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FIFTH PROGRESS REPORT

on

THE DEVELOPMENT OF A HIGH-LEVEL, DIRECTIONAL,
UNDERWATER-SOUND SOURCE USING EXPLOSION-
INDUCED SHOCK WAVES

to

ACOUSTICS BRANCH
OFFICE OF NAVAL RESEARCH

Project NR 385-409, Contract Nonr 903-(00)

March 31, 1954

by

D. Ensminger, F. E. Berger, and H. E. Trumbull

BATTELLE MEMORIAL INSTITUTE
505 King Avenue
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S O S K I N G A V E N U E C O L U M B U S , O H I O

June 3, 1954

Mr. W. Annis
Head, Acoustics Branch
Department of the Navy
Office of Naval Research
Washington 25, D. C.

Dear Mr. Annis:

Enclosed are six copies of the Fifth Progress Report on Contract Nonr 903-(00), entitled "The Development of a High-Level, Directional, Underwater-Sound Source Using Explosion-Induced Shock Waves". We are distributing another fourteen copies according to your "Distribution List of Technical Reports", Battelle Memorial Institute, Contract Nonr 903-(00), NR 385-409, dated 2 December 1953.

This report covers work done between January 4 and March 31, 1954. Much of the effort during that interval was of necessity directed toward rehabilitation of the test facilities which were closed down during the contract renegotiation period.

We regret the delay in issuing this report and wish to call your attention to the fact that the present status of the work is somewhat beyond that indicated in the report.

Sincerely yours,

R. K. Crooks

R. K. Crooks
Chief
Electrical Engineering Division

RKC:mpk
Enc. (6)

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TABLE OF CONTENTS

	<u>Page</u>
INTRODUCTION	1
SUMMARY	2
EQUIPMENT AND MAINTENANCE	2
PRIMACORD SOUND GENERATOR	2
Firing Mechanism	2
FUTURE WORK PLANS	5
Primacord Sound Generator	5
Firing Mechanism	5
Preparation for Sea Test	5
Detonation-Tube Research	6

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OFFICE OF NAVAL RESEARCH

Project NR 385-409, Contract Nonr 903-(00)

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BATTELLE MEMORIAL INSTITUTE

by

D. Ensminger, F. E. Berger, and H. E. Trumbull

March 31, 1954

INTRODUCTION

This is the Fifth Progress Report on Contract Nonr 903-(00), the purpose of which is to investigate the development of a high-level, underwater-sound source using explosion-induced shock waves. The period of the contract is from August 1, 1953 to July 31, 1954. This report covers research performed between January 4, 1954, and March 31, 1954.

The investigation has been concerned, first, with developing a Primacord-activated sound projector; and second, with the development of a detonation tube in which gas mixtures are used as the source of explosive energy.

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2

SUMMARY

With the preliminary maintenance work necessary for conducting research accomplished, studies are being conducted on both the detonation tube and the Primacord sound generator. The maintenance work consisted of adequately anchoring the test facility and repairing and protecting the power line from further weather damage.

Several firing mechanisms for the Primacord sound generator have been tested. Each one has presented problems in electrical insulation and shock resistance. However, methods for shielding all delicate parts from extreme shocks are being studied and tested.

EQUIPMENT AND MAINTENANCE

Four mud anchors for the test float were laid during the period covered by this report. Supplementing these anchors are three 7/8-inch guy cables attached to the banks of the quarry. This combination secures the test float adequately.

A section of the power cable had been damaged during the fall and winter seasons prior to the installation of suitable anchors. The underwater cable has been relocated on the bank of the quarry, and the power is now supplied to the test float by three single-conductor No. 6 wires swung between the test float and the bank.

PRIMACORD SOUND GENERATOR

Firing Mechanism

Work has been progressing toward the development of a suitable firing mechanism for the Primacord sound generator. The firing assembly shown schematically in Figure 25 of the Fourth Progress Report, page 17, permitted excessive current leakage past the cap.

To eliminate this current leakage, the new mechanism shown in Figure 26 was designed. In this design, there is no path parallel to the electrical path furnished by the cap. When the charge is detonated, the

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3

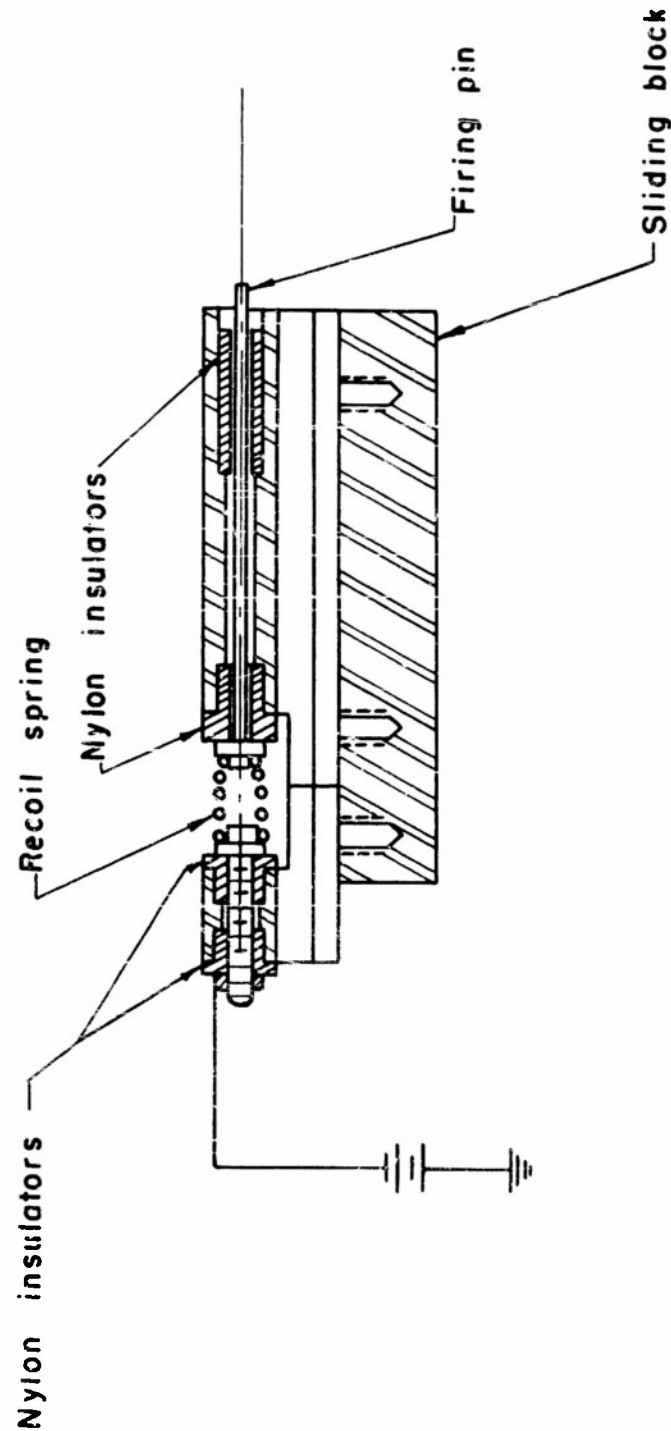


FIGURE 26. RECOILING FIRING PIN AND ASSEMBLY

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4

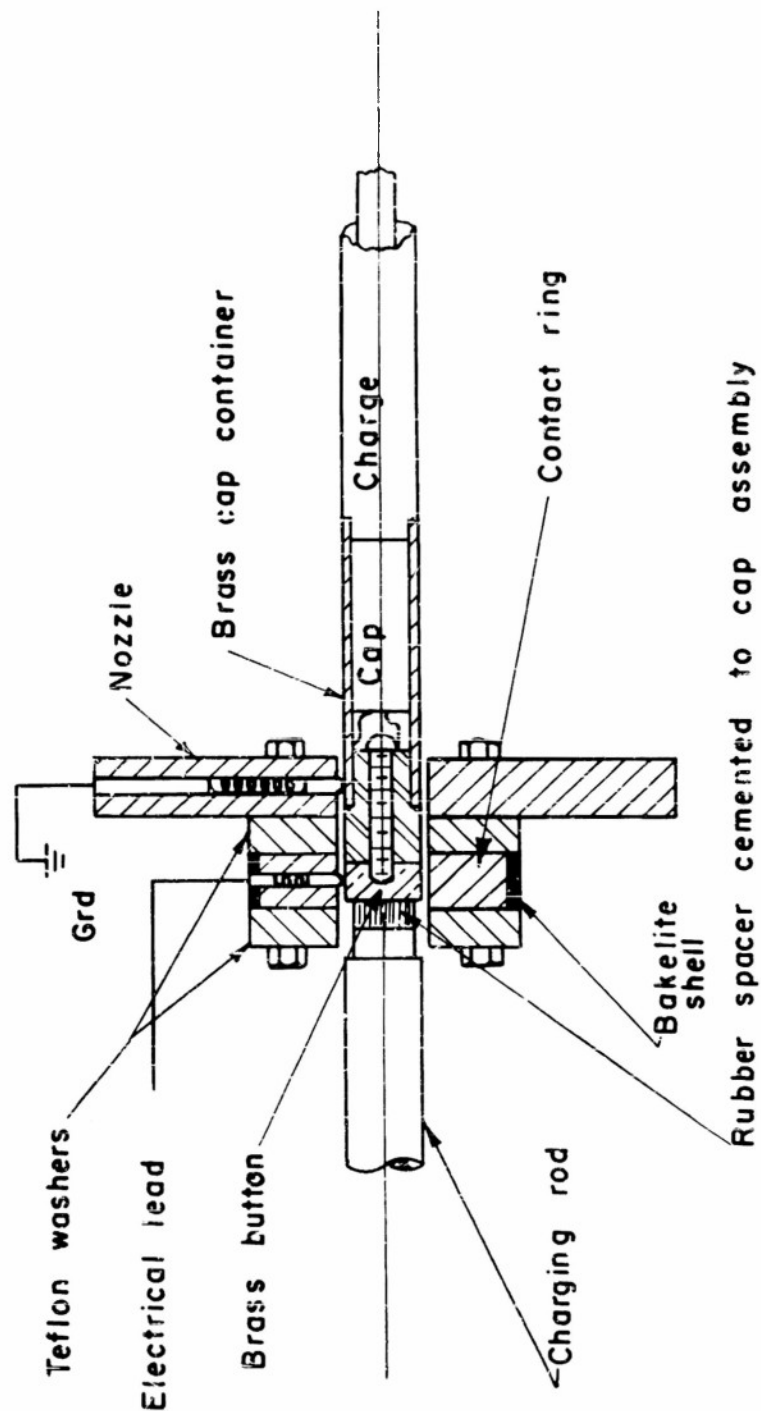


FIGURE 27. FIRING ASSEMBLY IN FIRING POSITION

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5

firing pin, which also serves as an electrical contactor, recoils into a nylon bushing protected by a heavy stainless steel barrel. When placed into operation, this mechanism was found to be unsatisfactory after only two discharges. The firing pin was driven backward with such a force that, on the rebound, the pin penetrated the end of the contact to a depth of 1/32 inch. Also, the plastic insulator at the base of the cap housing failed to withstand the force of the explosion and it fractured. This permitted an undesirable backward movement of remnants of the cap charge.

Therefore, the design of the firing assembly was modified and constructed as shown diagrammatically in Figure 27. This design is believed to be superior to previous designs, as in it, the mechanical and electrical functions are separated. The blasting cap, which sets off the Primacord, is enclosed in a brass cylinder. One wire from the cap is electrically connected to the cylinder, and the other wire is electrically connected to a brass button which is coaxial with the cylinder but electrically insulated from it. This forms a cylindrical assembly, including two sleeves for electrical connection to the blasting cap contained within.

The electrical connections are made to the electrical contact sleeves of the assembly through spring-loaded pins as shown. With this arrangement, the electrical connections are independent of the mechanism that feeds the cap and primacord through the firing assembly.

FUTURE WORK PLANS

Primacord Sound Generator

Firing Mechanism

The present mechanism, as described in this report, will be tested and parameters changed as necessity demands to obtain suitable directivity and a suitable firing system.

When the firing mechanism is functioning properly, a series of performance tests will be made. These will include directivity patterns (for each reflecting ring) and repeated-firing, reliability tests.

Preparation for Sea Test

Upon completion of the phase mentioned above, the Primacord sound generator should be ready for a sea test.

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6

Detonation-Tube Research

The theoretical work applicable to the detonation-tube development shows that the detonation tube as a source of energy is not promising. The problem involves the transfer of the sound energy to the water.

It is generally believed that the acoustic coupling of a gaseous detonation to water is very poor. Estimates and attempts to determine the energy transfer indicate that the transfer is less than one per cent. However, it is not certain that the factors used in obtaining this figure of one per cent may be applicable to the present problem. An experimental research is therefore planned as this approach is expected to yield an answer more readily than a continued extension of theoretical work.

In the present design considerations, there are two basic principles with which to work. The tube must be long enough so that a plane wave will form. This is necessary so that a sharp peaked pulse can be developed. It is also necessary for the tube to be wide enough to obtain an adequate amount of power and directionality. The power transferred to the water is dependent on the cross-sectional area through which it passes. Also, the tube must have a large enough cross-sectional area so that it does not act as a frequency discriminator and pass only high-frequency components.

These two basic principles, together with the results of the present system (insufficient power), indicate the following course of future investigation.

Volume is a prime requisite for power. This is limited by practical considerations such as handling, storage, and, most important, actual use in shipboard operation. The drag offered by the water in actual operation will increase tremendously as the volume increases and the ruggedization required for stability rapidly will reach practical limitations as the volume increases. A volume has been selected which is believed to be reasonable. The proposed detonation tube will have a 5-inch inside diameter and a length of 6 feet.

In an attempt to determine whether or not sufficient coupling can be accomplished, several lengths of 5-inch pipe and several adaptors at the discharge end of the tube will be tried. One of the adaptors will be a horn. The relatively large cross section at the mouth is expected to increase the total energy transfer. On the other hand, by the use of a converging adaptor, there is the possibility of increasing the energy of the shock wave inside the tube. It is not known which of the two effects is more significant; the purpose of such tests is to determine this.

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7 and 8

It is believed that the fuel mixture for maximum detonation intensity will be quite critical so provisions are being made for mixing the constituents quite accurately. Some improvements in the experimental set-up are being made to facilitate this work.

It is hoped that these experiments will provide sufficient and accurate data for evaluating the use of a detonation tube to generate high-intensity sound waves in water.

Data on which this report is based are found in BMI Laboratory Record Books Nos. 6360, pages 15 through 20; and 7769, pages 24 through 30.

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