECTRICAL HOOK-UPS
100cm
11 DELIVERY ROD BODY (STAINLESS STEEL)
10 REPLACEABLE BODY HOLDER
9 O-RINGS
8 SPONGE CUSHION
7 INNER RETAINING TUBE (GLASS)
BODY TUBE (PHENOLIC, GLASS) 6
DETONATOR WIRES 5
DETONATOR 4
3 DETONATOR RETAINER (STAINLESS STEEL)
2 EXPLOSIVE MATERIAL (MOULDABLE OR PLASTIC EXPLOSIVES: E.G. COMPOSITION C-4 OR DETAPRIME P-3)
1 TRAJECTORY CONE (STAINLESS STEEL)
DECONING SYSTEM FOR TRICONE DRILLING BITS
DRAWN BY:
SCALE: 1:1
CHECKED BY:
DWG. 1
APPROVED BY:
DATE: 5/4/88

## CONCLUSION AND RECOMMENDATIONS

The Deconing System has proven successful to this point of development and a patent has been applied for.

The system should prove to be a great saving of time and labour in the removal of cones from the tricone drill bits and will be usuable in all situations except for drill holes with an excessive quantity of mud that cannot be flushed away.

However, further field trials are recommended. A trial of one hundred shots would be the minimum required. Also, using a glass based phenolic rather than canvas based should eliminate possible jamming of the flushing hole by surviving pieces of the charge holder.

## ACKNOWLEDGEMENTS

The authors appreciate the assistance and advice of E. Contestabile and R.R. Vandebeek during the progress of this work.

The cooperation and efforts of D.R. Boyle and R. Thibedeau were indispensable to the success of this endeavour.

## BIBLIOGRAPHY

1. Conversation with D.R. Boyle, Geochemical Methodology and Research Section, Geological Survey of Canada.

2. Federoff, Basil T. et al, Picatinny Arsenal, Encyclopedia of Explosives and Related Items, Vol. 3, Picatinny Assard, Dover N.J. USA 1966 pp 1495.