

OP 1330:  
MINE DISPOSAL HANDBOOK  
*PART 1 OF 4\**

---

In the collection of the  
U.S. Naval Undersea Museum

NUM.2019.010.190

*\*Manual has been separated into four parts due to its large size*




WASTE DISPOSAL

TECH  
V856  
.5  
.M5  
1944

E.C.HADERLIE

Museum volunteer crossed out  
"Declass in Full" on sticker  
below on accident. Please  
disregard cross out on sticker.  
Booklet is declassified in Full

  
per OPNAVINST 5513.16-02 by  
COMNAVSEA DECLASS TEAM on

4/22/98  
Other Agency Interest DECLASSIFIED  
 YES  NO

P.O.C. for CLASS/DECLASS  
Commander Naval Sea Systems Command  
Attn: Security Office, SEA 09T  
2531 Jefferson Davis Hwy  
Arlington, VA 22242-5160

E.C.HADERLIE

Manufactured by  
VEVIER LOOSE LEAF CO.  
ST. LOUIS, MO., U. S. A.  
16430

E.C.HADERLIE

ORDNANCE PAMPHLET No. 1330

This copy is issued

to Haderlie E. C.

# MINE DISPOSAL HANDBOOK

## E.C.HADERLIE



NOVEMBER 1, 1944

THIS PUBLICATION IS CONFIDENTIAL AND SHOULD BE HANDLED IN ACCORDANCE WITH  
THE PROVISIONS OF ARTICLE 76, U.S. NAVY REGULATIONS, 1920

NAVY DEPARTMENT  
BUREAU OF ORDNANCE  
WASHINGTON 25, D. C.

October 1944

ORDNANCE PAMPHLET 1330

MINE DISPOSAL HANDBOOK

1. Ordnance Pamphlet 1330 has been prepared by the Navy Mine Disposal School for use by graduates of that School. Although it contains pertinent information relative to all underwater explosive ordnance known to the U. S. Navy and likely to be encountered by our forces, no attempt has been made to make this information complete. Rather, it is included as reference background material, with emphasis placed on the rendering safe techniques.

2. Rendering safe procedures contained in the Mine Disposal Handbook are known to be adequate under normal conditions, but Mine Disposal Officers are enjoined to exercise particular discretion in following or modifying them under conditions other than normal. In addition, Mine Disposal Officers should constantly bear in mind that in disposing of explosive ordnance there is no "safe" method but merely a least dangerous method.

3. Ordnance Pamphlet 1330 will contain nine parts. Each part will be issued separately when completed, without additional letters of promulgation. The separate parts will supersede Mine Disposal Bulletins as follows:

- Part I - Bulletins 15, 18, 19, 20, 21, 22, 23, 24 and 25.
- Part II - Bulletins 2, 3, 4, 16 and 27.
- Part III - Bulletin 5.
- Part IV - Bulletins 1, 6, 13 and 17.
- Part V - Bulletins 9, 11 and 14.
- Part VI - Bulletins 10 and 12.
- Part VII - Not previously covered.
- Part VIII - Bulletin 7.
- Part IX - Bulletins 8 and 26.

Upon receipt of any part, the superseded Mine Disposal Bulletins should be destroyed by burning.

4. It is not intended that this publication be carried in aircraft for use therein.

5. (a) Attention is directed to the fact that distribution of the Mine Disposal Handbook is limited to Mine Disposal personnel and to certain other personnel with duties in connection with underwater explosive ordnance; and that detailed information contained therein may be disclosed only to persons who require such information in connection with the assigned duties of the authorized holder.

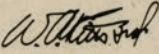
(b) It is desired that the Officer-in-Charge of the Mine Disposal School supervise distribution and accounting thereof. The Mine Disposal Handbook will be distributed directly to each addressee by name and remain in his personal custody until such time as he is assigned by the Bureau of Naval Personnel to duty unrelated to Mine Disposal.

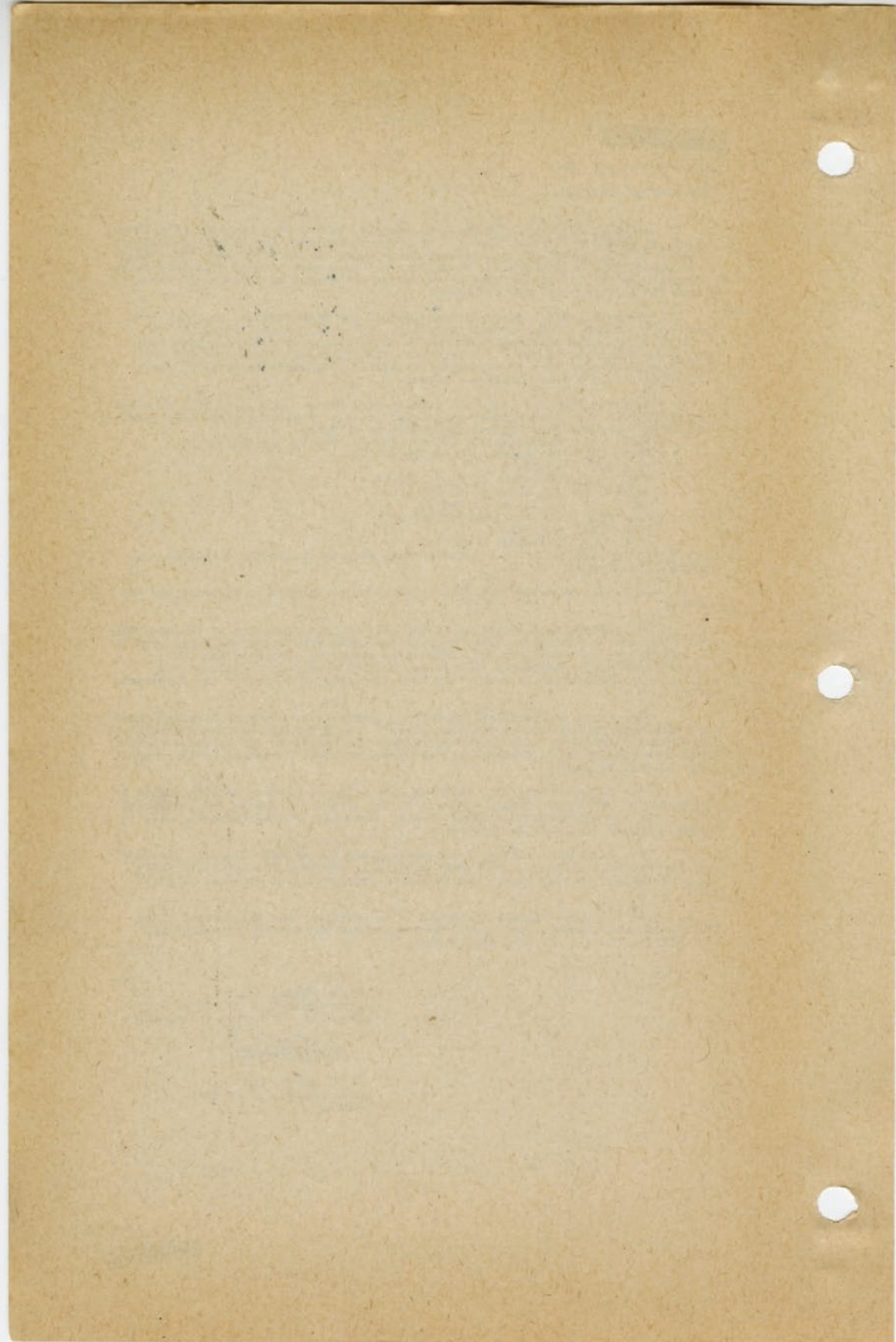
(c) On receipt of this Handbook, the attached Custody Receipt should be completed and forwarded through channels to the Officer-in-Charge, Mine Disposal School. If the addressee is ordered to duty unrelated to Mine Disposal, this Handbook should similarly be forwarded.

(d) Subsequent additions and corrections to the Mine Disposal Handbook will be handled similarly. Loose-leaf binding is provided to facilitate insertions of changes and additions, and to permit segregation of material as desirable.

(e) The Mine Disposal Handbook is an official, non-registered, CONFIDENTIAL Ordnance Pamphlet and should be safeguarded and handled in accordance with Article 76 of U. S. Navy Regulations.

G. F. HUSSEY, Jr.  
Rear Admiral, U. S. Navy  
Chief of the Bureau of Ordnance.

  
W. A. Kitts, 3rd  
Rear Admiral, U.S. Navy  
Acting





# MINE DISPOSAL HANDBOOK

## PART I

### GENERAL INFORMATION

• • • • •

APRIL 1, 1945






TABLE OF CONTENTS

PART I - GENERAL INFORMATION

CHAPTER 1

GENERAL INSTRUCTIONS FOR MINE DISPOSAL OFFICERS	Page
General Mission .....	3
Disposal Procedure .....	3
Diving on Mines .....	3
Recovery or Disposal Ashore .....	3
Recovery or Disposal Afloat .....	5
Chemical Horns .....	5
Situations Involving Influence Mines Laid Near Ships .....	5
Reporting and Shipping Captured Enemy Ordnance .....	7
Identifying Underwater Explosions .....	8
Mine Disposal Equipment .....	8
Policy Regarding Measurements .....	8

CHAPTER 2

UNDERWATER LOCATING	
History .....	3
Estimate of the Situation .....	3
Locating Technique .....	5
Ordnance Detector, Mark 1 .....	5
Ordnance Detectors, Mark 2 and 3 .....	9
Galvanic Drags .....	16
Ordnance Detector, X-11 .....	16
Locating and Recovery Nets .....	18
Underwater Locating with Sound Devices .....	18
Aids for Divers .....	20

CHAPTER 3

MILITARY EXPLOSIVES	
Introduction .....	3
Amatol, Ammonal, Baratol, Black Powder, Composition A .....	6
Composition B, Composition C, Composition C-2, Composition C-3, Composition Explosive, Cortex .....	7
Cyclotol, DEX, Dinol, DDP, Dunnite, Dynamite, Edna, Ednatol .....	8
Explosive D, HEX, Hexanite, HND .....	9
Lead Azide, Lead Styphnate, Lyddite, Melinite, Mercury Fulminate ..	10
Penthrite Wax, Pentolite, Pentoriru, PEP-3, PETN .....	11
Picramide, Picratol, Picric Acid, Pikrin Saure, Primacord, PTX-1, PTX-2 .....	12
Pyronite, RDX, Shimose, Smokeless Powder and Ballistite Propellants, Temporary Type 1 Explosive, Tetralite, Tetryl, Tetrylite, Tetrytol ..	13
TNA, TNT, Torpex, Trimonite .....	14
Trinitroaniline, Trinitroanisole, Triton, Tritonal, Type 88 Explosive, Type 91 Explosive, Type 92 Explosive .....	15
Type 94 Explosive, Type 97 Explosive, Type 98 Explosive .....	16

CHAPTER 5

DISPOSAL BY EXPLOSIVE MEANS	
Introduction .....	3
Accessories to Demolition and Their Use .....	
Mark 1 & 2 Demolition Charges .....	3
Preparation of Mark 1 & 2 Demolition Charges for Firing .....	3
Mark 3 & 4 Demolition Charges .....	4
Preparation of Mark 3 & 4 Demolition Charges for Firing .....	4
Plastic Explosives .....	4
Detonating Agents .....	4
Firing Cable .....	5
Blasting Machines .....	5
Ohmmeters .....	6
Theory and Use of Cavity Charges	
Introduction .....	7
Theory .....	7
Application of Cavity Effect .....	7
Navy Cavity Charge Containers .....	11
Army Shaped Charges .....	11
Cavity Charges for Disposal	
General .....	13

TABLE OF CONTENTS

(Chapter 5, Cont'd.)

	Page
Linear Cavity Charges for RMS	
General .....	17
Cavity Charge Liner, Type 1 .....	17
Cavity Charge Container, Types 2 and 3 .....	17
Curvilinear Disposal Charges .....	19
Cable and Chain Cutter, Mk 1 Mod 1 .....	19
Underwater Cutting .....	19
Depth Charges as Countermining Agents .....	22
Rigging Depth Charges for Static Firing .....	22
Rigging Booster Extender Mk 2-2 for Demolition Firing .....	23

CHAPTER 6

THERMIT BURNING

Introduction .....	3
Thermit Burning Charge, Mark 1 .....	3
Underwater Thermit Charge, Mark 2 (2-1) .....	5

CHAPTER 7

CORROSIVE PENETRATION

Introduction .....	3
Equipment .....	3
Operational Procedure .....	3

CHAPTER 8

UNLOADING EXPLOSIVE CHARGES

Introduction .....	3
Cast Charges .....	3
Block-Fitted Charges .....	5
Mine Type GY* .....	5
German Warhead, Type Ka .....	5
Mine Type JA .....	7
Japanese Warhead, Type 97 .....	7

CHAPTER 9

THE BUIE RECIRCULATING DIVING SUIT

Introduction .....	3
General .....	3
Description .....	3
Standard Accessories .....	5
Rigging the Gear .....	7
Dressing the Diver .....	9
Operation .....	11
General Information and Instructions .....	11

CHAPTER 10

MINE WATCHING

Introduction .....	3
Air Raid Mine Watch System .....	3
Beach Mine Watch System .....	5

# MINE DISPOSAL HANDBOOK

## PART I

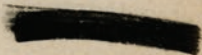
### GENERAL INFORMATION

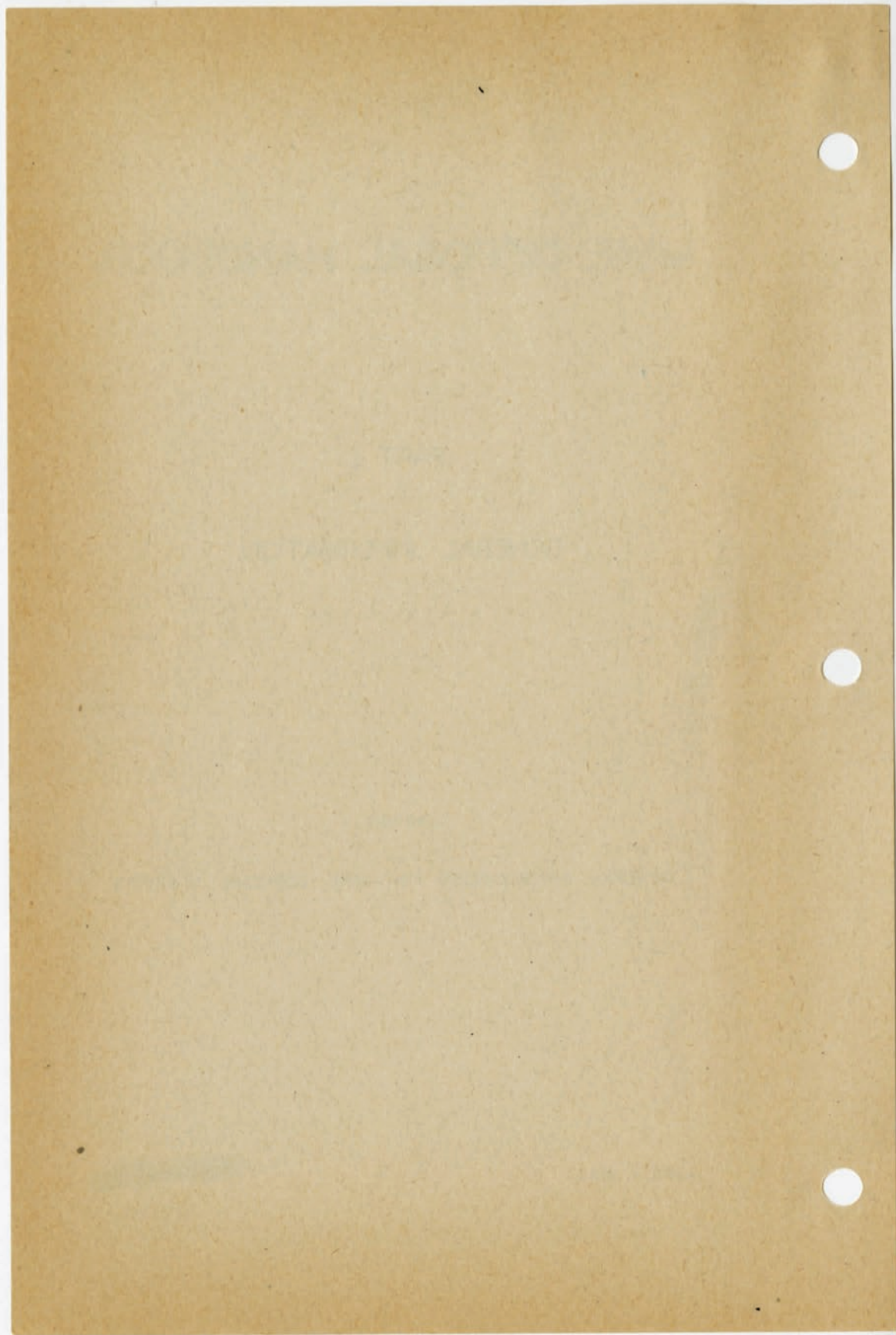
• • • • •

### CHAPTER I

#### GENERAL INSTRUCTIONS FOR MINE DISPOSAL OFFICERS

APRIL 1, 1945





GENERAL INSTRUCTIONS FOR MINE DISPOSAL OFFICERS

General Mission

1. Paragraph 3 of VCNO Conf. ltr Op-30M4-PK (SC) S76-1 Serial 0157830 of 22 June 1942 reads as follows:

"Mine Disposal personnel, who shall all be volunteers, are trained at the Advanced Mine School, Navy Yard, Washington, D. C., from selected graduates of the Naval Mine Warfare School, Yorktown, Virginia. They are trained to perform the following duties:

- (a) To safely recover mines for purposes incident to development of minesweeping and other measures for defense against mines.
- (b) To dispose of hostile mines by methods other than sweeping or countermining.
- (c) The recovery of hostile mines for purposes of our own mine development.
- (d) To advise and assist in the organization of mine watching and mine reporting parties.
- (e) To recover U.S. Navy mines which may become detached from defensive fields in order to furnish information of operational and design value.
- (f) To assist in salvage operations involving the handling of explosives underwater.
- (g) To dispose of any dangerous mines, depth charges, or torpedoes, the location of which constitutes a peril to personnel or property."

Disposal Procedure

1. Standard disposal procedures for all known types of underwater explosive ordnance are set forth in detail in subsequent chapters of this handbook. Rendering safe techniques, corrosive penetration, thermit burning, unloading explosive charges and countermining are all covered. It must be remembered, however, that it will not be feasible to follow every detail of the pertinent procedure in each case. The procedures laid down should be followed whenever practicable, but may be varied at the discretion of the Mine Disposal Officer when he deems it necessary.

Paragraph 6 of BuOrd endorsement AL7-25(Sp) of Feb 9, 1945 on Comdr., Naval Advanced Bases, U.S. Eighth Fleet, Marseille, France, Serial 482, dated 17 Nov 1944 reads as follows:

"In this Bureau's opinion, nonspecialist seniors would do well generally to refrain from, and in fact go somewhat out of their way to avoid, remarks to Mine Disposal personnel which may unduly influence the latter in their diving procedures, or in other technical details of their special work."

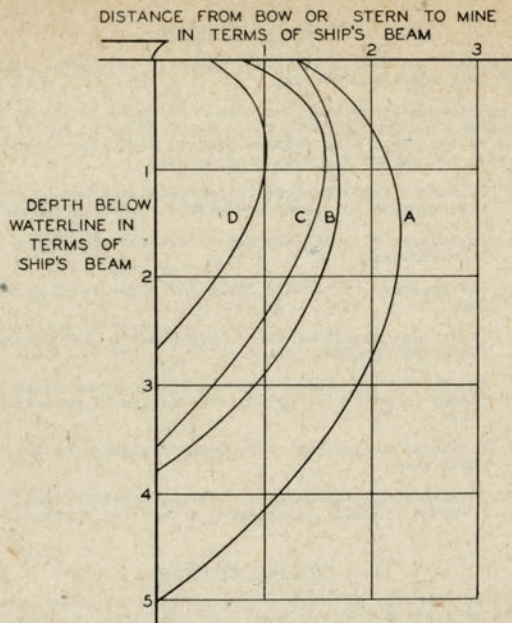
2. Diving on Mines

- (a) Diving on mines to render them safe should be attempted only when the tactical situation warrants the attendant risk. The following precautionary measures should be taken before diving is attempted:
  - (1) Sweep the area thoroughly, taking into account the fact that influence mines may be fitted with 15-place P.D.M.
  - (2) Do not use the standard transceiver or telephone and life line with the diving outfit; either one is sufficiently magnetic to actuate a sensitive firing unit.
  - (3) Note that ground mines are easily disturbed and moved underwater, involving great danger to the diver.

3. Recovery or Disposal Ashore

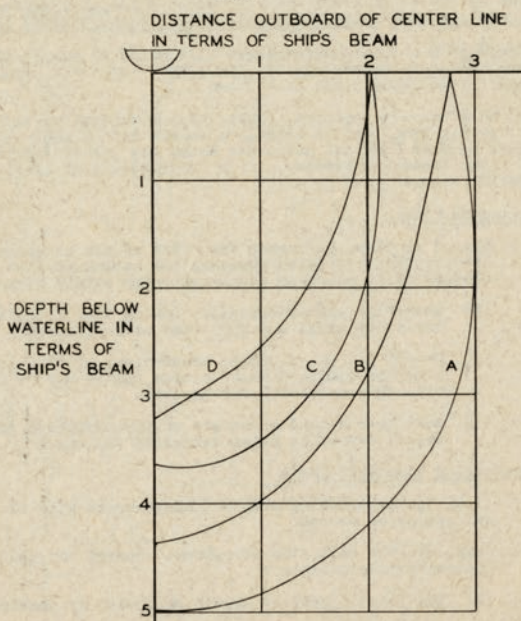
- (a) Clear the surrounding area as commensurate with the estimated type and weight of charge.
- (b) Establish the best line of retreat, basing the decision on the following considerations:
  - (1) The line of retreat should be upwind if possible.
  - (2) The line of retreat should be as clear as possible, not only because of the need for sure footing but also because small pieces of loose rock or rubbish are likely to become flying missiles in the event of an explosion.

GENERAL INSTRUCTIONS FOR MINE DISPOSAL OFFICERS



(Plate 1 of Re6b M.A.M. No. 53 of 12 Dec. 1942)

Fig. 1



(Plate 2 of Re6b M.A.M. No. 53 of 12 Dec. 1942)

Fig. 2

GENERAL INSTRUCTIONS FOR MINE DISPOSAL OFFICERS

Disposal Procedure (Cont'd.)

- (3) The blast effect of an explosion travels roughly in a straight line unless deflected.
- (4) Walls and small buildings should be avoided since they may be shattered by blast.
- (c) Approach the object cautiously, keeping all necessary noise to a minimum and allowing no movement of magnetic material.
- (d) Make photographs from all angles, record all markings and allow the object to settle firmly before attempting RMS.

4. Recovery or Disposal Afloat

- (a) Approach the object in a wooden or rubber boat manned by at least two men, one at the oars and one in the stern. A minimum of 200 yards of 21-thread line or its equivalent should be in the boat.
- (b) Determine whether the boat or the object is drifting more rapidly and back down on the object from such a direction that the prevailing drift will tend to separate it from the boat.
- (c) Secure the line to a padeye, taking care not to touch horns, antennae or attached lines.
- (d) Tow the object to a deserted beach.
- (e) If the object has no intelligence value, it may be sunk by gunfire in a minimum of ten fathoms of water and in an area not used as a channel, anchorage or fishing ground.

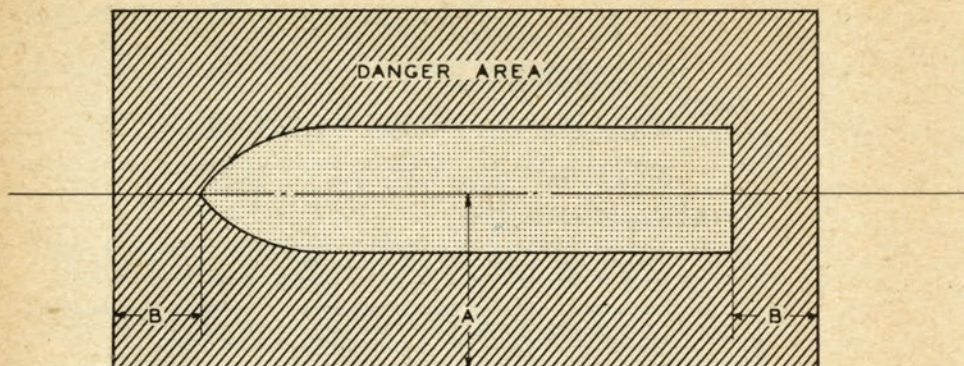
5. Chemical Horns

- (a) Chemical horns should never be removed from a submerged or floating mine. The danger exists that sea water entering the horn cell may act as an electrolyte and fire the mine.

6. Situations Involving Influence Mines Laid Near Ships

- (a) The following suggestions are presented to guide Mine Disposal Officers confronted with situations wherein influence mines have been laid near ships in restricted waters. Each such situation is unique and no set rules can be laid down to apply to all cases.
- (b) The following preliminary steps should be taken in all instances where influence mines are laid near ships:
  - (1) Leave the ship's degaussing current in status quo.
  - (2) Shut off as many of the ship's engines as military requirements will permit.
  - (3) Disembark as many of the ship's crew as possible.
  - (4) Obtain the most exact possible fix of the mine's position.
- (c) After carrying out the instructions given in Par. (b) above, the ship should be moved immediately if it can be done with comparative safety. Safety in such cases is determined by the following considerations:
  - (1) The maximum distance at which movement of the ship will fire the mine.
  - (2) The maximum distance at which detonation of a known weight of explosive will seriously damage the ship.
- (d) Figures 1 and 2 assume a 15-milligauss mine and also that the depth of water is greater than two ship's beams. For data pertinent to situations where the depth of water is less, see Figure 3.
- (e) Referring to Figures 1 and 2, if the ship must be moved past the mine and less than half its length is already past the mine:
  - (1) It may be moved with 100% safety, whether depermed or not, if the mine lies outside curve A.
  - (2) It may be moved with 90% safety if undepermed and with 100% safety if depermed if the mine lies between curves A and B.
- (f) Referring to Figures 1 and 2, if the ship must be moved past the mine and more than half its length is already past the mine:
  - (1) It may be moved with 100% safety whether depermed or not if the mine lies between curves B and C.

GENERAL INSTRUCTIONS FOR MINE DISPOSAL OFFICERS

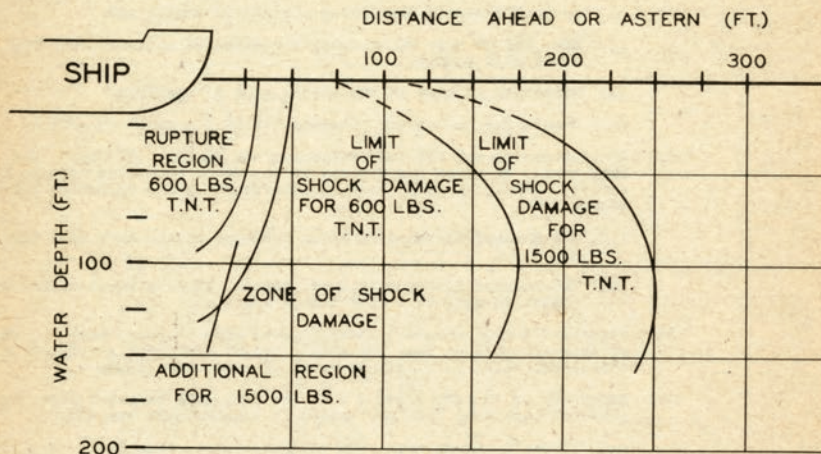


Limits of Danger Area for 15 Milligauss Mines (depth = 2 beams or less)

<u>Situation</u>	<u>Safety</u>	<u>Deperming Information</u>	<u>A = distance in beams from centerline</u>	<u>B = distance in beams from bow or stern</u>
More than 1/2 of ship moved past mine	100%	None	3	2.3
	90%	None	2.6	1.7
	100%	Depermed	2.6	1.7
Less than 1/2 of ship moved past mine	100%	None	2.3	1.6
	90%	None	2.0	1.1
	100%	Depermed	2.0	1.1

(Fig. 1 & Table I of Re6b M.A.M. No. 53 of 12 Dec. 1942)

Fig. 3



(Enc. A of Re6b Conf. Memo. to File S68 of 20 Oct. 1942)

Fig. 4



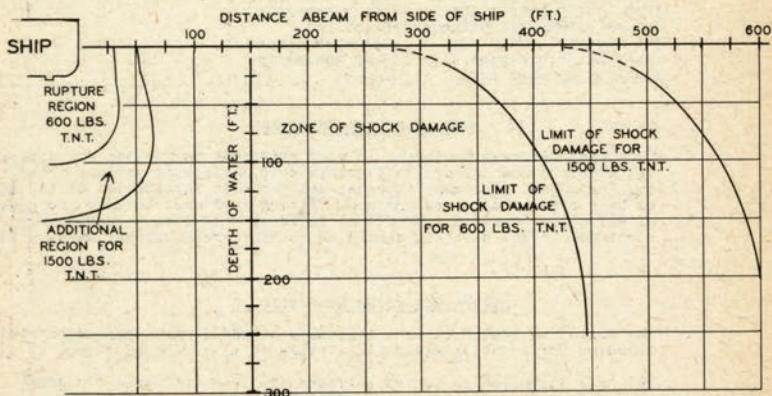
GENERAL INSTRUCTIONS FOR MINE DISPOSAL OFFICERS

Disposal Procedure (Cont'd.)

- (2) It may be moved with 90% safety if undeparmed and with 100% safety if deparmed if the mine lies between curves C and D.
- (g) Figures 4 and 5 are specifically applicable only where a TNT charge is involved, but may be used as a basis for comparison when figuring the damage radius of similar weights of other charges.

Reporting and Shipping Captured Enemy Ordnance

- Successful development of countermeasures for any particular enemy weapon is possible only through complete knowledge of its construction and operation. It is therefore imperative that Mine Disposal Officers make complete reports on all ordnance with which they deal and that they take the initiative in searching out sources of information (e.g. captured mine dumps, newly-taken beaches, etc.).
- The recovery or disposal of any previously-known enemy ordnance item shall be reported in the periodic reports to the Chief of Naval Operations. The recovery or disposal of an item not previously reported shall be reported immediately by dispatch to the Chief of Naval Operations with copies of the report to the Bureau of Ordnance, the Naval Ordnance Laboratory, the Mine Disposal School, the area Mobile Explosives Investigation Unit and other interested commands. This dispatch should embody essential details of the appearance and operation of the item as well as a tentative rendering safe procedure.
- As soon thereafter as possible, the item should be reported in detail in an official report to the addressees listed above. This report should include pictures and drawings, the most detailed operational analysis possible and all markings, labels, etc. which may be available. In the event that the use of the portable investigation facilities of an M.E.I.U. seems necessary, it should be requested by dispatch, always provided that military requirements do not necessitate immediate disposal of the item in question.
- Mine Disposal Officers should expedite shipment of recovered or captured enemy ordnance. If the ordnance contains explosive, it should be so marked and shipped to the Ordnance Investigation Laboratory, Indian Head, Maryland. Ordnance containing no explosive may be shipped to any Ordnance Station in accordance with CNO letter Cp-16-2 L11-1/EF74, Serial O2404716 of 18 September 1943. Mine and Bomb Disposal Officers are authorized to issue "Certificates of Safety" by NAVORD OCL X4-44 of 7 March 1944. The responsibility for the safe transit of explosive ordnance calls for care and judgment on the part of the Mine Disposal Officer. Should any situation arise wherein he doubts the advisability of returning enemy ordnance to the United States, he should request instructions from the Chief of Naval Operations via official channels, with copies of the request to the Bureau of Ordnance, the Mine Disposal School and the area M.E.I.U. Receipt of shipments will be expedited if the bill of lading number, date of shipment, means of shipment, and the ETA are forwarded to the shipping addressee under separate cover.



(Enc. B of Re6b Conf. Memo. to File S68 of 20 Oct. 1942)

Fig. 5

GENERAL INSTRUCTIONS FOR MINE DISPOSAL OFFICERS

Identifying Underwater Explosions

1. Occasions frequently arise where Mine Disposal Officers are able to interrogate survivors of ships which have been damaged or sunk by underwater explosions, the nature of which is unknown. The following information may be of use in identifying the source of the explosion.

	GROUND MINES	CONTACT MINES	TORPEDOES
<u>Noise</u>	Dull and prolonged, rather like a depth charge. Double explosion often reported due to the time lag between pressure wave and kinetic wave.	Short-sharp-loud (like a gun).	As for contact mines but sometimes slightly muffled by torpedo tending to enter hull.
<u>Flame</u>	As a rule, no flame or smell of fumes. Little smoke.	Flame generally seen and smell of fumes often reported. Much smoke.	As for contact mines.
<u>Splash</u>	Height of splash depends on depth of mine. GC type mine in 10 fathoms gives splash about 200-250 ft. high and approximately 120 ft. across. Splash follows pressure wave at interval of seconds, depending on depth of mine. (2 seconds interval to 100 ft.)  Splash generally on both sides.	550 lb. mine (Type GY) at 6 to 10 ft. below surface will give a large splash about 200 ft. high but not so wide as ground mine. Splash and explosion are coincident.  Splash on one side of ship only.	As for contact mines, but splash may be spread less owing to torpedo penetrating hull.  Splash generally on one side but occasionally on both sides if torpedo is running deep.
<u>Effect</u>	Lifts ship. Ship whips and vibrates. Crew thrown into the air.	Ship lurches. Crew thrown to one side. Blast effect immediately noticeable.	As for contact mines, but torpedoes tend to penetrate hull and explode inside, hence explosion appears less violent to those on deck.
<u>Damage</u>	Engines almost always stopped. Damage to bearings, beds and also castings. Ship often breaks back due to hogging and whipping. Damage general throughout ship. Ship rarely holed. Damage extensive, although not always immediately apparent. Ship generally sinks on an even keel.	Damage localized. Ship holed. Engines often continue to function. Damage immediately apparent. Blast and splinter damage. Ship generally lists.	As for contact mines.

Mine Disposal Equipment

1. Much Mine Disposal equipment is very difficult to replace and appropriate measures must always be taken to keep it in good working order. A running log of equipment expended and periodic inventories of all gear on hand are strongly recommended. Diving gear must be kept overhauled at all times to avoid operational failures. If diving gear is not furnished to the unit, it should be obtained from another Naval activity.

Policy Regarding Measurements

1. The following system (unless otherwise noted) is used throughout this handbook for locating external fittings on all ordnance items.
  - (a) All distances on curved surfaces are measured along the great circle.
  - (b) Distances from fitting to fitting are measured from the respective centers of each.

GENERAL INSTRUCTIONS FOR MINE DISPOSAL OFFICERS

Policy Regarding Measurements (Cont'd.)

- (c) All measurements in degrees are taken clockwise looking forward from aft.
- (d) All lengthwise measurements on cylindrical cases are measured from the foremost and aftermost surfaces of the nose or tail respectively and are measured along a line parallel to the longitudinal axis of the case.

# MINE DISPOSAL HANDBOOK

## PART I

### GENERAL INFORMATION

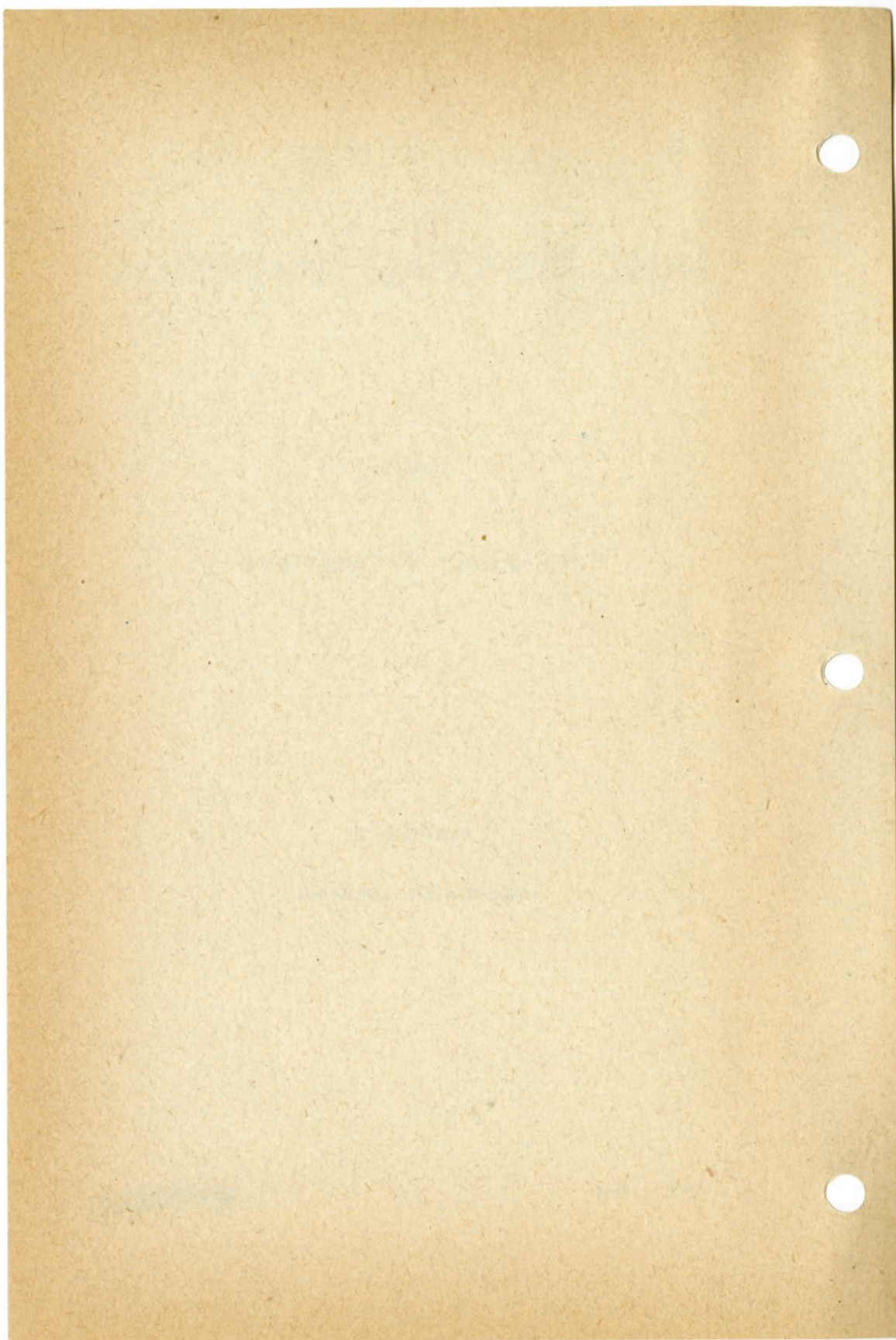
• • • • •

### CHAPTER 2

#### UNDERWATER LOCATING

APRIL 1, 1945

~~CONFIDENTIAL~~



## UNDERWATER LOCATING AND DETECTING

### History

1. The first known instance of locating submerged minefields with locating or detecting gear occurred during the Spanish Civil War when British destroyers patrolling the Spanish coast used echo-ranging gear (Asdic) to find their way through moored minefields. At the outset of the present conflict, however, the enemy introduced many new types of ground mines and firing units. Development of countermeasures to give adequate protection to Allied shipping demanded that effective means of underwater mine locating be found so that the mines could be swept or recovered for analysis.
2. The first step in this direction was to determine in which areas enemy minelaying was taking place. This was accomplished by three methods, viz:
  - (a) The Mine Watch System - an Air Raid Precaution (ARP) the function of which was to spot and locate accurately aircraft-laid mines as they were dropped. Part I, Chapter 10 gives more detailed information on such a program.
  - (b) Extensive use of Radar - this device served to plot the courses of enemy raiders, air, sea and submarine, and thus limit the areas where minelaying might have occurred.
  - (c) Intelligence Reports - these often gave accurate information concerning the location of planned enemy mining attacks.
3. Once the mined areas had been generally located, adequate sweeping measures were possible, but the recovery of any particular mine required much more accurate locating techniques than the systems outlined above were able to provide. In the early stages of the war, these problems were of primary concern only to the British and, as a result, most of the fundamental experimentation was carried out by them.
4. The results obtained were largely crude and ineffective since the equipment consisted for the most part of mechanical or galvanic bottom drags operated from small boats. These drags were designed to snag the mine on contact, at which time the drag line would be released, buoyed, and divers would descend to investigate. Later developments included refinements of the echo-ranging and fathometer gear, neither of which was particularly successful. The British even found it necessary to tow divers a few feet off the bottom to examine the bottom of the Suez Canal.
5. Reports of British experiences resulted in the decision that all methods in use up to the time of our entry in the war were inadequate. One of the prime deficiencies in the special locating gear developed hithertofore had been that physical contact was necessary to indicate the presence of a mine, making all operations of this nature tremendously hazardous where influence mines were concerned. The search for a detector which would give remote "strikes" resulted in the development of the Ordnance Detector, Mark I and in the refinement of the "King Kong" magnetometer gradiometer which was the forerunner of Ordnance Detectors, Mark II and III.
6. In addition to these influence detectors, the accidental recovery of mine fragments in a fishing net led to experimentation by the U.S. with nets as a means of locating and recovering ground mines. These experiments resulted in the "Iceland Trawl" which has proved to be effective under certain conditions. Also, since the use of sound for submarine detecting was progressing rapidly, the possibility of applying the same principles to mine locating, both moored and ground, was not ruled out. A brief description of each of the locating devices now in service, together with a general analysis of the capabilities and limitations of each, follows in the body of the chapter.

### Estimate of the Situation

1. The Mine Disposal Officer is warned that, even when the most modern and efficient devices are employed under ideal conditions, underwater locating problems require the utmost in good judgment, skill and perseverance. A well thought out estimate of each situation is of prime importance because so many variables are involved in each case as to obviate the possibility of a general policy being formulated to cover an average situation. All available information concerning the probable location of the object should be gathered by personal interview and from reports.
2. Such factors as the negative buoyancy and the local shape of the object, the prevailing currents in the area and the local bottom conditions should be studied with a view to reconstructing the accident which led to the loss of the object. Careful study of the third factor mentioned above will also be of assistance in determining the validity of strikes obtained with locating gear. Persons who witnessed the loss should be questioned

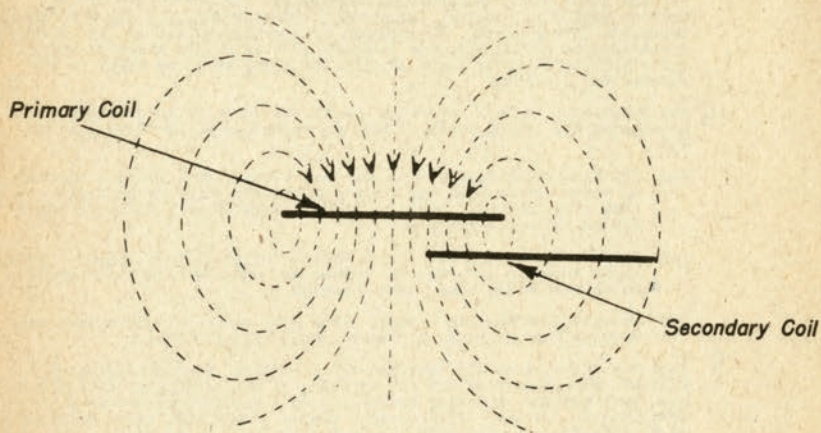


Fig. 1- Ordnance Detector MKI, Energy Flow Diagram Showing Primary and Secondary Coils in Condition of Zero Mutual Inductance

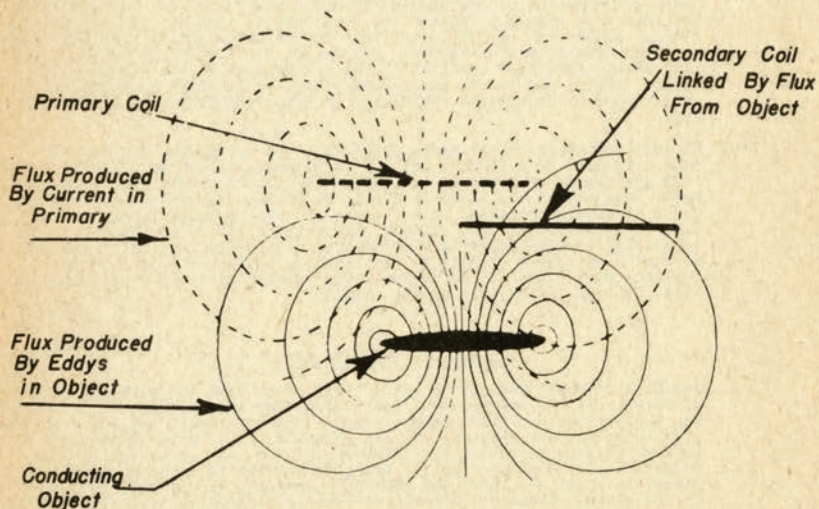


Fig. 2- Ordnance Detector MKI, Energy Flow Diagram Showing Zero Mutual Inductance Disturbed by Conducting Object

## UNDERWATER LOCATING AND DETECTING

### Estimate of the Situation (Cont'd.)

although their estimates and opinions should be accepted with reserve. Experience has shown that estimates of the location of a lost object obtained from witnesses sometimes vary as much as 2000 yards.

3. It is imperative that the Mine Disposal Officer be familiar with the various locating devices. Complete details of all locating operations conducted or observed by him should be reported in the regular monthly reports to the Chief of Naval Operations; in addition, any indication that the enemy utilizes such equipment should also be so reported.

### Locating Technique

1. In the majority of cases it is necessary to sweep from launches or small vessels, towing detectors singly or in pairs. It is of the utmost importance that the swept areas be properly marked either by buoys or other suitable means to obviate the possibility of holidays. Strikes should be narrowed down by successive passes over the suspected location until a maximum signal has been obtained. At this time, the location should be buoyed and a diver using a Mark 3 Detector (in the case of a ferrous object) or a probe (if the object is known not to be an influence mine) can verify the strike and complete the search. If more positive identification is desired prior to putting a diver over the side, the Mark 3 Detector may be weighted and cast over the side of the diving boat, dragging back and forth over the location previously indicated until a maximum signal is obtained. The detector should then be left in position, the diving boat moved over the indicated location and a diver directed to follow down the detector cable.

### Ordnance Detector, Mark I

#### General

1. The Ordnance Detector, Mark 1, originally known as the Electrical Discontinuity Discriminator (EDD), is an instrument designed to be towed five to eight feet off the bottom by a suitable vessel. The essential components are as follows:
  - (a) A hydrofoil containing detector coils.
  - (b) A source of power.
  - (c) A set of amplifying and recording equipment.
2. This gear was designed as an approximate detector (within 30 ft.) of metallic or plastic objects in sea water. It detects not only conducting materials on or under the bottom but also any object whose electrical conductivity differs from that of the surrounding medium. It distinguishes between magnetic and non-magnetic materials and is therefore more useful in mine locating than a locator which detects magnetic objects only.

#### Principles of Operation

1. The basic principle employed in the design of the Ordnance Detector, Mark 1, is as follows:
  - (a) An alternating voltage of constant frequency and strength is imposed on a primary coil in the presence of two secondary coils, arranged physically so that the resulting mutual inductance is zero; i.e., the effect of the signal from the primary coil is not apparent in the other two coils. Eddy currents from the fields produced by the alternating current in the primary coil are induced into any conducting object brought into its proximity. These eddy currents, in turn, produce fields which induce voltages in the secondary coils; i.e., the presence of the conducting object serves to disturb the zero mutual inductance so that the unbalance in the two secondaries can be detected. Two secondaries are used for practical balancing considerations although, in theory, one secondary would suffice. The detected signal in the secondary is then amplified to a point where it is of sufficient strength to operate recording instruments.
  - (b) The strength of the signal in the secondary resulting from the presence of the conducting object depends on the nearness and size of the object as well as its conductivity relative to the surrounding medium. Thus, metal objects (good conductors) give a very pronounced signal in comparison to rocks, logs and other non-conductors. Non-conducting objects are usually present and give signals of low intensity known as background "noise". Due to the difference in phase relationship between the signals from magnetic and non-magnetic conductors, the instrument is able to differentiate between them, the recorder needle making its initial swing in one direction upon receipt of a signal from a magnetic conductor and in the



UNDERWATER LOCATING AND DETECTING

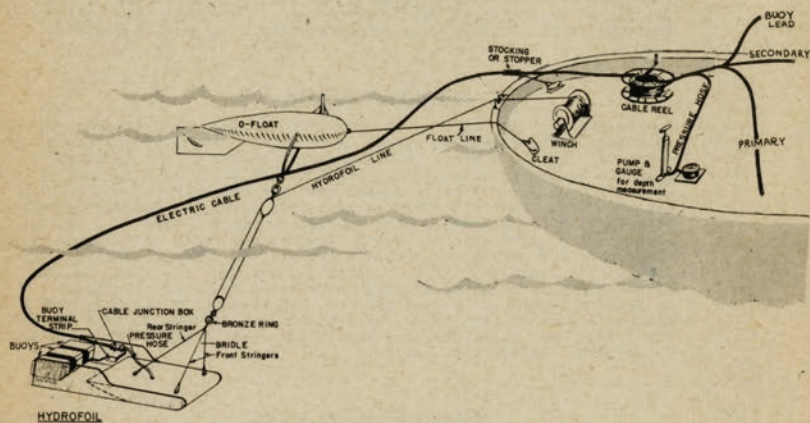


Fig.3-Ordnance Detector MKI, Single Tow with Orapesa Float

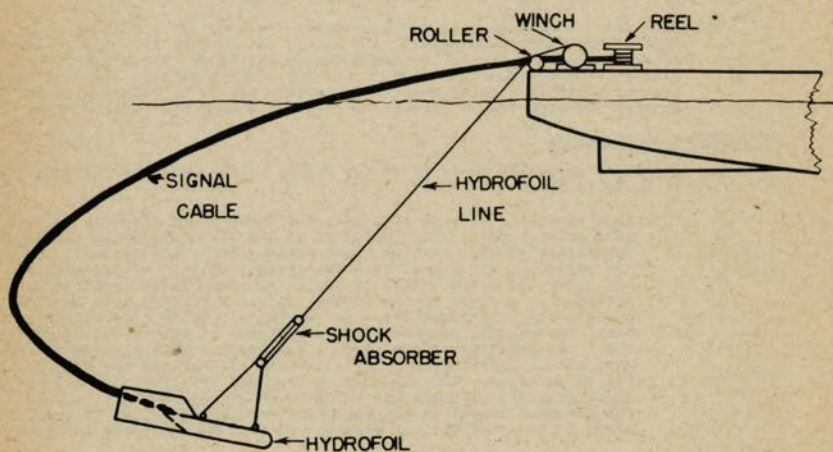


Fig.4-Ordnance Detector MKI, Single Tow Method

UNDERWATER LOCATING AND DETECTING

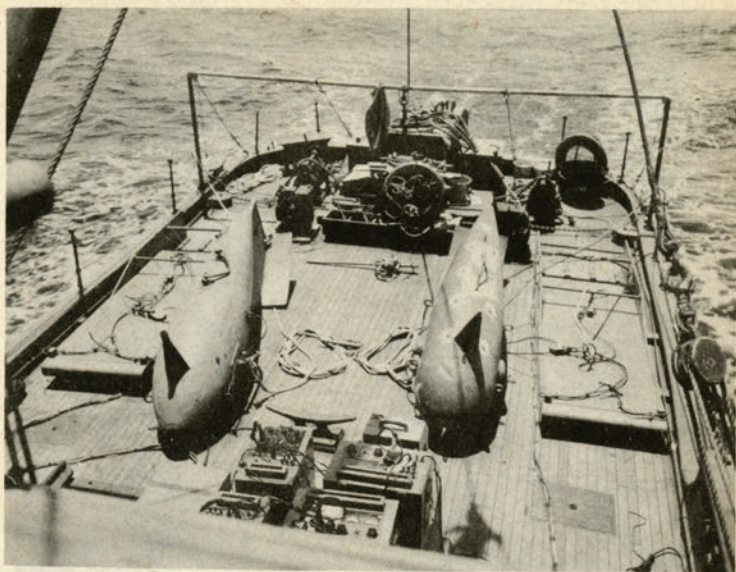


Fig.5-Ordnance Detector MKI, Ready for Streaming



Fig.6- Ordnance Detector MKI, Being Launched



Fig.7-Ordnance Detector MKI, Streamed

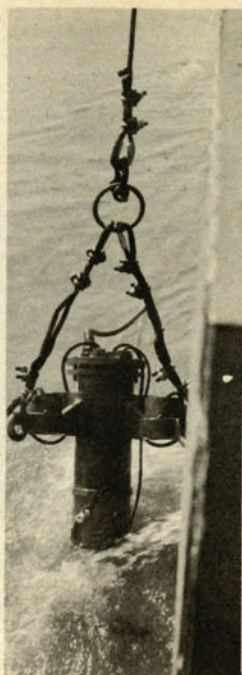
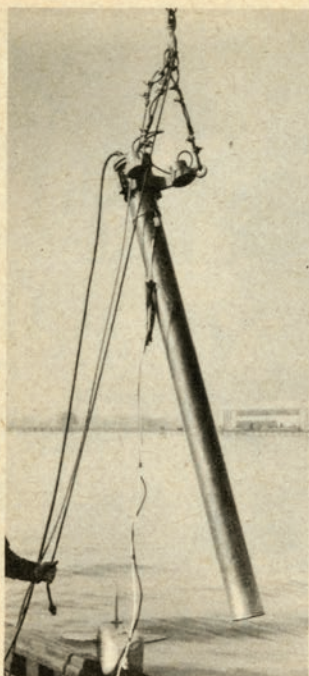


Fig 8 - Ordnance Detector, Mark 2, (with Position Buoy), Rigged for Vertical Tow

Fig.8a- Launching Ordnance Detector, Mark 2, Rigged for Vertical Tow

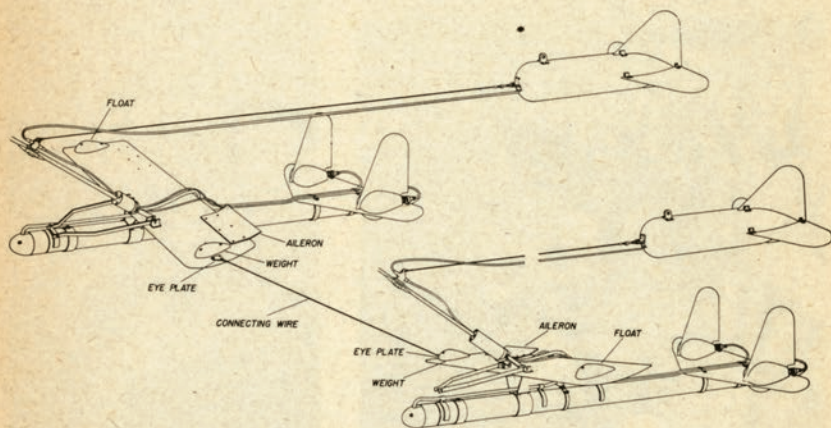


Fig. 9- Ordnance Detector, Mark 2, Auxiliary Gear for Horizontal Double Towing

UNDERWATER LOCATING AND DETECTING

Ordnance Detector, Mark I (Cont'd.)

opposite direction when a non-magnetic conductor is present.

Equipment

1. In order to make towing feasible, the primary and secondary coils are mounted in a hydrofoil. Attached thereto are transducers for the Mark I Underwater Position Indicator and three buoys which can be released when a signal or "strike" is observed on the recorder. The hydrofoil is necessarily heavy (700-1200 lbs.) and bulky because the air-core coils contained therein must be of a size large enough to give a practical range. It is also necessary that the overall buoyancy of the assembly be negative.
2. The size and weight of the hydrofoil require a ship of considerable size to accommodate the necessary launching and retrieving gear, although it is estimated that a vessel of 50 horsepower is adequate for a single tow. Towing lines must be able to withstand a steady 800-1000 pound strain and an occasional strain of up to 5000 lbs. The use of an Orapesa float as a shock absorber is recommended to ease the strain on the lines and aid in maintaining the hydrofoil at a reasonably constant depth. Adequate winches, booms, snatch blocks and personnel are required as commensurate with proper handling of gear of this size. It is to be noted that although the hydrofoil is large and heavy, it is not correspondingly rugged and must be handled with greater care than is usually given to equipment of such size and weight.
3. The oscillator which produces the current for the primary coil, the amplifier for the returning signal and suitable recording instruments are mounted aboard the towing ship. In addition, the Mark I Underwater Position Indicator, which records the distance between the hydrofoil and the bottom, and alternating and direct current sources for the instruments are provided.

Remarks

1. Definite limitations in the use of this detector will be encountered and should be carefully considered prior to undertaking any locating operations. Satisfactory results should be expected with the present equipment only if the bottom is relatively smooth and even, the water fairly calm and the total depth of water less than 150 ft. In addition, it is essential that the operating personnel be experienced in the use of the detector, competent in trouble-shooting and thoroughly grounded in the rudiments of search procedure. The maximum practical range at which the detector will locate three typical objects satisfactorily is given below.

	<u>Range in Feet (Hydrofoil to Target)</u>	<u>Effective Width of Swept Path in Feet</u>
Mine Mark 13	12 1/2	18
Mine Type GD	15	25
Mine Type GC	20	30

The above readings assume that the hydrofoil is about eight feet off the bottom.

2. As far as is known, the Ordnance Detector, Mark 1, is the first locating instrument of its type to be built by any nation and there are, consequently, many limitations to its equipment. However, to date it is the only instrument, except for one of very short range built by the British, which will distinguish between ferrous and non-ferrous objects underwater. More detailed information may be obtained by consulting NOLR's 800-803.

Ordnance Detectors, Mark 2 and 3

General

1. The Ordnance Detectors, Mark 2 and 3, are magnetometer gradiometers developed for the purpose of locating ferrous objects underwater. They are used extensively on torpedo ranges where the value of recoveries runs into the millions of dollars. They have also been useful in locating depth charges, crashed airplanes and numerous other items. Although they cannot be used for locating non-magnetic objects such as certain kinds of influence mine cases, experience shows that the majority of locating operations deals with the recovery of ferrous objects.
2. The Ordnance Detectors, Mark 2 and 3, with their interchangeable control equipment (Control Unit Mark II and Power Supply Mark II) appear to be and are, to a certain extent, complicated instruments. This is an unfortunate result of the fact that any detecting device of an influence nature which has been developed to date requires delicate mechanisms and specialized circuits. This will be readily apparent to all personnel who have studied influence mine firing circuits. For this reason, proper maintenance and operation require personnel with an adequate

UNDERWATER LOCATING AND DETECTING

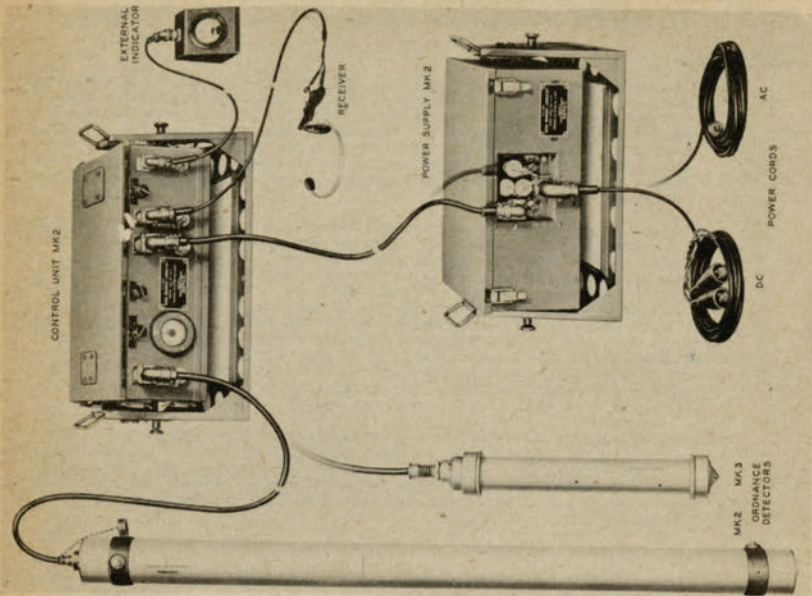


Fig. 10- Ordnance Detectors MKs II and III with Auxiliary Equipment

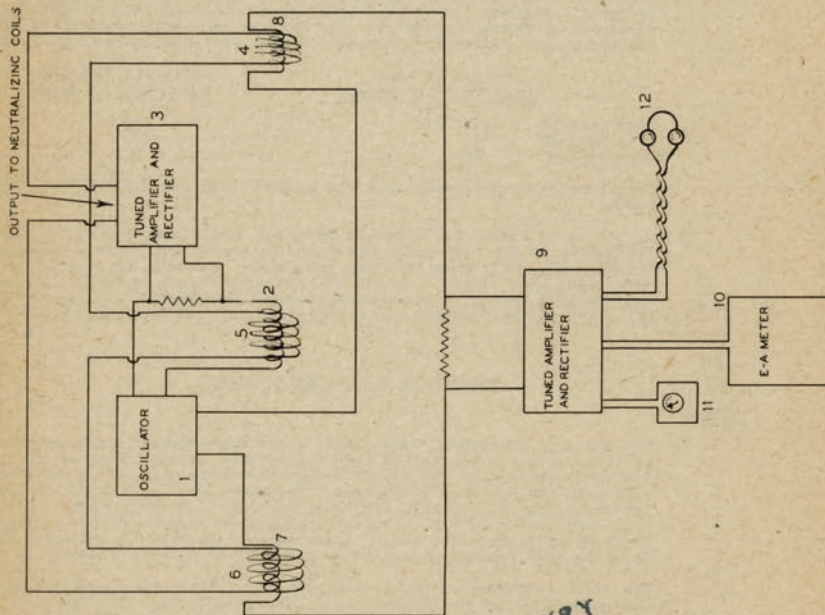


Fig. 11 - Ordnance Detectors MKs II and III, ~~Wiring~~ *Energy Flow* Diagram

## UNDERWATER LOCATING AND DETECTING

### Ordnance Detectors, Mark 2 and 3 (Cont'd.)

grounding in the operation and servicing of the gear.

#### Principles of Operation

1. Each detector is fitted with three solenoids in its tube, one at each end and one in the middle, each solenoid being wound around a permalloy core. The two end coils are used as magnetometers and are wound in series opposition to cancel out the effect of the earth's field. A 1000 cycle voltage is impressed onto each coil and the 2000 cycle harmonic is then measured. The size of this second harmonic is dependent upon the size of the earth's field affecting the permalloy core, hence it can be used to indicate the strength of the earth's field. The end coils are matched and aligned so as to cancel each other's output when they are in a uniform field. As soon as one coil moves into a stronger or weaker field than the other, a gradient exists, producing a net signal which is selected by a 2000 cycle band pass filter, amplified, and fed into a suitable indicator.
2. The high precision with which the two end coils must be matched and aligned is difficult to obtain in practice and certain refinements in the way of neutralizing coils are required for effective operation. These coils balance out the earth's field in the cores of the end detector coils and make the detection of a gradient much simpler. The balancing-out process consists principally of measuring the earth's field present by impressing the 1000 cycle voltage on the center element, filtering the 2000 cycle portion and amplifying and rectifying this output to provide the neutralizing potential applied to the three neutralizing coils.
3. The neutralizing circuit - The oscillator (1) produces 1000 cycle per second voltage which is impressed across center detector coil (2). The tuned amplifier (3) selects any current waves of the second harmonic (i.e., 2000 cycles per second) present in the center detector coil circuit. The 2000 cycle current is amplified, rectified, and fed back into the three neutralizing coils, (4), (5) and (6). The amplifier gain is adjusted until the rectifier output automatically neutralizes the earth's field for any value of field or orientation of coil.
4. The detecting circuit - the oscillator (1) impresses 1000 cycle voltage across the end detector coils (7) and (8) which are wound in opposition to each other. Any 2000 cycle current in one of the coils cancels out current of the same frequency in the other coil, provided that the two coils are situated in equal fields. In case a gradient exists, the second harmonic (2000 cycle current) of one coil is greater than that of the other and the net signal produced is selected by the tuned amplifier (9). The output of this amplifier is fed into suitable recording instruments such as the E-A recording milliammeter (10), the external meter (11), and the earphones (12).

#### Equipment - Ordnance Detector, Mark 2

1. The Mark 2, or towed unit, consists of a six-foot length of aluminum pipe which contains the various detector coils, cores and neutralizing coils. The two gradiometer elements are set five feet apart within the pipe, hence the name, "Five foot Queen". The elements must be as nearly parallel as possible because, if they are not properly situated, a false signal will result. Provision is made for alignment within  $0.001^\circ$ , further balance being accomplished by adding or subtracting turns of a small, tapped, tuner solenoid in one end of the detector element.
2. Stabilization while towing is at present made possible by wings mounted on the pipe forward of center, and by vertical and horizontal tail surfaces aft. Towing strain can be taken either on the lead-in cable which has a central strain relief member or, as in most cases, by a bronze or manila towing cable. A buoy fish which carries a marker buoy is secured to the strain relief cable just above the detector. The buoy which is released by closing a switch on the towing vessel provides a means of marking strikes which may have been received on the indicator or earphones. The strikes may then be made subject to further verification either by repeated passes or by underwater search by a diver. In order to insure that the detector is at the desired distance off the bottom at all times, the Underwater Position Indicator, Mark 1 is used as in the Ordnance Detector, Mark 1, the transducers being mounted on either side of the tail section of the towing gear.
3. The horizontal method of towing described above has several weaknesses which are being corrected by means of a new towing system. Although the horizontal method allows for searching at relatively high speeds, the gear is quite fragile and accidents which render the gear inoperative are not infrequent, especially where the bottom is rough or is littered with reefs, boulders or wrecks. In a new system now under development, the aluminum pipe is shock-mounted in a brass tube, the cable is led in through watertight stuffing boxes in the head and the transducers for the Underwater Position Indicator, Mark 1, are set into brass arms on the head casting. This system has been service-tested extensively on torpedo ranges and gives every indication of being satisfactory.

UNDERWATER LOCATING AND DETECTING

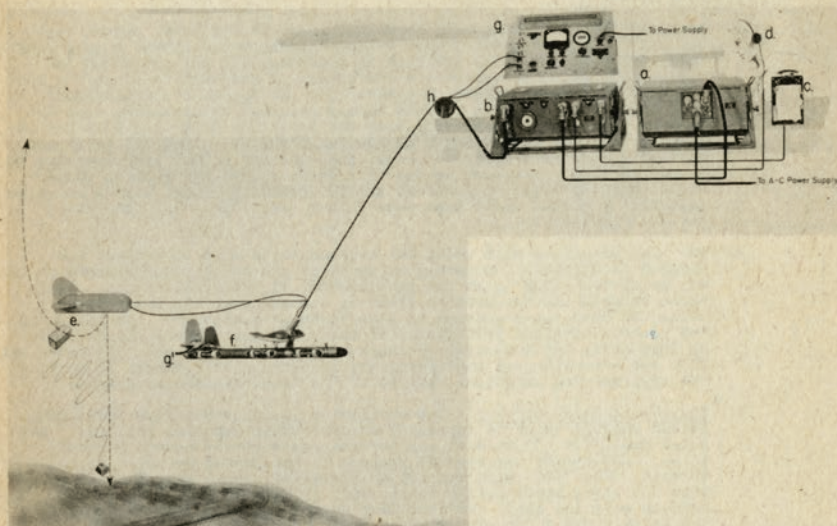


Fig.12- Ordnance Detector, Mark 2, Horizontal Towing Arrangement Showing Control Equipment

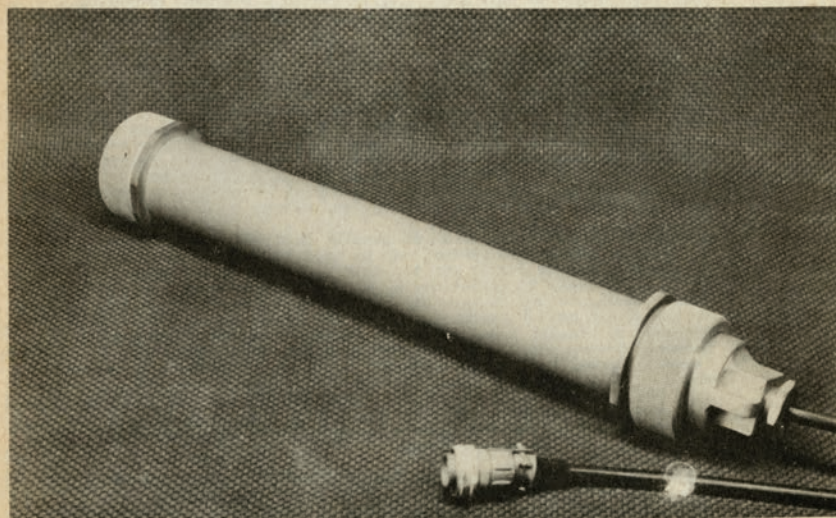


Fig.13- Ordnance Detector MK III

UNDERWATER LOCATING AND DETECTING



1. SET-UP READY FOR LAUNCHING



2. ATTACH AUXILIARY BRIDLE TO HOIST WITH PELICAN HOOK



3. PUT BUOY OVERSIDE AND LOWER DETECTOR INTO WATER



4. RELEASE PELICAN HOOK WHEN DETECTOR CLEARS SHIP

Fig. 14 - Ordnance Detector, Mark 2, Launching Procedure for Double Horizontal Towing



UNDERWATER LOCATING AND DETECTING

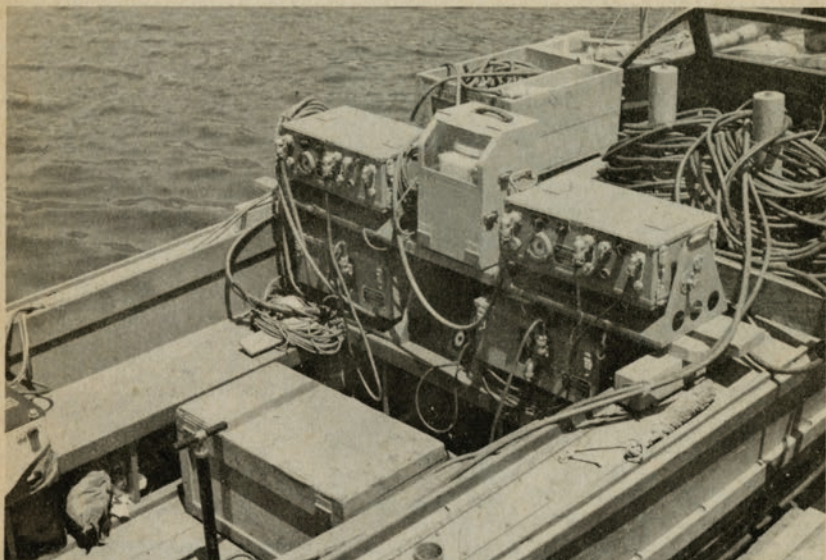


Fig.15- Ordnance Detectors, MKs II and III, Instruments

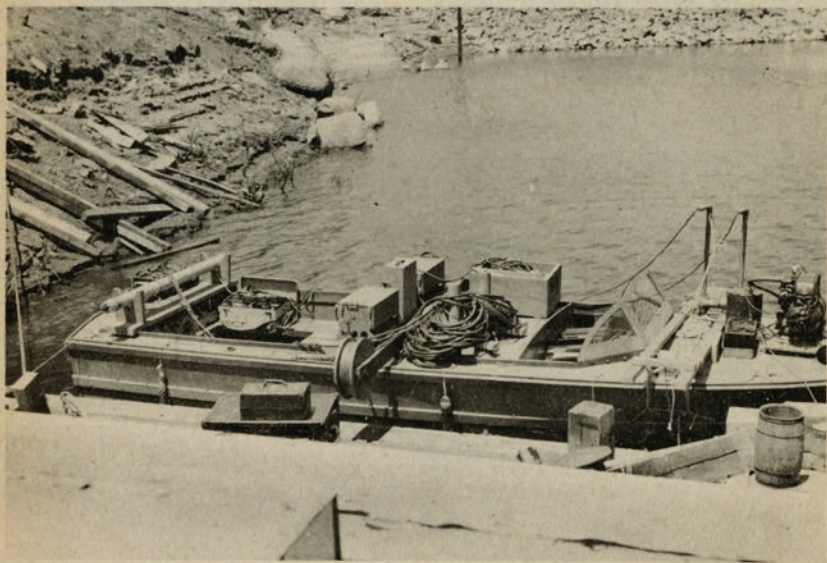


Fig.16- Ordnance Detectors MKs II and III, Instruments

UNDERWATER LOCATING AND DETECTING

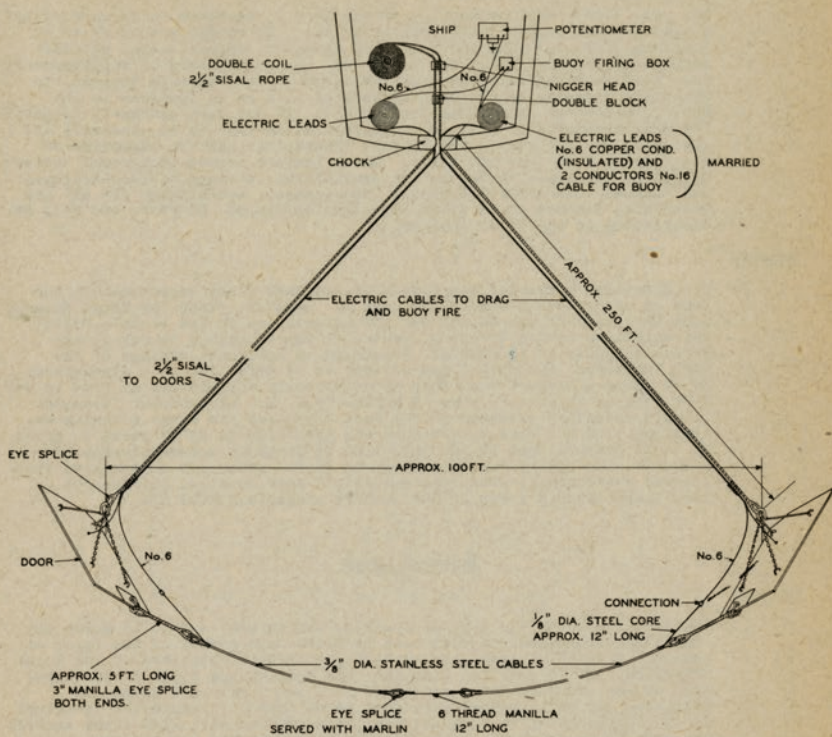


Fig.17-Ordnance Detector X-II

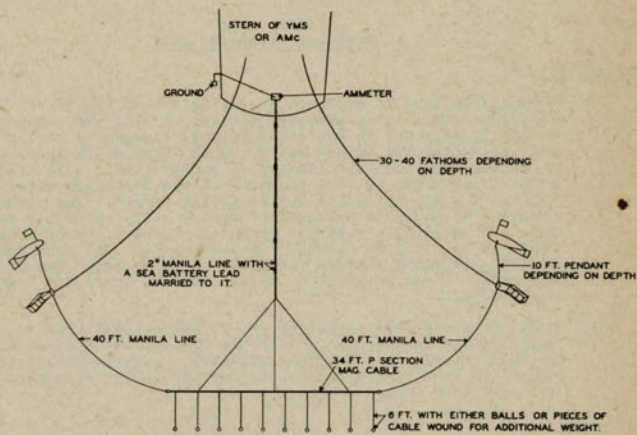


Fig.18-Improvised Galvanic Drag

## UNDERWATER LOCATING AND DETECTING

### Ordnance Detectors, Mark 2 and 3 (Cont'd.)

#### Equipment - Ordnance Detector, Mark 3

1. The Mark 3 is a smaller version of the Mark 2, designed to be carried by divers or cast from a small boat or a dock. It consists of a piece of aluminum pipe, 22" long and 4 1/2" in diameter, capped at one end and with cable leading out of the other end. No transducers or supplementary gear need be attached because of its nature. The distance between its detecting elements is one foot instead of five as is the case in the Mark 2, hence the name, "One foot Queen". It has been extremely effective, the main drawbacks to its use at present being that it is adversely affected by the magnets in the diver's transceiver and the magnetism of the diver's life line and knife. These factors create background "noise", making it necessary to reduce the sensitivity settings of the instrument and thereby, its effective range. Non-magnetic substitutes for all the disturbing factors noted above have been developed, however, and will be distributed to the field shortly.

#### Remarks

1. The effective range and swept path of the Mark 2 are approximately the same as those obtained with the Mark 1. However, since the range depends upon the shape of the object and its orientation in the earth's field, the detecting distance varies, making it impracticable to set up any definite tables of distances. Presuming an empirical average of the many variables, the Mark 2 may be said to be effective at a distance of 20 ft. from a large target such as an aircraft torpedo and at five to six feet from an object the size of a Mine Type JE. The shorter distance between detecting elements on the Mark 3 reduces its range slightly as compared with the Mark 2, although the reduction is by no means so great as to be proportional to the reduction in distance between detecting elements. Torpedoes buried as deep as 18 ft. under the bottom have been located successfully with this detector. More detailed information on both these detectors may be obtained by consulting NOLR 871.

### Galvanic Drags

#### General

1. The decision as to the type of locating device best suited to solve any locating problem must in each case be based on a survey of the types of gear and facilities available, and on a considered estimate of the local situation. It is realized that the more complicated types of locators such as the Ordnance Detectors, Mark 1, 2 and 3 will not always be available nor will trained personnel be on hand to operate the detectors in all instances where they are available. Cases will also arise wherein the area to be searched is so large as to render the short-range, influence-type locators inefficient if the search is to be completed within a reasonable length of time. In such cases, if the bottom is reasonably free of major obstructions such as coral heads, boulders and wrecks, and if the object is not liable to explode on contact, drags of various types may be used with a reasonable expectation of favorable results.

### Ordnance Detector, X-11

#### Description

1. This simple type of galvanic drag consists of two 55 ft. lengths of 3/8" stainless steel cable with eye splices at each end. The end of one length is attached to the other by a 12" length of manila line, the other ends being secured to two shrimp doors, similar to those used by shrimp fishermen, by five-foot lengths of manila line. A #6 insulated copper cable is attached to each door end of the stainless steel cable and is led up to a potentiometer on the towing vessel. The potentiometer is grounded by means of a length of bronze cable which may be trailed in the water or secured to a copper ground on board. A buoy attached to each door may be fired by closing a switch on deck and provides a means of marking suspected strikes for later verification. The drag is towed by two manila lines attached to bridles on the doors and towed from a nigger head on deck.
2. From the above brief description, it can be seen that the detector is a much simpler device than either the Ordnance Detectors, Mark 1, 2 or 3. It incorporates no electronic circuits, requires but little electric power, is very simple from a rigging and towing standpoint and can be streamed from a single power launch.

#### Operation

1. The gear is streamed as shown in Figure 17. Very little adjustment is necessary and sweeping may be started immediately upon streaming. A limited background usually appears on the meters due to the galvanic

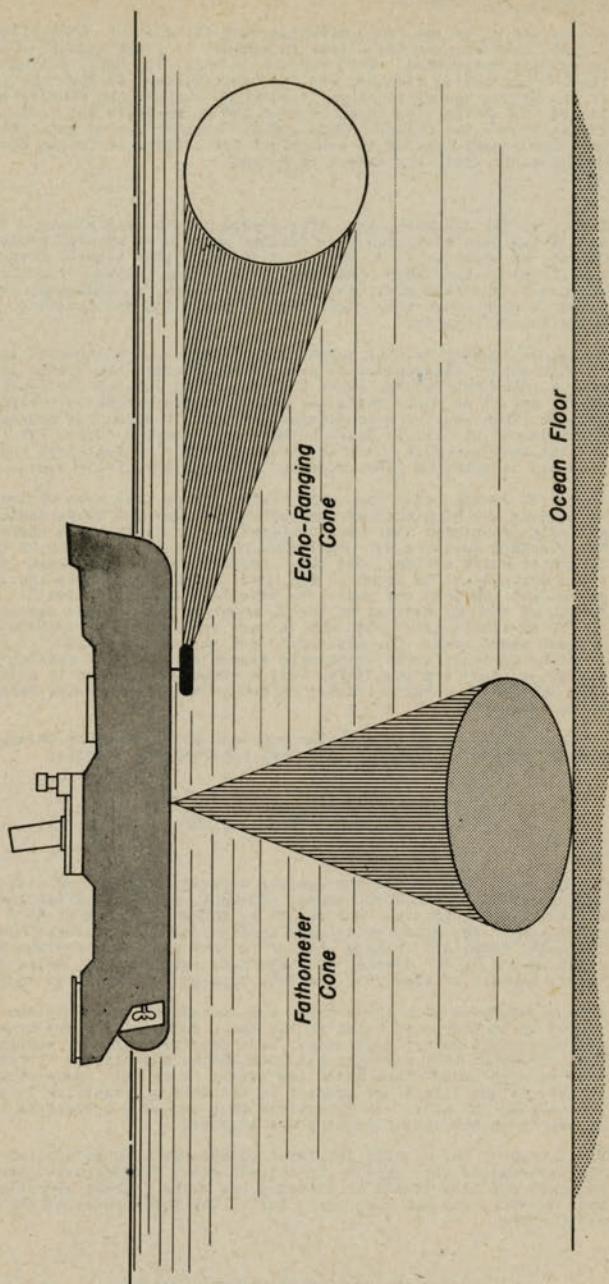


Fig.19-Fathometer and Echo-Ranging Cones, Schematic Drawing

## UNDERWATER LOCATING AND DETECTING

### Ordnance Detector, X-11 (Cont'd.)

action set up by the cable scraping over the bottom. This effect is very slight, however, and the signal on contact is large enough so that it may be readily recognized. When contact is made, the buoys attached to the trawl doors may be released and the cable allowed to snag on the object. If the towing vessel is stopped promptly, contact can usually be maintained and the manila line taken in over the stern until the vessel is directly over the object. This permits maintenance of positive contact with the object, making it convenient for a diver to follow down the towing cable until the object is found.

### Remarks

1. When properly streamed, this drag sweeps a path approximately 90 ft. wide and it has been used with considerable success on several occasions. Objects as small as U. S. Mark 13 mines have been located under favorable conditions as have many other objects, ranging in size from aircraft engines to complete aircraft. In one instance, a submerged aircraft was found in four hours after four days of grappling had failed to produce satisfactory results.
2. There are however several outstanding disadvantages inherent in locators of this type. They cannot be used in areas where the bottom is littered with sizable debris and, since they depend on contact for locating purposes, are of no value where the object of the search is buried in the bottom. They require a considerable amount of space for maneuvering, and hence cannot be used in small harbors or alongside docks. It is also obvious that the risk involved in the use of a contact-type locating device may be great if live ordnance is the object of the search.
3. It may be readily seen that many variations of this type of locator can be devised out of miscellaneous materials. Several drags employing galvanic principles have been designed and built in areas where none of the standard locators was available and where a search had to be conducted on short notice. One such locator, successfully used in a search for a depth bomb, is shown in Fig. 18. A YMS was used as the towing vessel and the drag was made from materials available aboard. A 35-ft. length of the "K" section of the LL magnetic sweep tails was attached to 40 ft. of manila line which was in turn secured to the paravanes of the Orapesa sweep gear. The paravanes were suspended by a 10 ft. pendant from the Orapesa floats which were veered out on 30-40 fathoms of sweep cable. A lead from the 35-ft. tail section was married to a 2" manila line and led to a potentiometer on deck, the potentiometer being grounded as indicated.
4. It should also be noted that the galvanic principles may be applied to divers' probes and search lines with considerable success.

### Locating and Recovery Nets

#### General

1. In the early days of the war against Germany, when mining attacks on the eastern coast of the U. S. seemed imminent, a method of retrieving submarine-laid ground mines was sought by those in charge of mine disposal operations. One means which gave indications of usefulness was the Icelandic trawl net, a type similar to that used by fishermen off the north coast of the U. S. Several of these nets were made up, using phosphor-bronze instead of steel for the foot rope and on the trawl doors.
2. Some experiments with these nets were successful in that mines were picked up in the nets, towed to the beach and dumped where Mine Disposal Officers could render them safe. As a practical type of search equipment, however, they have not had outstanding success due to the fact that in most areas where mines are likely to be laid, many kinds of obstructions and debris are present on the bottom, resulting in snagging and tearing the nets. This requires that sweeping operations be interrupted frequently while repairs are effected.
3. The Bureau of Ships later initiated experimentation with a two-ship type. The experiments gave promise of success and a considerable quantity was procured and distributed to minesweeping ships. Their operational success, however, has not been great due to the fundamental difficulties noted above.

### Underwater Locating With Sound Devices

#### General

1. Echo-ranging and fathometer gear may prove quite useful in underwater locating under certain conditions. They are not so effective generally as the Ordnance Detectors and would not ordinarily be used when the

## UNDERWATER LOCATING AND DETECTING

### Underwater Locating With Sound Devices (Cont'd.)

latter are available. Nevertheless, if a situation arises where a choice must be made between attempting an extended search by a diver and searching with sound gear, the latter should be tried if the following conditions exist:

- (a) The ocean floor is well charted and known to be fairly regular. The nature of the bottom should be such that the object may be assumed to be resting on it rather than buried beneath it.
  - (b) The object is of sufficient size to give a good strike on the gear.
2. Whereas obtaining effective results with the various Ordnance Detectors requires personnel particularly skilled in rigging and streaming the gear, such is not the case here as the gear is almost always permanently installed in the search vessels. The main requirement in this case is that the operating personnel be sufficiently experienced in the use of the equipment to properly interpret and evaluate the signals or strikes obtained.

### Echo-Ranging Gear

1. Although many types of echo-ranging gear are now in general service, each operates on the same general principle, i.e., the gear puts out sound pulses in the form of a cone ahead of the ship, the fore and aft range of the sound and the horizontal coverage given being dependent on the individual models. The accompanying drawing shows the type of coverage obtained. If these sound pulses strike a fairly hard-surfaced object with the proper angle of incidence, they are reflected back and recorded aboard the transmitting vessel. The recorded reflection is scaled and measured to give the range and bearing of the object although it is not possible with this gear to determine the exact size and shape of the object. Echo-ranging gear may be trained in azimuth but not in elevation.

### Fathometers

1. Two types of fathometers are now in general service, the NJ series and the NK series. The former is a permanent installation while the latter is portable, usually being streamed over the side. This gear puts out sound pulses in the form of a cone directly under the ship and the sound is reflected back from the bottom, indicating not only the depth of water beneath the ship but the general contour of the bottom. This latter property permits general definition of the relative size and shape of any sizable object recorded.

### Locating Technique

1. Although either the fathometer or echo-ranging gear may be used singly, the most effective results from a locating point of view will be obtained if they are used in combination. It is readily apparent that neither type of gear comprises a satisfactory locating device in itself due to the fact that echo-ranging gear cannot be used as the ship nears the object whereas a fathometer does not become effective until the ship is directly over the object. The most satisfactory technique, then, is to pick up the object using the echo-ranging gear, maintaining contact thereby during the approach, and then switch on the fathometer as the ship passes over the suspected location of the object.

### Remarks

1. The above search technique has been applied successfully in locating both moored and ground mines and especially in locating wrecks and crashed airplanes. It is to be noted, however, that the smaller the object, the less chance there is of locating it successfully. The echo-ranging gear is not ideally suited for locating in that false signals of considerable intensity will be received from such unrelated objects as logs, boulders, water temperature gradients and fish. It must be re-emphasized that only an experienced and skillful operator can consistently distinguish between these and a bona fide strike.
2. Nevertheless, examples are on record where moored mines have been picked up at a range of 400 yards and contact maintained to within a range of 25 yards. In one case, a sunken moored mine was picked up at a range of 700 yards and contact maintained to within a range of 25 yards. Although ground mines are not so easily located because of the probability of false signals as noted above, one instance is recorded where divers searched an area of 200 square yards for a period of twelve days without success. Echo-ranging and fathometer gear were then put into use as a last resort and located two ground mines in the same area within two hours.
3. It may be concluded, then, that while locating with sound gear has but a limited application, it may be used to good effect in locating moored mines and in general locating problems where standard locating devices are not available and bottom conditions are suitable.

UNDERWATER LOCATING AND DETECTING

Aids for Divers

General

1. Once an object has been tentatively located by any of the methods mentioned previously, it is still necessary to confirm both the location and the identity of the suspected object. The most common means of accomplishing this involves search by a diver of the area immediately surrounding the suspected location. While this offers no particular problem on an even, sand or rock bottom, visibility in most cases is sufficiently restricted so that locating the object, not to mention positively identifying it, becomes a difficult task.

Search Line Drag

1. The search line drag discussed herein and pictured in the accompanying drawing has been used successfully by divers in several instances. Briefly, a copper ground plate is suspended over the opposite side of the ship from which the diver descends and is connected electrically to a galvanometer aboard. An additional copper or bronze cable is connected to the other side of the meter and married to the diver's descending line with an additional length being provided for use as a search or circling line. The diver searches the indicated area, using the bronze or copper cable as circling line. The cable provides an additional possible means of locating the desired object, since a reading will be obtained on the galvanometer if the cable contacts a dissimilar metal. The diver may then follow the circling line back toward the foot of his descending line until he contacts the object.

Remarks

1. Other divers' aids such as probes may also be fashioned using the same principles of operation as above. Obviously, the drag is only effective when the object of the search is made of steel or some similar metal. However, experience has shown that such is the case in most locating operations.
2. Other devices such as mechanical drags, divers' lights and probes may be of value depending on the situation. It should be noted that any aids which can be effectively utilized by the diver are ordinarily of great value in shortening the time expended on a search of this type. Every effort should be made to make the best possible use all facilities available along this line.

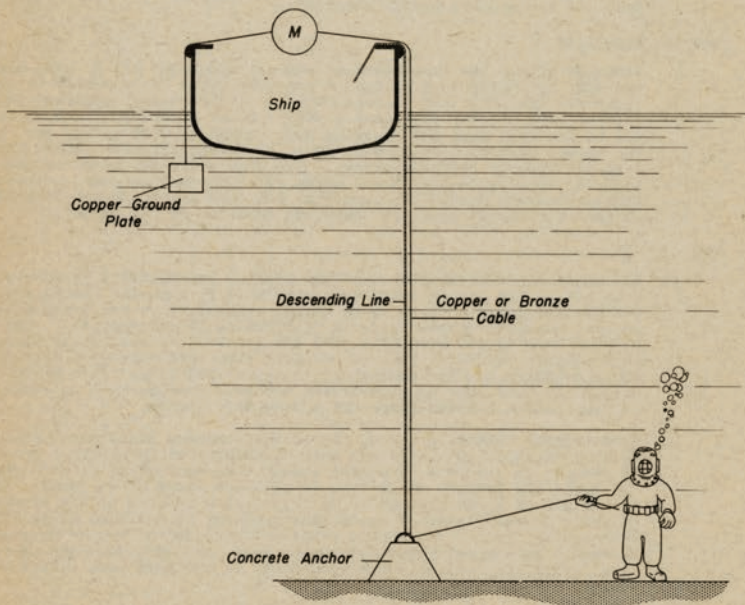


Fig. 20-Diver's Search-Line Drag

# MINE DISPOSAL HANDBOOK

## PART I

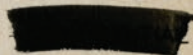
### GENERAL INFORMATION

• • • • •

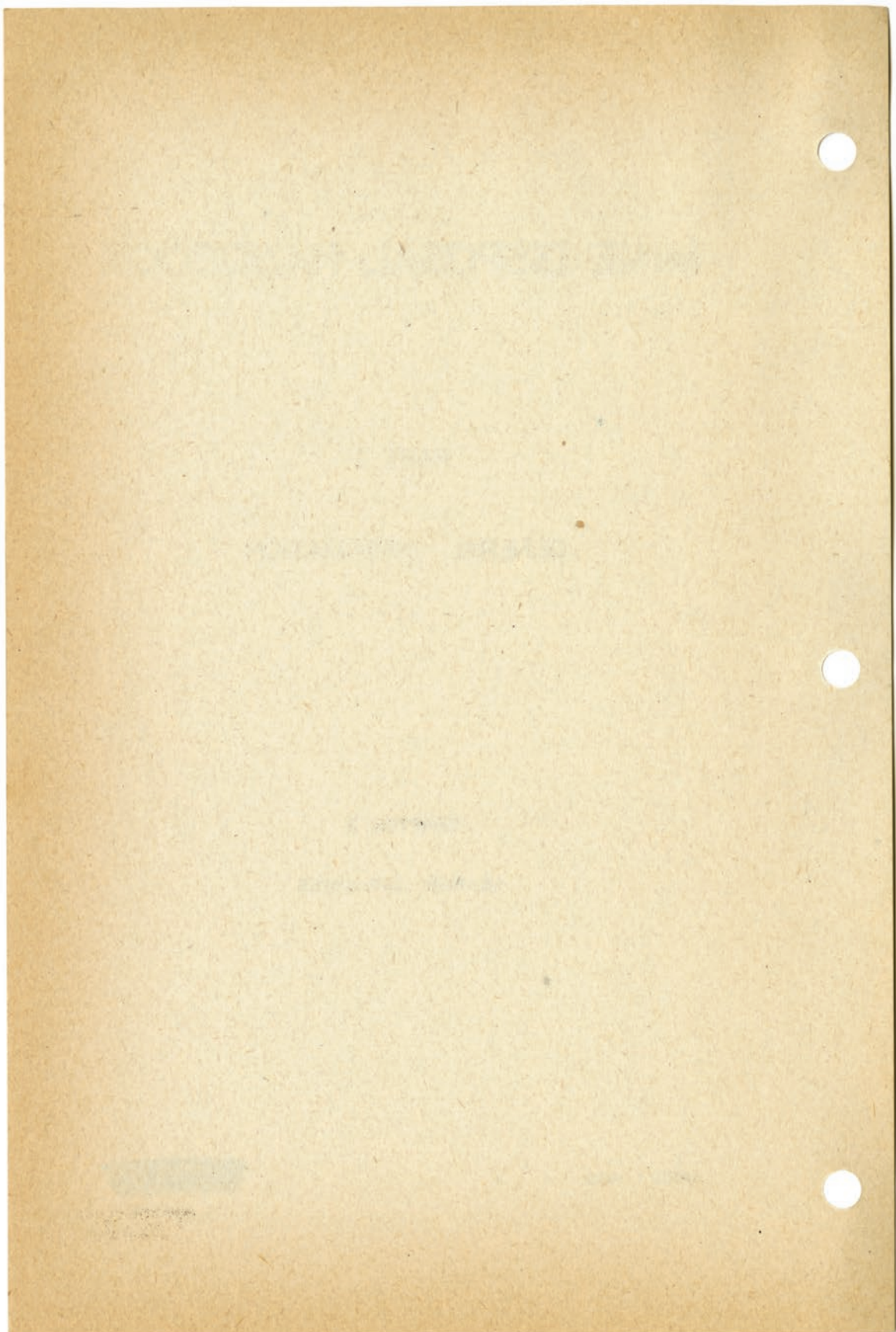
### CHAPTER 3

#### MILITARY EXPLOSIVES

APRIL 1, 1945







## MILITARY EXPLOSIVES

### Introduction

1. The information compiled herein purports to give a brief representative picture of the field of military high explosives. Its primary purpose is to aid in the identification of and provide a sound basis for treatment of explosive charges during disposal operations on underwater explosive ordnance. Each explosive is discussed briefly using an arbitrary standard outline form, the various outline topic headings being explained below in detail to aid in the evaluation of the information to follow. Where pertinent information is not known or is unavailable, the topic heading is omitted.
  - (a) Name(s) - gives the names in common usage.
  - (b) Composition - gives components and percentages thereof, where known. Two or more explosives of similar composition may be listed together.
  - (c) Color - gives the possible color range in most cases rather than a single color, due to the fact that explosives often vary in color as a result of age or slight variations in composition. Cast explosives are ordinarily uniform in color and show no definite crystalline structure except when various components segregate. Pressed explosives may be mottled or spotted, depending on the type and number of components.
  - (d) Melting point - gives the results obtained, in °C, from submitting the explosive to the standard melting point test.
  - (e) Detonating temperature - gives the temperature at which the explosive detonated when its temperature was raised at a rate of 5-10°C per minute. It should be noted, however, that the given temperature is not the lowest at which the explosive will detonate without any outside actuation or influence other than heat. Slightly lower temperatures may set up the explosive if they are maintained over relatively long periods of time.
  - (f) Sensitivity - gives a general statement of the explosive's sensitivity plus the results of the following tests, where available:
    - (1) The Laboratory Impact-Sensitivity Test - a test wherein a given weight, usually a two kilogram block, is dropped from various heights on a given amount of the explosive. The height from which the block must be dropped to detonate the explosive determines its relative sensitivity to impact. This reading is computed on an arbitrary scale, with TNT at 100 being used as a reference index. Decreasing numbers indicate increasing sensitivity.
    - (2) The Bullet Sensitivity Test - a test wherein 0.30 calibre ball ammunition is fired into small amounts of the explosive from a distance of 75 ft. The results are tabulated in a table of insensitivity, with RDX as 0 and TNT as 100.
  - (g) Power and Brisance - gives a general statement of the explosive's power and brisance plus the results of the following tests, where available:
    - (1) The Trauzle Lead-Block Test - the measured quantity in this test is the volume hollowed out of a block of lead by 10 grams of the explosive. The readings given are relative volumes expressed as percentages of the volume obtained for picric acid.
    - (2) The Sand Test - the measured quantity in this test is the weight of sand crushed by 0.4 grams of the explosive. The readings given are percentages of the weight given for TNT.
    - (3) The Ballistic Mortar Test - a test wherein a given amount of explosive is placed in a gun and fired directly into a heavy mortar suspended as a pendulum. The mortar test value is the amount of explosive necessary to raise the pendulum to the height to which it is raised by 10 grams of TNT. The readings given are percentages of the TNT value.
  - (h) Velocity - gives the rate of detonation in feet per second at the normal loading density. Velocity at other loading densities may be estimated by adding 1200 feet per second to the given reading for each increment of 0.1 g/cc. of loading density.

MILITARY EXPLOSIVES

(Introduction, Cont'd.)

- (i) Stability - gives a general statement of the explosive's stability when stored alone and notes conditions under which it may become more or less stable.
  - (j) Reaction with Metals - gives the extent to which the explosive attacks metals commonly used in munitions.
  - (k) Loading - gives the form in which the explosive is loaded; i.e., cast, block-fitted, pressed, etc.
  - (l) Use - gives the explosive's common military uses and the nations by which it is used. If specific nations are not noted, the explosive is used universally.
  - (m) Remarks - gives general points of interest plus the results of the following tests, where available:
    - (1) The Shaped-Charge Efficiency Test - the measured quantity in this test is the relative volume of a hole which the jet from a charge of standard size and shape cuts out of a thick steel plate. The readings given are percentages of the volume given for TNT.
    - (2) The Air-Blast Energy Test - the measured quantity in this test is the energy of the shock wave (blast wave) given off upon detonation of a given quantity of explosive. The readings given are percentages relative to TNT.
    - (3) The Water Energy Shock Test - the measured quantity in this test is the corresponding relative energy of the shock wave produced by charges fired underwater as compared with the air-blast energy reading for the same explosive.
    - (4) The Index of Inflammability Test - the measured quantity in this test is the explosive's relative sensitivity to flame as compared with TNT. Respective number readings lower or higher than 100, the TNT index reading, indicate lesser or greater sensitivity to flame.
2. The following points should be borne in mind when dealing with high explosive charges:
- (a) Initiators such as detonators, blasting caps and primers are extremely sensitive to friction, heat or shock.
  - (b) Boosters, while not so sensitive as initiators, are much more sensitive than main charges and should be handled accordingly.
  - (c) Main charges are the least sensitive components of the explosive train and will normally require detonation of another explosive or an extremely heavy impact to effect detonation. A limited number of main charge loadings, such as the Japanese explosive Type 88, are extremely sensitive to friction and require more extensive precautions in handling.
  - (d) Explosives which have been subjected to abnormal climatic or handling conditions, which tend to deteriorate in storage or which are in the impure state may be extraordinarily sensitive to friction, heat or shock.
  - (e) Explosives which have a lower numerical bullet impact reading than TNT should be considered bullet sensitive.
  - (f) All explosives containing Hexanitrodiphenalimine are extremely toxic. Exposure to fumes or smoke therefrom, as well as actual contact with the explosive, may be extremely injurious to lung or skin tissues.
  - (g) The gaseous products of detonation and burning of explosives are irritating and/or toxic.
  - (h) Explosives which melt at temperatures above 95°C cannot be steamed out readily.
  - (i) Explosives containing Aluminum, Torpex or Hexanite burn violently when unconfined and usually detonate if burned in confined spaces.

MILITARY EXPLOSIVES

(Introduction, Cont'd.)

- (j) Various small, sensitive pellets may be found imbedded in the upper part of Japanese sub-boosters (gaines) as follows:
    - (1) A lead azide pellet designed to be fired by cap or delay train.
    - (2) Mercury fulminate in pressed layers separated by thin papers or in an asbestos container, designed to be fired by striker action.
    - (3) Mercury fulminate in granular form in a small copper cup, designed to be fired by a cap or delay train. Serious accidents have resulted from the failure of disposal personnel to realize the danger inherent in breaking down these gaines. Attention is drawn to the fact that German gaines may also be fitted with pellets of this type and that any attempt at burning will probably result in complete detonation.
  - (k) Damaged explosive containers offer the possibility that chemical action may take place between the explosive and certain non-ferrous metals, resulting in blue or green powder or crystals. This substance may be highly sensitive to friction or shock and must be treated with great care or kept wet. If accessible, it may be washed off with warm water, or scraped off under water with a wooden instrument. Friction should be kept to a minimum, and direct blows should be avoided.
3. Unless otherwise noted, figures representing the results of tests on any particular explosive apply only to the U.S. grade thereof.

## MILITARY EXPLOSIVES

### Amatol

Composition- - - - Mechanical mixture of Ammonium Nitrate and TNT. U.S. Amatol comes in three grades, 50/50, 60/40 and 80/20. British Amatol is 80/20 and German, 65/35.

Color- - - - - Light straw to dark brown; the greater the Ammonium Nitrate content, the darker the color.

Melting Pt.- - - - 81°C for U.S. 50/50. 80/20 does not melt.

Detonating Temp. - 254-256°C for 50/50, 290°C for 80/20.

Sensitivity- - - - Similar to TNT. Laboratory impact - 84, bullet impact - 100.

Brisance  
and Power - - - - Varies inversely with the Ammonium Nitrate content. Lead block - 120, sand test - 86.

Velocity - - - - - 50/50 - 19,680 ft/sec. 60/40 - 18,400 ft/sec. 80/20 - 16,700 ft/sec.

Stability- - - - - Decreases as % of Ammonium Nitrate increases; rather hygroscopic.

Reaction  
with Metals - - - - Forms dangerous compounds with tin and copper. May corrode steel when dry, brass and bronze when wet.

Loading- - - - - 50/50 - cast or pressed, 80/20 - extruded or pressed.

Use- - - - - By almost all nations as a TNT substitute.

Remarks- - - - - Shaped charge efficiency - 54%, air-blast energy - 82%, water energy shock - 94%.

### Ammonal

Composition- - - - Ammonium Nitrate - 70%, TNT - 20%, Aluminum Powder - 10% (Ger). Ammonium Nitrate - 67%, TNT - 22%, Aluminum Powder 11% (U.S. & Br).

Color- - - - - White to dark gray.

Melting Pt.- - - - Does not melt.

Detonating Temp. - 265°C

Sensitivity- - - - Less than TNT.

Brisance  
and Power - - - - Lead block - 125, sand test - 107.

Velocity - - - - - 21,500 - 25,000 ft/sec.

Stability- - - - - Hygroscopic; damaged by moisture.

Loading- - - - - Pressed.

Use- - - - - Bomb-loading.

Remarks- - - - - Gives off poisonous fumes.

### Baratol

Composition- - - - TNT - 90%, Barium Nitrate - 10%

Color- - - - - Pale straw.

Melting Pt.- - - - Approx. 90°C.

Sensitivity- - - - Slightly less than TNT.

Stability- - - - - Non-hygroscopic, very stable in storage.

Reaction  
with Metals - - - - None

Loading- - - - - Cast

Use- - - - - British bombs.

Remarks- - - - - Very efficient. High density permits better propagation of detonating wave and increases weight of filling.

### Black Powder

Composition- - - - Potassium Nitrate - 75%, Charcoal - 15%, Sulfur - 10%.

Color- - - - - Shiny black crystals or flakes.

Melting Pt.- - - - Does not melt.

Detonating Temp. - 450°C.

Sensitivity- - - - Very sensitive to friction, heat or shock.

Brisance  
and Power - - - - Extremely low.

Velocity - - - - - 1300 ft/sec.

Stability- - - - - Very hygroscopic

Reaction  
with Metals - - - - None

Loading- - - - - Granular or pressed.

Use- - - - - Powder train delay fuzes, safety fuzes and primers.

Remarks- - - - - Burns rapidly. Rendered inert by immersion in water. Becomes active again upon drying.

### Composition A

Composition- - - - RDX - 91%, Wax - 9%.

Color- - - - - White to buff.

Detonating Temp. - 250°C.

Sensitivity- - - - Laboratory impact - 75, bullet impact - 100.

Brisance  
and Power - - - - Ballistic mortar - 134, sand test 115.

Velocity - - - - - 27,060 ft/sec.

Stability- - - - - Non-hygroscopic; stable in storage.

Reaction  
with Metals - - - - Corrodes steel and brass slightly when dry; copper, brass, magnesium and steel slightly when moist.

MILITARY EXPLOSIVES

Composition A (Cont'd.)

Loading- - - - - Pressed  
 Use- - - - - Anti-aircraft ammunition.  
 Remarks- - - - - Index of inflammability - 195.

Composition B

Other Names- - - - Cyclotol.  
 Composition- - - - B-1; RDX - 59%, TNT - 40%, Beeswax - 1%.  
                   B-2; RDX - 60%, TNT - 40%.  
 Color- - - - - Pale yellow to brown.  
 Melting Pt.- - - - 81°C  
 Detonating Temp. - 188-194°C.  
 Sensitivity- - - - Slightly greater than TNT. Laboratory impact - 73, bullet impact - 80.  
 Brisance  
     and Power - - Lead block - 122, sand test - 118, ballistic mortar - 134.  
                   About 30% more powerful than TNT.  
 Velocity - - - - - 24,500 ft/sec.  
 Stability- - - - - Non-hygroscopic; stable in storage.  
 Reaction  
     with Metals - Corrodes copper and brass slightly when dry, magnesium slightly when moist.  
 Loading- - - - - Cast  
 Use- - - - - Replaces TNT in some large G. P. and Frag. bombs.  
 Remarks- - - - - Shaped charge efficiency - 169, air-blast energy - 116, water energy shock - 121, index of inflammability - 177.

Composition C

Composition- - - - RDX - 88%, Oil - 11.4%, Lecithin - 0.6%. Composition C-1 is 88/12.  
 Color- - - - - Yellow to yellow brown.  
 Melting Pt.- - - - 81°C.  
 Detonating Temp. - 177-180°C.  
 Sensitivity- - - - Laboratory impact - 80, bullet impact - 100.  
 Brisance  
     and Power - - Lead block - 120, sand test - 180, ballistic mortar - 124.  
 Velocity - - - - - 26,570 ft/sec.  
 Stability- - - - - Very stable, may exude oil.  
 Reaction  
     with Metals - None  
 Loading- - - - - 1/2 lb. blocks (U.S.), 4 oz. parchment covered rolls (Jap).  
 Use- - - - - Demolition.  
 Remarks- - - - - Shaped-charge efficiency - 121. May cause dermatitis.

Composition C-2

Composition- - - - RDX - 74%, Oil - 6%, TNT - 4%, Nitrocellulose - 1%, MNT - 5%, DNT - 10%.  
 Color- - - - - Light tan to yellow brown.  
 Melting Pt.- - - - 67°C.  
 Detonating Temp. - 172-177°C.  
 Sensitivity- - - - Same as TNT. Bullet impact - 100.  
 Brisance  
     and Power - - Sand test - 110, ballistic mortar - 126.  
 Velocity - - - - - 25,700 ft/sec.  
 Stability- - - - - Slightly hygroscopic; loses weight due to exudation.  
 Loading- - - - - Plastic blocks.  
 Use- - - - - Demolition blocks.  
 Remarks- - - - - Fumes may be toxic; may cause dermatitis. Index of inflammability - 178.

Composition C-3

Composition- - - - RDX - 77%, Tetryl - 3%, TNT - 4%, Nitrocellulose - 1%, MNT - 5%, DNT - 10%.  
 Color- - - - - Brown  
 Melting Pt.- - - - 68°C.  
 Detonating Temp. - Approx. 175°C.  
 Sensitivity- - - - Laboratory impact - 98, bullet impact - 100 plus.  
 Brisance  
     and Power - - Ballistic mortar - 126.  
 Velocity - - - - - 26,000 ft/sec.  
 Stability- - - - - More stable than any other C Series plastic explosive; remains plastic over a wider temperature range.  
 Loading- - - - - Plastic blocks.  
 Use- - - - - Demolition.  
 Remarks- - - - - About 35% more powerful than TNT; replacing C and C-2. May cause dermatitis.

Composition Explosive (see Tetryl)

Cortex (see PETN)

## MILITARY EXPLOSIVES

### Cyclotol (see Composition B)

#### DEX

Composition - - - RDX - 21%, Ammonium Nitrate - 21%, TNT - 40%, Aluminum - 18%.  
Color - - - - - Gray  
Melting Pt. - - - - 98-105°C.  
Sensitivity - - - - Similar to Torpex. Bullet impact - 51.  
Brisance  
and Power - - - Ballistic mortar - 146.  
Velocity - - - - - 22,300 ft/sec.  
Stability - - - - - Stable in storage.  
Reaction  
with Metals - Corrodes brass slightly when dry, steel when moist.  
Loading - - - - - Cast  
Use - - - - - Originally designed for depth bombs but may replace Torpex in other munitions.  
Remarks - - - - - Air-blast energy - 122, water energy shock - 136

#### Dinol

Other Names - - - - DDNP  
Composition - - - - Diazodinitrophenol  
Color - - - - - Bright yellow to brown.  
Melting Pt. - - - - 159°C.  
Sensitivity - - - - Slightly less sensitive than mercury fulminate or lead azide.  
Brisance  
and Power - - - More powerful than other initiators; comparable to Tetryl.  
Stability - - - - Desensitized by water.  
Loading - - - - - Pressed.  
Use - - - - - Military detonating caps; undergoing tests for use in Navy detonators.  
Remarks - - - - - When used in Priming Compositions, Dinol is more sensitive to friction, shock and flame than when in the pure state.

#### DDNP (see Dinol)

### Dunnite (see Explosive D)

#### Dynamite

Composition - - - Nitroglycerine, Sodium Nitrate, Antacid and Wood Pulp. The Nitroglycerine content may vary from 20% to 60% with the other components varying accordingly.  
Color - - - - - Buff to brown.  
Melting Pt. - - - - Does not melt.  
Sensitivity - - - - Sensitive to flame, shock, heat and extremes of temperature. Very sensitive when frozen.  
Brisance  
and Power - - - Half as powerful as TNT.  
Velocity - - - - - 9000-20,000 ft/sec. depending on its composition.  
Stability - - - - - Becomes unstable at less than 45°F or more than 110°F.  
Loading - - - - - Paper-wrapped rolls.  
Use - - - - - Demolition.  
Remarks - - - - - Fumes may be irritating.

#### Edna

Other Names - - - - Haleite  
Composition - - - - Ethylene Dinitramine.  
Melting Pt. - - - - 178°C.  
Detonating Temp. - 169-173°C.  
Sensitivity - - - - Same as Tetryl. Laboratory impact - 36.  
Brisance  
and Power - - - Ballistic mortar - 136, sand test - 118.  
Velocity - - - - - 25,000 ft/sec.  
Loading - - - - - Pressed, if used alone.  
Use - - - - - Mixed with other explosives for use as a main charge (see Ednatol).  
Remarks - - - - - Index of inflammability - 138.

#### Ednatol

Composition - - - - Ethylene Dinitramine - 60%, TNT - 40%.  
Color - - - - - Cream to light yellow.  
Melting Pt. - - - - 80.2°C. Does not actually liquify but becomes a paste.  
Detonating Temp. - 159-165°C.  
Sensitivity - - - - Same as TNT. Bullet impact - 87. Impact sensitivity - 70.  
Brisance  
and Power - - - Sand test - 112, ballistic mortar - 117.  
Velocity - - - - - 24,270 ft/sec.  
Stability - - - - - Stable in storage.

MILITARY EXPLOSIVES

Ednatol (Cont'd.)

Reaction  
with Metals - Corrodes copper, brass and steel slightly when dry; corrodes all metals except aluminum and stainless steel when moist.  
Loading- - - - - Cast  
Use- - - - - Large G. P. and Frag. bombs.  
Remarks- - - - - Rated about 22% more powerful than TNT; used as a substitute for Composition B. Air-blast energy - 106, water shock energy - 113

Explosive D

Other Names- - - - - Dunnite  
Composition- - - - - Ammonium Picrate  
Color- - - - - Lemon yellow to red.  
Melting Pt.- - - - - Does not melt.  
Detonating Temp. - 288-291°C.  
Sensitivity- - - - - Laboratory impact - 88, bullet impact - 100.  
Brisance  
and Power - - - - - Slightly less than TNT. Sand test - 88, ballistic mortar - 99.  
Velocity - - - - - 21,3000 ft/sec.  
Stability- - - - - Fairly hygroscopic due to presence of Ammonium Nitrate.  
Reaction  
with Metals - Same as Picric Acid.  
Loading- - - - - Pressed.  
Use- - - - - U.S. and British A.P. ammunition.  
Remarks- - - - - Very difficult to ignite.

HEX

Composition- - - - - RDX - 40%, TNT - 38%, Aluminum Powder - 17%, desensitizer - 5% (Desensitizer is 84% Wax, 14% Nitrocellulose and 2% Lecithin).  
Color- - - - - Gray.  
Sensitivity- - - - - Approx. same as Tritonal.  
Brisance  
and Power - - - - - Approx. same as Torpex.  
Velocity - - - - - Approx. same as Torpex.  
Stability- - - - - Quite stable, although it gives off gases. Calcium Chloride may be added to reduce gas given off.  
Reaction  
with Metals - None  
Loading- - - - - Cast  
Use- - - - - Under experimentation for use in torpedoes, mines and bombs.  
Remarks- - - - - Designed to replace Torpex; safer in handling due to lower sensitivity. All munitions loaded with HEX will have the name of the explosive stencilled in red on the charge container. Air-blast energy - 134, water shock energy - 140.

Hexanite

Other Names- - - - - Otsu (Japanese)  
Composition- - - - - HND - 11%, TNT - 63%, Aluminum powder - 24% (Ger)  
HND - 24%, TNT - 60%, Aluminum Powder - 16% (Jap)  
Color- - - - - Greenish gray.  
Melting Pt.- - - - - 80°C.  
Sensitivity- - - - - More sensitive than TNT and sensitive to penetration and case-cutting; believed to be bullet sensitive.  
Brisance  
and Power - - - - - Same as Picric Acid. Lead block - 98.  
Velocity - - - - - 24,300 ft/sec.  
Stability- - - - - Entirely stable.  
Reaction  
with Metals - None.  
Loading- - - - - Cast.  
Use- - - - - German and Japanese underwater ordnance.  
Remarks- - - - - Burns violently; toxicity same as HND. Rated about 30% more powerful underwater than TNT. Contact with skin tissues will cause dermatitis.

HND

Other Names- - - - - Hexil, Hexite or Hexamin.  
Composition- - - - - Hexanitrodiphenylamine.  
Color- - - - - Yellow to orange.  
Melting Pt.- - - - - 242°C.  
Detonating Temp. - 237-246°C.  
Sensitivity- - - - - Same as Tetryl; too sensitive for use as bursting charge without addition of desensitizer.  
Brisance  
and Power - - - - - Lead block - 101, sand test - 110, ballistic mortar - 113.  
Velocity - - - - - 23,000 ft/sec.



MILITARY EXPLOSIVES

HND (Cont'd.)

Stability- - - - Entirely stable.  
 Reaction  
     with Metals - None.  
 Loading- - - - - Pressed or cast in mixtures with other explosives.  
 Use- - - - - German and Japanese bursting charges. Mixed with TNT in German mines, with trinitroanisol in Japanese G. P. bombs and with TNT in Japanese torpedoes.  
 Remarks- - - - - Extremely toxic and poisonous; will cause dermatitis.

Lead Azide

Composition- - - - Lead Azide  
 Color- - - - - White to buff gray  
 Melting Pt.- - - - Detonates before melting.  
 Detonating Temp. - 335-350°C.  
 Sensitivity- - - - Very high; extremely sensitive to flame. Laboratory impact - 15.  
 Brisance  
     and Power - - Slightly greater than Mercury Fulminate.  
 Velocity - - - - - 17,400 ft/sec.  
 Stability- - - - - Entirely stable.  
 Reaction  
     with Metals - Corrodes copper, brass and aluminum when moist.  
 Loading- - - - - Pressed, in small capsules.  
 Use- - - - - As an initiator by all nations. Primer Compositions. Usually loaded in aluminum cups; never brass or copper. Reacts with brass, bronze or copper to form copper azide which is extremely sensitive to heat, friction or shock.

Lead Styphnate

Composition- - - - Lead Styphnate.  
 Color- - - - - Straw to yellow.  
 Melting Pt.- - - - Detonates before melting.  
 Detonating Temp. - 280°C.  
 Sensitivity- - - - Same as Mercury Fulminate; very sensitive to flame and impact.  
 Brisance  
     and Power - - Lowest of the primary explosives.  
 Velocity - - - - - 14,800 ft/sec.  
 Stability- - - - - Entirely stable.  
 Reaction  
     with Metals - None.  
 Loading- - - - - Pressed, in small pellets. Primer Compositions.  
 Use- - - - - As an initiator by Germany. Mixed with lead azide in German detonators to facilitate ignition.  
 Remarks- - - - - Not sufficiently violent for use alone in detonators. Invariably mixed with oxidizing agents or fuels. When combined in mixtures, such as priming compositions, Lead Styphnate is much more sensitive than when used alone as an initiator.

Lyddite (see Picric Acid)

Melinite (see Picric Acid)

Mercury Fulminate

Composition- - - - Mercury Fulminate.  
 Color- - - - - White to gray or brownish yellow.  
 Melting Pt.- - - - Detonates before melting.  
 Detonating Temp. - 180-210°C.  
 Sensitivity- - - - Extremely sensitive to shock, friction or heat. Laboratory impact - 8.  
 Brisance  
     and Power - - Very low. Lead block - 44.  
 Velocity - - - - - 16,500 ft/sec.  
 Stability- - - - - Very unstable; deteriorates at temperatures above 60°C. 30% moisture content inert.  
 Reaction  
     with Metals - Corrodes aluminum when dry, copper, brass and aluminum when moist.  
 Loading- - - - - Pressed into small capsules at pressures of 3000 lbs/2 sq. in. Becomes inert if compressed to 10,000 lbs/sq. in.  
 Use- - - - - As an initiator by all nations. Primer Compositions.  
 Remarks- - - - - Will not detonate cast TNT nor Explosive D. Becoming obsolete because of inefficiency, instability and semi-strategic nature. Explodes if burning is attempted. Much more sensitive when used in priming Compositions than in the pure state.

MILITARY EXPLOSIVES

Methyl Picrate (see Trinitroanisole)

Minol

Composition- - - - Ammonium Nitrate - 40%, TNT - 40%, Aluminum - 20%.  
 Color- - - - - Gray.  
 Melting Pt.- - - - 81°C.  
 Detonating Temp. - 254-264°C.  
 Sensitivity- - - - Laboratory impact - 68, bullet impact - 52.  
 Brisance  
 and Power - - - Lead block - 155, sand test - 96, ballistic mortar - 143.  
 Velocity - - - - - 18,830 ft/sec.  
 Stability- - - - - Very hygroscopic; deteriorates in storage.  
 Reaction  
 with Metals - Corrodes brass and steel when moist or wet.  
 Loading- - - - - Cast  
 Use- - - - - British underwater ordnance.  
 Remarks- - - - - Air-blast energy - 130, water shock energy - 135.

Nitrostarch

Composition- - - - Mixture of nitrated starch and oxidizing salts.  
 Color- - - - - Gray.  
 Sensitivity- - - - Slightly greater than TNT.  
 Brisance  
 and Power - - - Slightly less than TNT.  
 Velocity - - - - - 15,000 ft/sec.  
 Stability- - - - - Entirely stable.  
 Loading- - - - - Pressed or wrapped in one lb. blocks.  
 Use- - - - - As a substitute for TNT in demolition blocks.  
 Remarks- - - - - Fumes are toxic.

OTSU (see Hexanite)

Penthrite (see PETN)

Penthrite Wax (see PETN)

Pentolite

Other Names- - - - Pentoriru (Japanese)  
 Composition- - - - Mechanical mixture of PETN and TNT, usually 50/50.  
 Color- - - - - Yellow white to yellow.  
 Melting Pt.- - - - 76-120°C.  
 Detonating Temp. - 174-178°C.  
 Sensitivity- - - - Laboratory impact - 44, bullet impact - 38.  
 Brisance  
 and Power - - - Lead block - 115, sand test - 131, ballistic mortar - 129.  
 Velocity - - - - - 24,270 ft/sec.  
 Stability- - - - - Less than TNT. Subject to thermal deterioration.  
 Reaction  
 with Metals - Corrodes steel and zinc slightly when dry; copper and brass  
 slightly when moist.  
 Loading- - - - - Cast.  
 Use- - - - - Small shells, grenades, cast, shaped charges and bursting  
 charges by U.S. and Japanese.  
 Remarks- - - - - Shaped charge efficiency - 149.

Pentoriru (see Pentolite)

PEP-3

Composition- - - - PETN - 86%, Plasticizing Oil - 14%.  
 Color- - - - - Light brown.  
 Sensitivity- - - - Same as Composition C.  
 Brisance  
 and Power - - - Slightly less than Composition C.  
 Velocity - - - - - 25,500 ft/sec.  
 Stability- - - - - Very stable  
 Use- - - - - Plastic explosives, demolition work, shaped charges.  
 Remarks- - - - - A new explosive with greater plasticity range than Com-  
 position C.

PETN

Other Names- - - - Penthrite, Penthrite Wax, Cortex, Primacord.  
 Composition- - - - Pentaerythritetetranitrate.  
 Color- - - - - PETN - white, Penthrite Wax - pink.  
 Melting Pt.- - - - 141°C.  
 Detonating Temp. - 172-175°C.

MILITARY EXPLOSIVES

PETN (Cont'd.)

Sensitivity- - - - Greater than RDX. Laboratory impact - 18, bullet impact - 0. Primacord is very insensitive to flame, shock or friction.

Brisance and Power - - - Lead block - 166, sand test - 150, ballistic mortar - 145.

Velocity - - - - 26,080 ft/sec. (Primacord - 20,500 ft/sec.)

Stability- - - - Subject to thermal deterioration.

Reaction with Metals - Corrodes brass slightly when moist.

Loading- - - - - Pressed.

Use- - - - - In Primacord by U.S.; in detonating fuzes or trains by Germany; in projectile fuzes by Japan. Used as a base charge in various compound detonators.

Remarks- - - - - A so-called super-explosive as powerful as Nitroglycerine and more brisant than TNT. Often found in army ordnance loaded as a mixture with TNT. Most commonly loaded in 50-50 percentages, i.e., 50% PETN and 50% TNT; also loaded 60% TNT and 40% PETN.

Picramide (see Trinitroaniline)

Picratol

Composition- - - - Picric acid - 52%, TNT - 48%

Color- - - - - Brownish yellow.

Loading- - - - - Cast

Use- - - - - Found in Russian Underwater Ordnance and U. S. bombs.

Picric Acid

Other Names- - - - Lyddite (Br), Shimose (Jap), Melinite (Fr), Pikrin Saure or Granatfullung (Ger).

Composition- - - - Trinitrophenol.

Color- - - - - Lemon yellow.

Melting Pt. - - - - 122°C.

Detonating Temp. - 300-304°C.

Sensitivity- - - - Laboratory impact - 76, bullet impact - 76.

Brisance and Power - - - Lead block - 100, sand test 109, ballistic mortar - 111.

Velocity - - - - - 23,370 ft/sec.

Stability- - - - - Entirely stable in storage.

Reaction with Metals - Forms dangerous and sensitive compounds with all metals except aluminum and tin. Corrodes steel, copper, brass and lead slightly when dry.

Loading- - - - - Usually pressed; may be cast.

Use- - - - - U.S. and British bursting charges, German and Japanese booster, French bursting charges when combined as in Trimonite and Tridite.

Remarks- - - - - High melting point makes cast loading difficult; most sensitive when cast. May cause dermatitis. Fumes are very toxic if inhaled.

Pikrin Saure (see Picric Acid)

Primacord (see PETN)

PTX-1

Composition- - - - RDX - 30%, Tetryl - 50%, TNT - 20%.

Color- - - - - Yellow.

Sensitivity- - - - Less than Tetrytol. Laboratory impact - 40 (est.).

Brisance and Power - - - Same as Composition B or Pentolite.

Velocity - - - - - 24,200 ft/sec.

Stability- - - - - Greater than Tetrytol.

Loading- - - - - Cast (?)

Use- - - - - Bursting charges.

Remarks- - - - - Undergoing experimentation for general use in shells, bombs etc.

PTX-2

Composition- - - - RDX - 43.2%, PETN - 28%, TNT - 28.8%.

Color- - - - - Yellow.

Sensitivity- - - - Greater than Composition B. Laboratory impact - 44.

Brisance and Power - - - More brisant than any other binary explosive.

Velocity - - - - - 26,200 ft/sec.

Loading- - - - - May be cast.

Use- - - - - Boosters, fragmentation ammunition main charges, shaped charge ammunition.

Remarks- - - - - Undergoing experimentation.

## MILITARY EXPLOSIVES

### Pyronite (see Tetryl)

#### RDX

Other Names- - - - Cyclonite  
Composition- - - - Cyclotrimethylenetrinitramine.  
Color- - - - - British - yellow, Italian - pink, Japanese and U.S. - white.  
Wide color range comes from addition of desensitizing wax.  
Melting Pt.- - - - 190-205°C.  
Sensitivity- - - - Laboratory impact - 28, bullet impact - 0. Very sensitive.  
Brisance  
and Power - - - - Lead block - 166, sand test - 136, ballistic mortar - 151.  
Velocity - - - - 26,900 ft/sec. at 1.65 g/cc, 28,000 ft/sec. at 1.70 g/cc.  
Stability- - - - - Non-hygroscopic, entirely stable.  
Reaction  
with Metals - None  
Loading- - - - - Pressed.  
Use- - - - - Italy and Japan - boosters, U.S., Britain, Germany - main charges. Almost always mixed with desensitizer or other explosive to lower sensitivity.

### Shimose (see Picric Acid)

#### Smokeless Powder and Ballistite Propellants

Composition- - - - (a) Smokeless powder (Gelatinized Nitrocellulose).  
(b) Ballistite (Guncotton - 60-80%, Nitroglycerine - 40-20%).  
Color- - - - - (a) Light amber, brown or black.  
(b) Grayish green to black.  
Melting Pt.- - - - Do not melt.  
Sensitivity- - - - Slightly greater than black powder.  
Brisance  
and Power - - - - Low.  
Velocity - - - - - Burns, does not detonate.  
Stability- - - - - Deteriorates at high temperatures.  
Loading- - - - - Flakes, strips or pellets.  
Use- - - - - As propellants by all nations.  
Remarks- - - - - These propellants burn extremely rapidly, and have been known to detonate if burned in large quantities.

### Temporary Type 1 Explosive

Composition- - - - Ammonium Picrate - 81%, Aluminum - 16%, Wood Powder - 2%,  
Crude Oil - 1%.  
Color- - - - - Greenish brown powder.  
Melting Pt.- - - - Does not melt.  
Detonating Temp. - Approx. same as TNT.  
Sensitivity- - - - Approx. same as TNT.  
Brisance  
and Power - - - - Slightly greater than TNT.  
Velocity - - - - 14,000 ft/sec.  
Loading- - - - - Granular.  
Use- - - - - Japanese depth charges.  
Remarks- - - - - Very little recovered; has distinctive oil odor.

### Tetralite (see Tetryl)

#### Tetryl

Other Names- - - - Tetralite, Tetrylite, C. E., or Pyronite.  
Composition- - - - Trinitrophenylmethylnitramine.  
Color- - - - - Canary yellow or yellow; gray if graphite is added during pressing.  
Melting Pt.- - - - 130°C.  
Detonating Temp. - 164-165°C.  
Sensitivity- - - - Laboratory impact - 49, bullet impact - 61.  
Brisance  
and Power - - - - Lead block - 120, sand test 118, ballistic mortar - 129.  
Velocity - - - - 24,030 ft/sec.  
Stability- - - - - Entirely stable in storage; must be kept dry.  
Reaction  
with Metals - Corrodes steel when dry.  
Loading- - - - - Pressed; graphite or stearic acid may be added as lubricants during pressing.  
Use- - - - - U.S., British and Japanese boosters.  
Remarks- - - - - Causes dermatitis.

### Tetrylite (see Tetryl)

#### Tetrytol

Composition- - - - Tetryl - 70-75%, TNT - 30-25%.  
Color- - - - - Yellow.  
Melting Pt.- - - - 67-116°C.  
Detonating Temp. - 179-181°C.

MILITARY EXPLOSIVES

Tetrytol (Cont'd.)

Sensitivity- - - Slightly less than Tetryl. Laboratory impact - 59, bullet impact - 65.  
 Brisance and Power - - Ballistic mortar - 122.  
 Velocity - - - - - 24,000 ft/sec.  
 Stability- - - - - Relatively stable.  
 Reaction with Metals - Corrodes aluminum slightly when dry; brass, copper and steel slightly when moist.  
 Loading- - - - - Cast blocks.  
 Use- - - - - In bursting tubes in chemical bombs, 2 1/2 lb. demolition blocks, cast shaped charges.  
 Remarks- - - - - Shaped charge efficiency - 123.

TNA

Composition- - - - Tetranitroaniline.  
 Color- - - - - Yellowish brown.  
 Melting Pt.- - - - Melts and decomposes at 210°C.  
 Sensitivity- - - - Same as Tetryl.  
 Brisance and Power - - Approx. same as Tetryl.  
 Velocity - - - - - 24,500 ft/sec.  
 Stability- - - - - Unstable in storage.  
 Reaction with Metals - None.  
 Loading- - - - - Pressed.  
 Use- - - - - In projectile boosters and primers; little used.

TNT

Other Names- - - - Triton (Fr), Trotyl (Br), or Type 92 Explosive (Jap).  
 Composition- - - - Trinitrotoluene.  
 Color- - - - - Pale straw to light brown.  
 Melting Pt.- - - - 81°C.  
 Detonating Temp.- - 288-292°C.  
 Sensitivity- - - - Laboratory impact - 100, bullet impact - 100. Practically insensitive to friction, shock or flame; least sensitive of all high explosives to bullet impact.  
 Brisance and Power - - Lead block - 92, sand test 100, ballistic mortar - 100.  
 Velocity - - - - - 22,300 ft/sec.  
 Stability- - - - - Non-hygroscopic; entirely stable in storage.  
 Reaction with Metals - None.  
 Loading- - - - - Granular, pressed or cast.  
 Use- - - - - By all nations as a bursting charge or booster.  
 Remarks- - - - - Fumes are slightly toxic and may cause jaundice. Shaped charge efficiency - 100, air-blast energy - 100, water shock energy - 100, index of inflammability - 100. May cause dermatitis in some cases.

Torpex

Composition- - - - RDX - 23%, TNT - 51%, Aluminum - 26%. (Ger) RDX - 44-42%, TNT - 37-39%, Aluminum - 18%, Beeswax - 1%. (U.S.)  
 Color- - - - - Slate gray to gray.  
 Melting Pt.- - - - 380°C.  
 Detonating Temp.- - 185-190°C (U.S.) 194-205° (Ger)  
 Sensitivity- - - - Laboratory impact - 64, bullet impact - 48.  
 Brisance and Power - - Lead block - 154, sand test - 160, ballistic mortar - 134.  
 Velocity - - - - - 24,000 ft/sec.  
 Stability- - - - - Non-hygroscopic; entirely stable in storage. May give off gasses; addition of calcium chloride prevents this.  
 Reaction with Metals - Corrodes brass slightly when moist.  
 Loading- - - - - Cast.  
 Use- - - - - U.S., British and German underwater ordnance.  
 Remarks- - - - - Over 50% more efficient than TNT underwater. Shaped charge efficiency - 134, air-blast energy - 140, water shock energy - 140, index of inflammability - 196. Should not be stored in any place likely to be struck by shell fire.

Trimonite

Composition- - - - Picric Acid - 90%, Mononitronaphthalene - 10%.  
 Color- - - - - Yellow.  
 Melting Pt.- - - - 105°C.  
 Detonating Temp.- - 314-320°C.  
 Sensitivity- - - - Same as TNT.

MILITARY EXPLOSIVES

Trimonite (Cont'd.)

Erisance  
 and Power - - - Same as TNT; lowered by percentage of dilution.  
 Velocity - - - - - 21,000 ft/sec.  
 Stability - - - - - Not entirely stable; somewhat hygroscopic.  
 Reaction  
 with Metals - Same as Picric Acid.  
 Loading - - - - - Cast.  
 Use - - - - - As bursting charge in large French bombs.

Trinitroaniline

Other Names - - - Picramide.  
 Composition - - - Trinitroaniline.  
 Color - - - - - Yellow to orange red.  
 Melting Pt. - - - 188°C.  
 Sensitivity - - - Same as TNT.  
 Erisance  
 and Power - - - Slightly lower than Picric Acid.  
 Stability - - - - - Entirely stable in storage.  
 Reaction  
 with Metals - None  
 Loading - - - - - Pressed.  
 Use - - - - - By all nations as a substitute main charge.  
 Remarks - - - - - Slightly soluble in water.

Trinitroanisole

Other Names - - - Methyl Picrate or Type 91 Explosive.  
 Composition - - - Trinitroanisole.  
 Color - - - - - Brownish yellow.  
 Melting Pt. - - - 68°C.  
 Sensitivity - - - Less than TNT.  
 Erisance  
 and Power - - - Lead block - 98, sand test 110, ballistic mortar - 108.  
 Velocity - - - - - 21,900 ft/sec.  
 Stability - - - - - Somewhat hygroscopic.  
 Reaction  
 with Metals - Attacks various metals when damp.  
 Loading - - - - - Cast.  
 Use - - - - - Japanese bursting charges.  
 Remarks - - - - - Poisonous; produces severe skin irritation.

Triton (see TNT)

Tritonal

Composition - - - Tritonal; TNT - 80%, Aluminum - 20%.  
 Color - - - - - Gray.  
 Melting Pt. - - - 81°C.  
 Detonating Temp. - 292-294°C.  
 Sensitivity - - - Laboratory impact - 94, bullet impact - 79.  
 Erisance  
 and Power - - - Lead block - 117, sand test - 98, ballistic mortar - 118.  
 Velocity - - - - - 18,040 ft/sec.  
 Stability - - - - - Relatively stable in storage.  
 Reaction  
 with Metals - None.  
 Loading - - - - - Cast.  
 Use - - - - - Small caliber ammunition.  
 Remarks - - - - - Air-blast energy - 122, water shock energy - 120.

Type 88 Explosive

Composition - - - Ammonium Perchlorate - 75%, Silicon - 16%, Wood Powder - 6%,  
 Crude Petroleum - 3%. The percentage of various components  
 may vary as much as 10%.  
 Color - - - - - Dark gray.  
 Melting Pt. - - - Does not melt.  
 Sensitivity - - - Insensitive to shock, extremely sensitive to friction.  
 Becomes more sensitive to friction as the petroleum content  
 dissipates.  
 Erisance  
 and Power - - - Lead block - 46; low reading due to low velocity (see below).  
 Velocity - - - - - 13,800 ft/sec.  
 Stability - - - - - Becomes unstable with age.  
 Loading - - - - - Granular.  
 Use - - - - - Japanese mines, depth charges and demolition charges.  
 Remarks - - - - - Resembles fine crystalline powder. Burns violently even  
 when unconfined, likely to detonate during burning. Handle  
 with extreme care.

Type 91 Explosive (see Trinitroanisole)

Type 92 Explosive (see TNT)

MILITARY EXPLOSIVES

Type 94 Explosive

Composition- - - - RDX - 40%, Trinitroanisol - 60%.  
Color- - - - - Cream yellow.  
Sensitivity- - - - Slightly greater than Picric Acid.  
Brisance  
and Power - - - - Approx. same as Picric Acid.  
Velocity - - - - - 24,600 ft/sec.  
Loading- - - - - Cast.  
Use- - - - - Japanese torpedo warheads.  
Remarks- - - - - Information is from intelligence sources only; believed to  
be toxic.

Type 97 Explosive

Composition- - - - HND - 40%, TNT - 60%.  
Color- - - - - Yellow, somewhat darker than Picric Acid.  
Melting Pt.- - - - 79-80°C.  
Sensitivity- - - - Greater than TNT.  
Brisance  
and Power - - - - Lower than TNT.  
Velocity - - - - - 23,400 ft/sec.  
Loading- - - - - Cast.  
Use- - - - - Japanese torpedoes and depth charges.  
Remarks- - - - - Extremely toxic.

Type 98 Explosive

Composition- - - - Trinitroanisol - 60-70%, HND - 40-30%.  
Color- - - - - Orange yellow, slightly darker than Picric Acid.  
Melting Pt.- - - - 70°C.  
Sensitivity- - - - Greater than TNT.  
Brisance  
and Power - - - - Same as Picric Acid.  
Velocity - - - - - 24,400 ft/sec.  
Stability- - - - - Not entirely stable.  
Reaction  
with Metals - - - - None.  
Loading- - - - - Cast.  
Use- - - - - Japanese bursting charges.  
Remarks- - - - - Extremely toxic.

There is no Chapter 4 in this  
publication



# MINE DISPOSAL HANDBOOK

## PART I

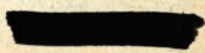
### GENERAL INFORMATION

• • • • •

### CHAPTER 5

#### DISPOSAL BY EXPLOSIVE MEANS

APRIL 1, 1945



DISPOSAL BY EXPLOSIVE MEANS

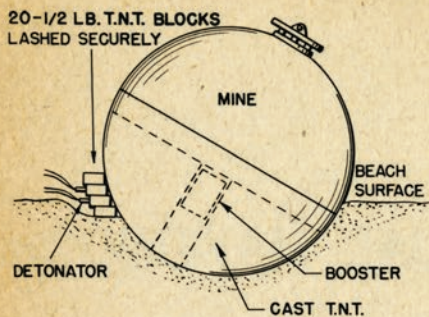


FIG. 1- ARRANGEMENT FOR COMPLETE DETONATION OF MINE USING 1/2 LB. T.N.T. BLOCKS

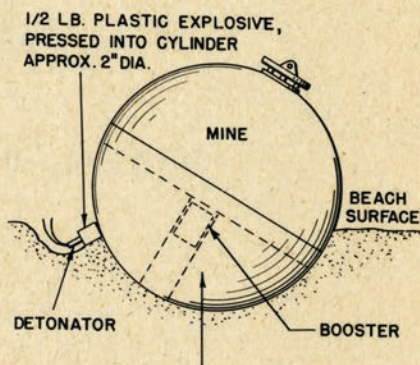


FIG. 2- ARRANGEMENT FOR COMPLETE DETONATION OF MINE USING 1/2 LB. PLASTIC EXPLOSIVE

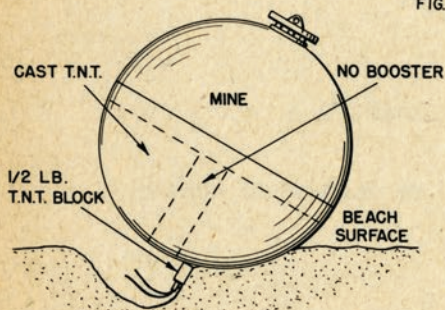


FIG. 3- ARRANGEMENT FOR PARTIAL DETONATION OF MINE (BOOSTER REMOVED) USING 1/2 LB. T.N.T. BLOCK FLUSH WITH CASE

NOTE: IF MINE IS SUSPECTED TO CONTAIN A SENSITIVE MAIN CHARGE (TORPEX OR HEXANITE), PLACE T.N.T. BLOCK ONE IN. AWAY FROM CASE

## DISPOSAL BY EXPLOSIVE MEANS

### Introduction

1. Disposal by explosive means constitutes one of the most convenient methods of dealing with any type of explosive ordnance. Proper selection and use of explosives will enable the Mine Disposal Officer to obtain complete or partial detonation, sectionalization or burning of the charge. This chapter purports to give detailed information with regard to standard demolition equipment and special demolition techniques which are particularly applicable to mine disposal. A detailed discussion of other demolition techniques and materiel which are generally applicable will be found in U.S. Army Field Manual #5-25 and O.P. 1178, issued to all graduates of the Mine Disposal School.
2. It is assumed that those who use this chapter for reference material are thoroughly familiar with the basic demolition techniques and with the risks involved in handling explosives generally and in undertaking demolition work in particular. For this reason, and for the sake of brevity, no attempt is made in the following pages to include the common precautionary instructions which would ordinarily be a part of a discussion of this sort. Special precautions which are not universally recognized or generally practiced or prescribed will be found.

### Accessories to Demolition and Their Use

#### Demolition Charge Mk 1 Mod 0

1. This charge consists of 55 lb. of TNT cast into a copper case approximately 9 1/2" square and 12 1/2" long. A tapered, cylindrical booster pocket is cast into the charge and contains a special 1.8 lb. granular TNT booster fitted with a detonator envelope. The charge is provided with gaskets, packing pieces and covers so that the complete assembly, with detonator inserted, can be made watertight and submerged to a depth of 40 ft. without distortion. This charge is obsolete and unlikely to be encountered in the field.

#### Demolition Charges Mk 2 Mod 0 and Mk 2 Mod 1

1. These charges, designed to replace the Mk 1-0, contain the same type and weight of charge as the Mk 1-0. They differ in that their cases are made of rust-proof steel and in that they use the Demolition Charge Mk 3-0 or Mk 4-0 as a booster.

#### Rigging Demolition Charges Mk 1 Mod 0 and Mk 2 Mods 0 and 1 for Firing

1. Remove the rubber sheathing from the last six inches of the firing cable, leaving the individual conductors enclosed in their individual insulation.
2. Remove the water cap from the demolition charge.
3. Pass the two conductors of the firing cable through the water cap and then through the rubber packing piece until the packing piece is about five inches from the end of the conductors.
4. Pass an Army Engineer special blasting cap (Electric Detonator Mk 1-1 may be used with the Mk 1-0) through the screw cover and into the detonator well in the booster.
5. Connect the blasting cap leads to the firing leads.
6. Place the packing piece over the booster pocket and make a watertight seal by screwing the water cap down tightly.
7. Stop the firing cable to the charge case with a few turns of marlin to prevent strain from being transmitted to the detonator splice.

#### Demolition Charge Mk 3 Mod 0

1. This charge consists of one half pound of TNT compressed into a block, 1 3/4" square and 378 long. The block is non-hygroscopic and is contained in a water-resistant, five-ply cardboard container closed at both ends by a lacquered tin plate. A blasting cap well is fitted in one end.
2. It should be noted that the ends of these blocks are magnetic and give off a small field. A pyramid of 20 blocks should not be placed less than seven inches from a magnetic firing device. The limiting distance to be observed for a four-block charge is four inches.

#### Demolition Charge Mk 4 Mod 0

1. This charge is similar in size and shape to the Mk 3-0, the main differences being that the Mk 4-0 is fitted with a 35 gram Tetryl booster cast into the charge and is cast in non-magnetic chipboard containers. The addition of the booster facilitates detonation.

## DISPOSAL BY EXPLOSIVE MEANS

(Accessories to Demolition, Cont'd.)

### Rigging Demolition Charges Mk 3 Mod 0 and Mk 4 Mod 0 for Firing

1. These charges are especially convenient for making up small demolition charges when the use of so large a quantity of explosive as that contained in the Mark 1-0 would be wasteful and inefficient. Any standard blasting cap is normally sufficient to explode 35 blocks, provided it is placed in the middle of the charge. If a larger charge is desired, two or more caps should be used, spacing them so as to give effective distribution to their detonating power.
2. In the case of built-up charges, care should be exercised to insure that the blocks are tightly bound together. Small wooden boxes or empty cans with the tops cut off make excellent containers for these charges since, being non-hygroscopic, the charges do not require a watertight container. Such charges may be used underwater if the leads to the blasting cap are watertight.
3. The charge is rigged for firing as follows:
  - (a) Clean the ends of the blasting cap leads and splice them to the firing cable. Splices made for underwater use must be made watertight by the use of rubber tape or other suitable means. Splices made for use on land need only have the leads separated from each other. If several blasting caps are to be used, they must be connected in series.
  - (b) Break the paper diaphragm on the TNT block and insert the blasting cap, pushing it in until the end of the cap is flush with bottom of the cap well. This condition must be obtained for effective operation. A piece of friction tape or a rubber band should be attached to prevent the cap from falling out.
  - (c) Secure the blasting cap lead wires to the block to prevent strain from being transmitted to the cap.
  - (d) Stop the firing cable at a point beyond the splice to some rigid object near the charge. The charge is now ready to be placed in position and fired.

### Plastic Explosives

1. The various modifications of Composition C (C, C-2, C-3) (Part I, Chapter 3) plastic explosives may be used for all types of demolition work for which TNT is used, although they are most commonly used in cavity charges. They are issued in paper-wrapped, 1/2-lb. and 2 1/4-lb. blocks. Although these explosives are considerably more powerful than TNT, they are not so sensitive to detonation and require a more powerful detonating agent than comparable quantities of TNT. Only a knot of primacord or the Army Engineer Special blasting cap should be used to effect detonation.

### Detonating Agents

1. Three types of detonating agents are in general use; electric blasting caps, non-electric blasting caps (used with safety fuse) and detonating fuses. Electric detonators may also be used in some instances. The various types of each are as follows:
  - (a) Electric blasting caps - three are in common use; the #6 and #8 commercial blasting caps and the Army Engineer Special blasting cap. The #6 and #8 caps are generally satisfactory for demolition work with all except plastic explosives, for which the Army Engineer Special blasting cap is standard. The #8 cap contains twice as much explosive as the #6. It is possible however, to obtain satisfactory results with plastic explosives by using two #8 blasting caps if no Engineer caps are available. It should be noted that the Engineer Special caps are made by three different manufacturers, the three different makes of caps having different resistances. Misfires often occur if caps of different resistances are wired in series and, for this reason, care must be taken to insure that all caps used in series wiring are of the same manufacture. Identifying features are as follows:
    - (1) The Atlas cap consists of a clear lacquered copper shell with a square lead clip safety shunt on the bare end of the lead wires.
    - (2) The Dupont cap consists of a red lacquered shell with a metal foil safety shunt around the bare end of the lead wires.
    - (3) The Hercules cap consists of a clear lacquered copper shell with an eyelet or ring safety shunt on the bare end of the lead wires.

## DISPOSAL BY EXPLOSIVE MEANS

(Accessories to Demolition, Cont'd.)

- (b) Non-Electric Blasting Caps - these caps are made commercially in two sizes which correspond to the #6 and #8 electric caps and may be put to the same general use. They should not, however, be used in underwater charges or in any charge made up for use in an extremely damp place because they are extremely difficult to water-proof. They are ordinarily detonated by a delay train safety fuse which consists of a black powder train wrapped in several layers of waterproof fabric. The fuse may be ignited either by a fuse lighter or a match and burns at a rate of about one foot per 30-45 second period.
- (c) Detonating Cord - the most common type, primacord, consists of a core of PSTN wrapped in a plain or wire-reinforced fabric covering. It is designed to explode throughout its entire length with sufficient force to detonate simultaneously any arrangement of charges properly connected for detonation. A #8 or Engineer Special blasting cap may be used to effect detonation. The following general rules and precautions should be observed when dealing with detonating cord:
- (1) Handle with special care in cold weather to avoid breaking either the sheathing or the explosive train. Never remove the sheathing.
  - (2) Note that although the cord is insensitive to friction or ordinary shock, it may be bullet sensitive when used in large quantities.
  - (3) Lay out the lines as straight as possible, but do not stretch them. Misfires are likely to occur if kinks or sharp bends are present.
  - (4) When using detonating cord in underwater charges or in any charges which are to be left in place several hours before firing, seal the ends of the cord with cap sealing compound or other suitable means to prevent moisture from damaging the train.
  - (5) When using wire-reinforced detonating cord, remove the wire at the point where the blasting cap is to be attached.
- (d) Electric Detonators - although the Navy Electric Detonator Mk 1-1 is prescribed for use with the Demolition Charge Mk 1-1, detonators of this type are not generally suitable for demolition work and should be used only when no blasting caps are available.

### Firing Cable

1. Two types of firing cable are standard for demolition use, the Navy Standard Double Conductor Cable and the Platoon Demolition Kit Firing Cable. Each is a double conductor cable, with the two conductors being insulated from each other and enclosed in a rubber sheathing. 1000-ft. lengths of the Navy and platoon cables have resistances of nine and six ohms respectively. Steel strands are added to the Navy Standard cable to give additional strength.
2. If neither of the two above types of cable is available, any standard double conductor may be employed for demolition work provided that the combined resistance of the cable and the caps to be fired is sufficiently low to pass 1.5 amperes thru the blasting caps.

### Blasting Machines

1. The ten-cap blasting machine, part of the Platoon Demolition Kit, is the most convenient device to use for demolition work because it is light, small and capable of performing most of the types of work likely to be encountered. (Bad policy to over estimate the machine. Never use over 10 caps in one series. Fast rotation required.)
2. The thirty-cap blasting machine is heavier and bulkier than the ten-cap machine although, by definition, its capacity is greater. When using this machine, it must be emphasized that an extremely strong downward thrust is necessary to insure proper operation. "Try to knock the bottom out of the machine."
3. Although both these machines are very sturdy and not likely to break through normal usage, it must be emphasized that they contain moving electrical parts and therefore must be treated with a certain degree of care. Keep them as dry as possible and store them in a reasonably cool and dry place. The ten-cap machine occasionally loses its effectiveness after long periods of idleness. It may be revitalized by shorting its two terminal posts and twisting the handle several times. Any repairs on the thirty-cap machine must be effected by the manufacturer.

DISPOSAL BY EXPLOSIVE MEANS

(Accessories to Demolition, Cont'd.)

Ohmmeters

1. Standard Navy Ohmmeter - this instrument is the Weston Electric Co. Model 689, Type 1A. It consists of a small, dry cell battery connected in series to a galvanometer and a resistance. Approximate readings from 0-2000 ohms may be obtained. A slotted screw head on the lower part of the dial face permits adjustment to compensate for gradual weakening of the battery with age. Before using the ohmmeter, short the terminals. This should give full-scale deflection of the needle and, if not, proper adjustment should be made by means of the slotted screw head until this condition is obtained. Should it be impossible to obtain full scale deflection, the battery (Navy Spec. 17B7, Type C) is too weak for efficient operation and must be replaced.
2. RCP Circuit Tester - the shortage of standard ohmmeters has led to the issue of many of these combination volt-ohm-milliammeters of standard commercial design. It should be noted that most accurate readings are obtained with this instrument when the range selected gives the greatest needle deflection. For example, when measuring a voltage believed to be in the 0-10 volt range, the 10 volt scale should be used although the instrument is capable of measuring such a voltage on the 50-volt scale as well.
  - (a) To measure D. C. voltage, proceed as follows:
    - (1) Insert one end of one of the two sets of double tip jacks in the jack plug marked DC COM and one end of the other set of jacks in the plug marked MA-OHMS VOLTS. Turn the range selector switch to the proper setting and test the circuit, using the DC COM jack as the positive lead and the MA-OHMS VOLTS jack as the negative lead.
  - (b) To measure direct current, proceed as follows:
    - (1) Insert the jacks as in (a) above, turn the range selector switch to the proper setting and test the circuit. This measures currents from 0-1000 milliamperes. For currents from 0-10 amperes, use the DC COM and 10 AMP plugs, turning the range selector switch to the 1 AMP setting.
  - (c) To measure resistance, proceed as follows:
    - (1) Insert the jacks as in (a) above. Turn the range selector switch to the appropriate setting as follows:
      - (i) For resistances from 0-100 ohms, to the LO setting. Adjust the rheostat knob on the upper face until an exact, full-scale deflection is registered. Put the two unattached jacks across the resistance and take the reading from the LOW OHMS scale.
      - (ii) For resistances from 100-1000 ohms, to the MO setting. Short the unattached jacks together and adjust the rheostat until an exact, full-scale deflection is registered. Take the reading from the OHMS scale and multiply by 10 to obtain the correct resistance.
      - (iii) For resistances from 1000-50000 ohms, to the HO setting, and proceed as in (ii) above, multiplying the reading by 100 to obtain the correct resistance.- 3. Army Type Galvanometer - this instrument is very similar to the Navy standard ohmmeter, differing mainly in that it contains no internal resistance in its circuit. For this reason, it is imperative that no battery except that issued with the device be used while testing detonators because sufficient current might be passed to fire the detonator. It should also be noted that the issue battery freezes and becomes inoperative at temperatures below 0°F and precautionary measures should be taken.

## DISPOSAL BY EXPLOSIVE MEANS

### Theory and Use of Cavity Charges

#### Introduction

1. One of the most useful and highly exploited phenomena in the field of explosives is the Munroe effect, also known as the shaped charge, hollow charge or cavity charge effect. Although the foregoing names are used interchangeably between the various English-speaking countries and their armed services, the term "cavity charge" is probably the most descriptive and will be used throughout this chapter except where it is contrary to official designations of service equipment.
2. The cavity charge effect has been developed to the point where it is now employed in many types of explosive ordnance ranging from small calibre ammunition to the largest bombs. For mine disposal purposes, however, interest is confined generally to the following considerations:
  - (a) Disposal of explosive ordnance by complete or partial detonation of the charge, by breaking up the charge or case or by igniting the charge.
  - (b) Gaining access to the interior of the cases of various pieces of explosive ordnance for the purposes of inspection and/or rendering safe.
  - (c) In general demolition.

#### Theory

1. When a quantity of explosive is detonated, it creates an explosive wave which travels from the point of detonation through the explosive. The wave progresses from layer to layer of molecules, causing each to vibrate and detonate. As the explosive wave leaves the charge, its force is directed in lines perpendicular to the various surfaces of the charge. However, if two explosive waves can be directed one against the other and if the angle of incidence is less than  $180^{\circ}$ , the resultant wave produced is stronger than either of the two original waves and also stronger than the waves projected from any of the other surfaces of the charge. The effect produced by the resultant wave constitutes the cavity effect.

#### Application of Cavity Effect

1. In practice, the cavity effect is obtained by hollowing out a cone-shaped section in an explosive charge, the base of the cone being one of the surfaces of the charge. The longitudinal axis of the cone represents the direction of the desired resultant wave. When the charge is fired, the waves coming from the sides of the cavity are concentrated into a jet which is similar to a light beam, except that it is composed of hot gases. The destructive force of the jet is greater than that of the detonation wave of the explosive. Addition of a metal lining to the conical cavity adds metal pellets or fragments to the jet, thus enhancing its effectiveness.
2. The operational efficiency of any cavity charge is dependent upon the following four factors or variables:
  - (a) The type of explosive used. The explosive should be one of the types known as a "high explosive" and should be chosen from among those which have high brisance and detonation velocity ratings. Explosives commonly used are TNT, tetryl, pentolite and any of the composition plastic explosives with an RDX base.
  - (b) The cone or cavity angle and the stand-off distance. The significance of the former is self-evident and the latter is defined as the distance between the target and the lower edge of the charge. The two factors are interdependent and are listed together for that reason. Although the optimum cavity and angle and stand-off distance vary with the job to be done, those listed below are generally effective subject to slight modification to conform to specific situations. The cavity space and stand-off distance should be air-filled in all cases. The jet cannot form properly in water.

#### Cavity Angle

#### Stand-Off Distance (charge diameters)

30°	One
45°	Two
80°	Three
120°	Four

DISPOSAL BY EXPLOSIVE MEANS

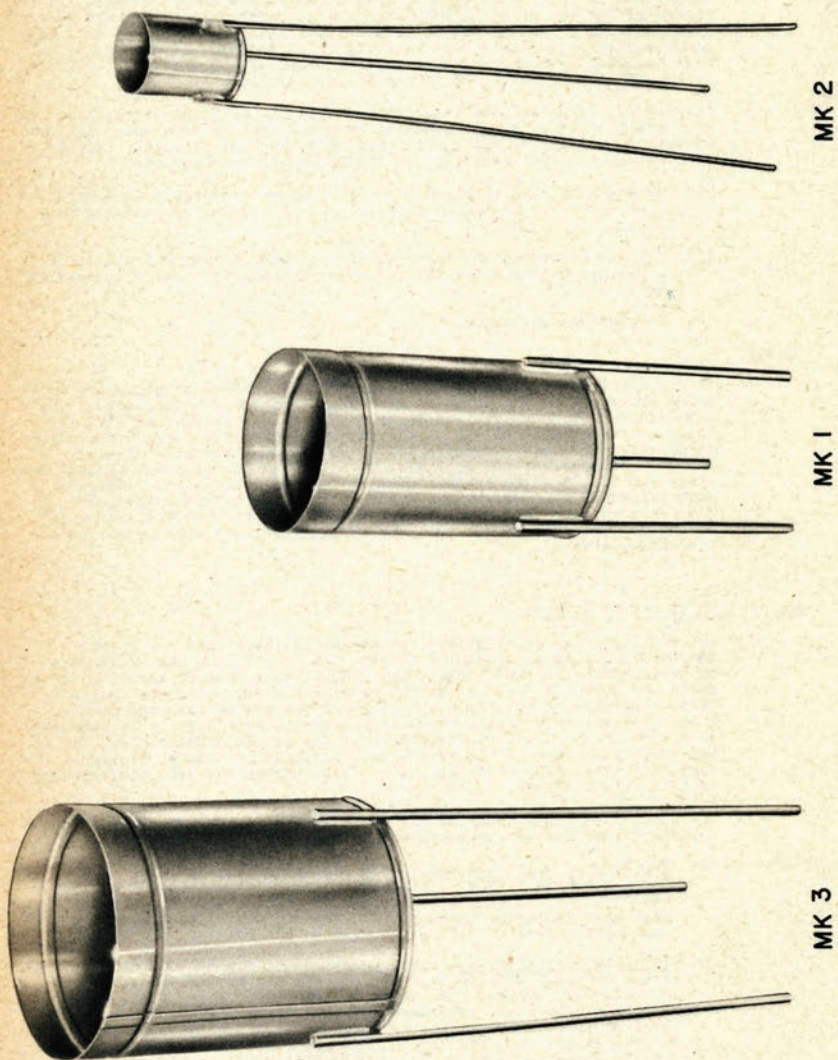
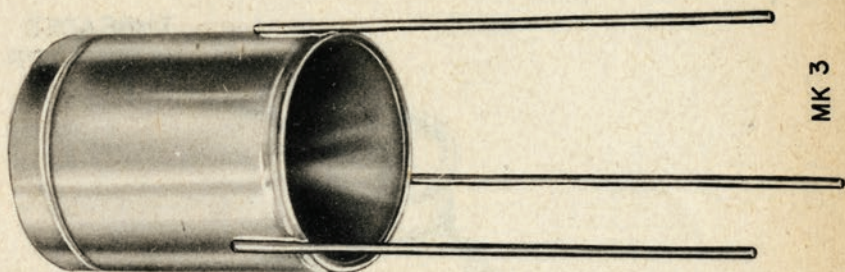
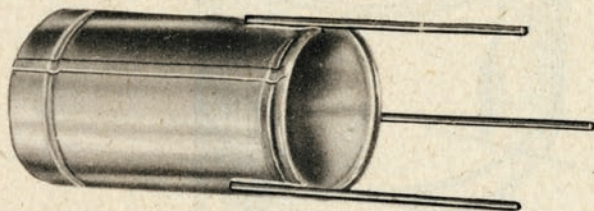


FIG. 4 - U.S. NAVY CAVITY CHARGE CONTAINERS, TOP VIEWS

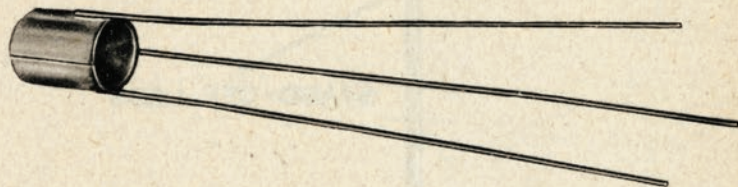




MK 3



MK 1



MK 2

FIG. 5 - U.S. NAVY CAVITY CHARGE CONTAINERS, BOTTOM VIEWS

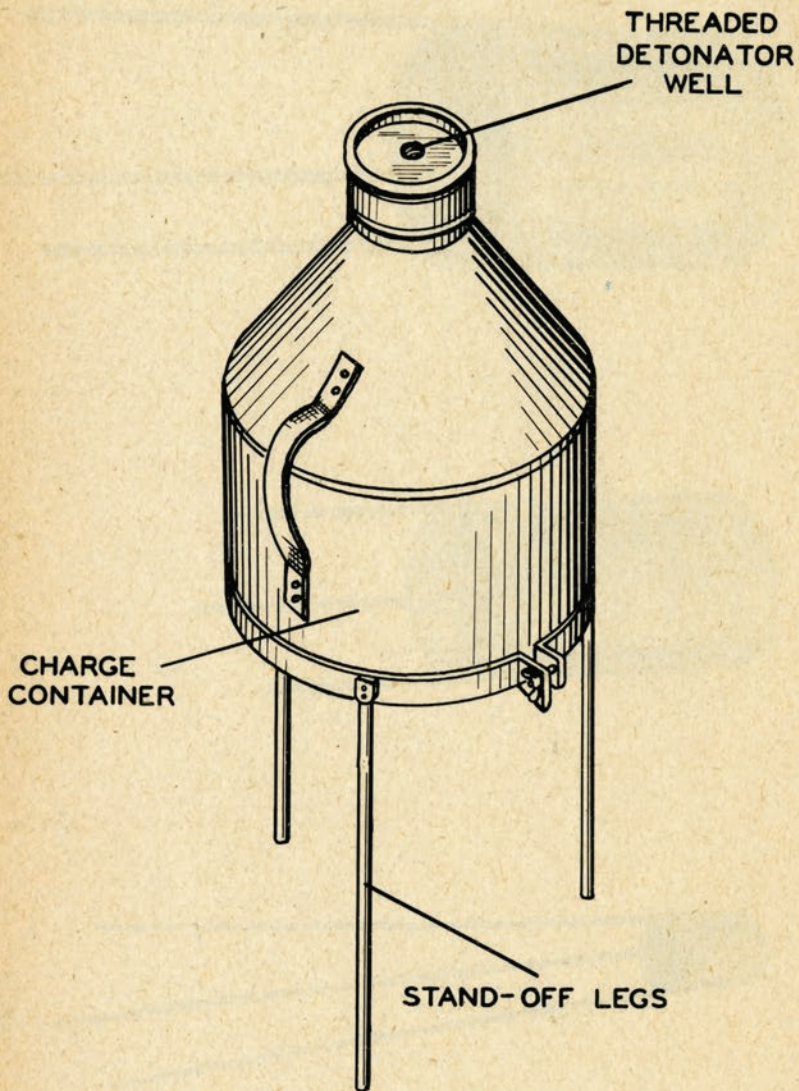


FIG. 6 - U.S. ARMY SHAPED CHARGE, M3

## DISPOSAL BY EXPLOSIVE MEANS

### (Theory and Use of Cavity Charges, Cont'd.)

It should be noted that cavity angles greater than  $120^\circ$  are considered impractical because the best stand-off distance at such angles is too great for service adaptation.

- (c) The thickness and type of cavity liner. Experiment has indicated that when a cavity angle of  $80^\circ$ , the most generally effective angle, is used, steel of a thickness of  $\frac{3}{8}$  of the charge diameter is the best material for the liner. It is to be noted, however, that the type of work to be done will in every instance govern the exact thickness of the liner, which may vary from 1-4% of the charge diameter. In every case, however, the liner should be of uniform thickness throughout, best results being obtained when it is stamped or turned out on a mandrill. Recently issued Army demolition charges employ glass as a liner, with the result that the hole blasted by the charge in a solid object is wider and the danger to personnel from shrapnel is considerably reduced, although the depth of penetration is not so great as when steel is used.

### Special Cavity Charges and Charge Containers

#### 1. Navy Cavity Charge Containers

- (a) Three types of cavity charge containers have been developed by the Navy for special use in explosive disposal. Each is made of thin sheet metal and is fitted with three wire legs soldered to its side, the legs being of the correct length to insure the proper stand-off distance. The containers are issued without explosive charge. Optimum results are obtained when these containers are packed with any of the Composition C plastic explosives and detonated by an Engineer Special blasting cap. When loading the explosive, care should be taken to pack the explosive into each corner of the container, making sure that no crevices or air pockets are present. For best results, the detonator should not be inserted into the explosive more than  $\frac{3}{8}$ ". Pertinent data on each container follow below:

##### (1) Cavity Charge Container Mk 1 Mod 0

Dimensions - - - - - 2 1/4" diam., 4 5/32" high.  
Stand-off - - - - - 3"  
Charge - - - - - 2/3 lbs.  
Cavity angle - - - - -  $42\ 1/2^\circ$   
Cone material - - - - - 0706 steel

The jet produced is capable of penetrating 3/2 of armor plate or 12" of reinforced concrete.

##### (2) Cavity Charge Container Mk 2 Mod 0

Dimensions - - - - - 1" diam., 1 1/4" high.  
Stand-off - - - - - 8"  
Charge - - - - - 3/4 oz.  
Cavity angle - - - - -  $80^\circ$   
Cone material - - - - - 0703 steel

The jet produced is capable of opening light-case ordnance with a case thickness of  $\frac{3}{4}$ " or less.

##### (3) Cavity Charge Container Mk 3 Mod 0

Dimensions - - - - - 3" diam., 4" high.  
Stand-off - - - - - 6"  
Charge - - - - - 1 1/3 lbs.  
Cavity angle - - - - -  $80^\circ$   
Cone material - - - - - 0709 steel

The jet produced is capable of causing low or high order detonation of the charge in thin-skinned ordnance ( $\frac{3}{4}$ " case or less) which is buried beneath one foot of tightly-packed earth or beneath three feet of loose earth. For demolition purposes, the jet is capable of penetrating about 6" of armor plate or 18" of reinforced concrete.

### Army Shaped Charges

1. The Army issues five large cavity charges for general demolition use, each of which is shipped to the field already packed with explosive. 10-lb., 15-lb. and 40-lb. charges are issued, the 10-lb. charges being approximately 7" in diameter and 14" long, the 15-lb. charges, 7" in diameter and 16" long, and the 40-lb. charge, 10" in diameter and 30" long. Sheet metal, fabric and plastic containers are used. Any of the charges may be detonated by a #6 blasting cap with the single exception of the M2, which requires an Engineer Special blasting cap to insure complete detonation. Pertinent data on each of the charges

DISPOSAL BY EXPLOSIVE MEANS

(Theory and Use of Cavity Charges, Cont'd.)

follow below:

- (a) Shaped Charge, M1, 10 lb. This charge consists of 10 lbs. of TNT and a tetryl booster cast into a sheet metal container and fitted with a steel cavity liner. Metal legs, folded against the body during shipping, provide proper stand-off. The jet produced is capable of penetrating 30" of reinforced concrete and, if the concrete is more than 30" thick, will cut a hole about 25" deep which tapers from 2 1/2" in diameter at the outer end to 1 1/4" in diameter at its inner end. A second charge centered over the same hole will increase the depth of the hole although little or no increase in diameter will be effected.
  - (b) Shaped Charge, M2 (M2A1), 10 lb. This charge consists of 10 lbs. of pentolite cast into a plastic-impregnated cloth container and fitted with a glass cavity liner. A cardboard cylinder, nested over the charge during shipping, provides proper stand-off. The M2A1 differs from the M2 in that the upper body is slightly flattened. The rated capacity of these charges is the same as the M1.
  - (c) Shaped Charge, M2A3, 15 lb. This charge consists of 11 lbs. of pentolite cast into a water-resistant fibre container and fitted with a glass cavity liner. A cardboard cylinder provides proper stand-off as in the M2. The jet produced is capable of penetrating 36" of reinforced concrete and, if the concrete is more than 36" thick, will cut a hole about 30" deep which tapers from 3 1/3" in diameter at its outer end to 2" in diameter at its inner end.
  - (c) Shaped Charge, M3, 40 lb. This charge consists of 29 lbs. of pentolite cast into a thin sheet metal container and fitted with a steel cavity liner. A circular bracket or pedestal issued with the charge provides proper stand-off. No capacity ratings are available and it should be noted that future shipments of these charges will probably be loaded with Composition B which is considerably more brisant than pentolite.
3. It is emphasized that the most powerful blasting caps available should be used with these charges. The use of two or more caps is advised where feasible if any doubt exists as to the efficacy of the caps on hand.

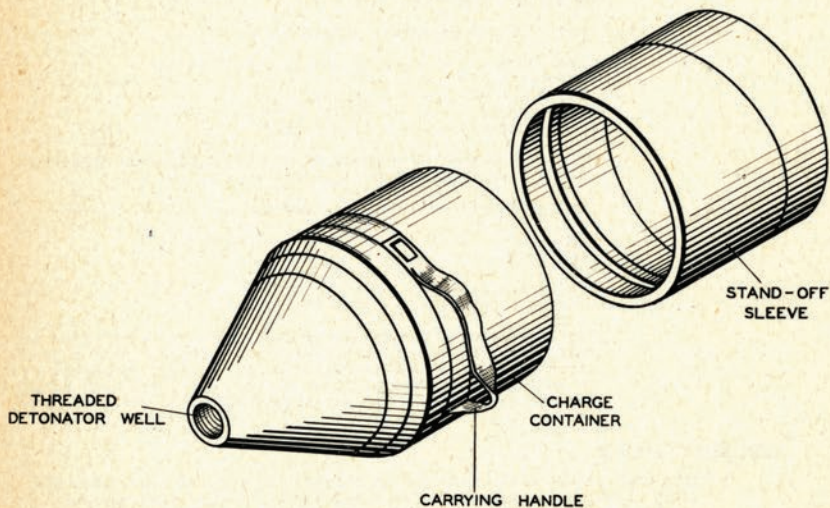


FIG. 7-U.S. ARMY SHAPED CHARGE, M2

## DISPOSAL BY EXPLOSIVE MEANS

### Cavity Charges for Disposal

#### General

1. When using cavity charges in disposal operations, it is possible, by proper placing of the charge on the mine case, to control the degree of detonation within certain limits. Any one of the following results may be obtained:
  - (a) High order detonation.
  - (b) Low order detonation.
  - (c) Breaking up the case and/or charge.
  - (d) Ignition of the charge.
2. When dealing with exposed ordnance, a Navy Cavity Charge, Mark 1 or 3, when placed on the mine so that its axis points to the mine booster, will give high order detonation. High order detonation may also be expected if the charge is placed on a mine case which has explosive directly beneath, irrespective of the relative location of the booster. If however the main charge of the mine is separated from the mine case by an air gap, as is the case in many U. S. and British moored mines, a low order detonation or breaking up of the case may be obtained if the cavity charge is not pointed directly at the booster. Use of the Cavity Charge, Mark 2, will ordinarily result in low order detonation, ignition of the charge or in breaking up of the charge and case, regardless of the relative position of the charge and mine booster.
3. When dealing with buried ordnance, use of the Cavity Charge, Mark 3, will ordinarily result in low order detonation if the ordnance is buried from 12-18" beneath hard-packed dirt or 36" beneath loosely packed dirt.
4. No extensive experimentation has ever been carried out using Army shaped charges for explosive disposal but, from a comparison with Navy Cavity Charges, the following assumptions may be drawn:
  - (a) When dealing with exposed ordnance, high order detonation may be expected if the axis of the shaped charge points to any portion of the main mine charge.
  - (b) When dealing with buried ordnance, high order detonation may be expected if the ordnance in question is buried at any depth up to eight feet and if the axis of the shaped charge points to any portion of the main mine charge.
5. The following points should be noted when carrying out explosive disposal with cavity charges:
  - (a) High order detonation is always possible in cases where low order detonation would ordinarily be expected. Always assume a high order detonation when planning the safety of personnel and surrounding installations.
  - (b) More sensitive main charge loadings such as torpex and hexanite are often ignited by a low order detonation and may detonate again after ignition. Proper precautions should be taken.
  - (c) In many cases where a low order detonation is desired, several attempts must be made before proper results are obtained. In such instances, each of the successive cavity charges used should be positioned at a new location on the mine case. Repeated "shots" on a single section of the case surface almost always result in high order detonation.

DISPOSAL BY EXPLOSIVE MEANS

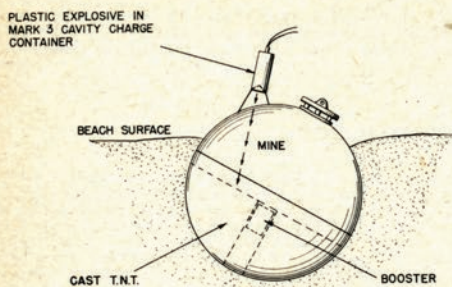


FIG. 8 - ARRANGEMENT FOR COMPLETE OR PARTIAL DETONATION OF BURIED MINE USING CAVITY CHARGE DIRECTED TO ONE SIDE OF BOOSTER

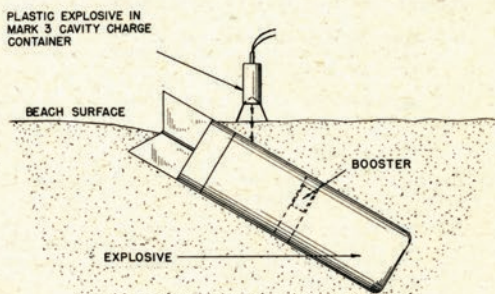


FIG. 9 - ARRANGEMENT FOR COMPLETE OR PARTIAL DETONATION OF BURIED MINE (LOCATION OF BOOSTER NOT KNOWN)

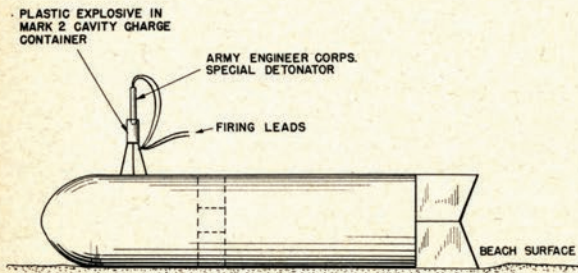


FIG. 10 - ARRANGEMENT FOR OPENING MINE LOADED WITH SENSITIVE EXPLOSIVE

PLASTIC EXPLOSIVE IN  
MARK 3 CAVITY CHARGE  
CONTAINER

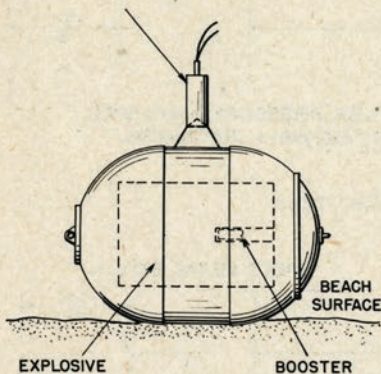


FIG. 11- ARRANGEMENT FOR COMPLETE OR  
PARTIAL DETONATION OF MINE  
USING CAVITY CHARGE DIRECTED  
AT MINE CHARGE ACROSS AIR GAP

PLASTIC EXPLOSIVE IN  
MARK 3 CAVITY CHARGE  
CONTAINER

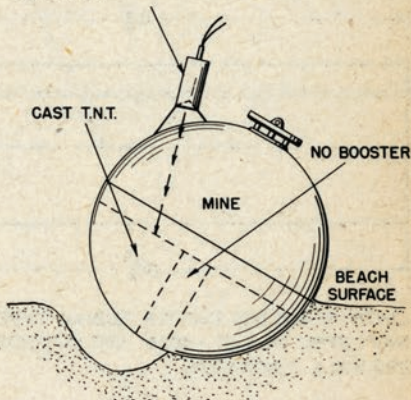


FIG. 12- ARRANGEMENT FOR PARTIAL  
DETONATION OF MINE (BOOSTER  
REMOVED) USING CAVITY CHARGE  
DIRECTED AT MINE CHARGE  
ACROSS AIR GAP

PLASTIC EXPLOSIVE IN  
MARK 3 CAVITY CHARGE  
CONTAINER

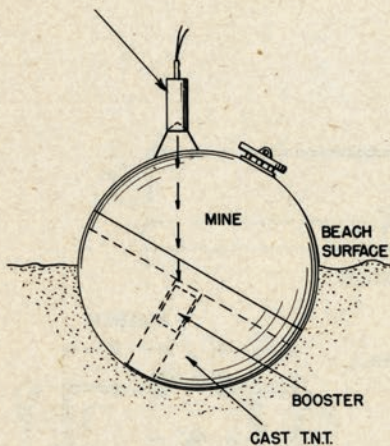
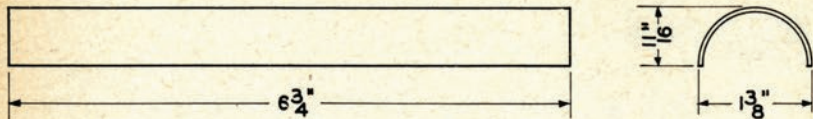
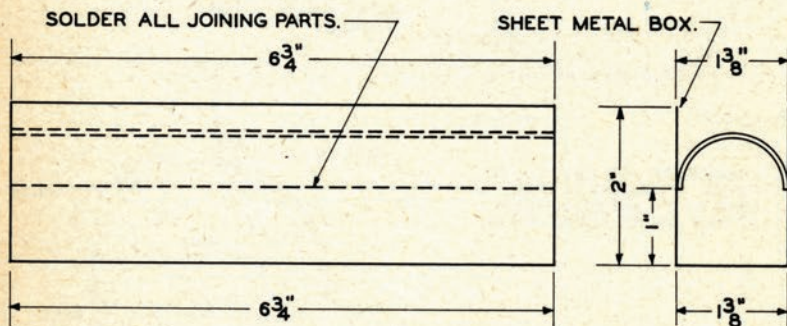


FIG. 13- ARRANGEMENT FOR COMPLETE  
DETONATION OF MINE USING  
CAVITY CHARGE DIRECTED AT  
BOOSTER

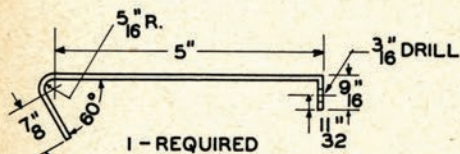
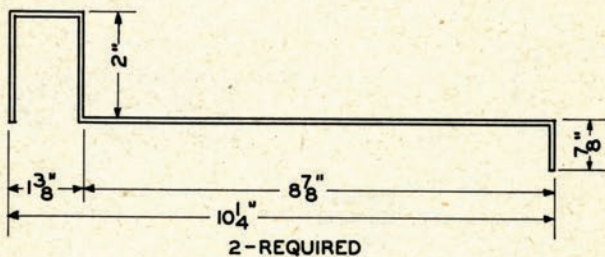


SEAMLESS COPPER TUBING TYPE 'A' 100 LBS. PRESSURE. NAVY SPEC. No. 44T - 4956. 1.315 OUTSIDE DIAMETER, .120 WALL THICKNESS.

Fig-14 Cavity Charge Liner Type I



LINER: SEAMLESS COPPER TUBING TYPE 'A' 100 LBS. PRESSURE. NAVY SPEC. No. 44T - 4956. 1.315 OUTSIDE DIAMETER, .120 WALL THICKNESS.



MATERIAL: 1/2 STRIP 16 GA. GALV. SHEET METAL.

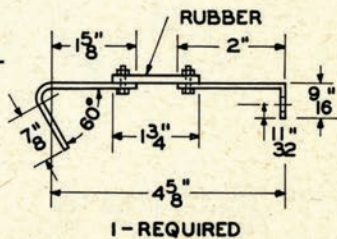


Fig. 15-Cavity Charge Container Type 2



DISPOSAL BY EXPLOSIVE MEANS

Linear Cavity Charges for RMS

General

1. If a cavity charge of the type previously considered is elongated in the plane which passes through the longitudinal axis of the charge cavity, a linear cavity charge is produced. When this type of charge is detonated, the resultant wave takes the form of a progressive sheet rather than that of a jet. This phenomenon is particularly applicable to various phases of explosive disposal and demolition.
2. The extreme sensitivity of some of the influence firing devices now in service makes the standard procedure of RMS by disassembly both impractical and extremely dangerous. It has been found that the mines containing these units may be easily and safely rendered safe by use of various cavity charges made up using the liners described below. These charges, when properly positioned, will send a copper slug through the mine case into the unit, cutting the vital operating leads and damaging the unit so that it cannot operate.
3. This section is concerned only with the preparation of the cavity charge liners. Directions for packing the liners with explosive, and the use of each with various individual mines, will be included in the information on the particular mine to which the charge is to be fitted.
4. These liners were designed for use with the Composition C plastic explosives, and positive results should not be expected if other types of explosive are used. As in all cases where plastic explosive is used, Army Engineering Corps Special Detonators should be used to insure complete detonation of the charge.
5. The designations given these liners are temporary, and it is expected that permanent designations will be assigned by the Bureau of Ordnance. These liners are not carried in stock and must be made up in the field.

Cavity Charge Liner Type 1

1. Obtain a length of Seamless Copper Tubing, Type "A," 100 lb. pressure, Navy Spec. #44T-4956 if possible, but any type of seamless copper tubing with an outside diameter of approximately 1 1/8" and a wall thickness of .12" should be satisfactory.
2. Saw the tubing in half, and cut the resulting hemi-cylindrical liner into 6 3/4" lengths.

Cavity Charge Container Type 2

1. Prepare Cavity Charge Liner Type 1, and enclose it in a watertight box as specified in the accompanying drawing. The clamps shown are designed to hold the charge on the mine regardless of the mine's position, and to insure proper positioning.
2. This liner may be used in any instance where Cavity Charge Liner Type 1 is called for, although it was designed primarily for underwater work.

Cavity Charge Container Type 3

1. Obtain a length of seamless copper tubing as specified for the Cavity Charge Liner Type 1.
2. Saw the tubing in half, and cut the resulting hemi-cylindrical liner into 6 1/2" lengths.
3. Enclose the liner in a watertight sheet metal box as specified in the accompanying drawing. Two helical springs and two wire clamps are used to secure and position the liner on the case.

DISPOSAL BY EXPLOSIVE MEANS

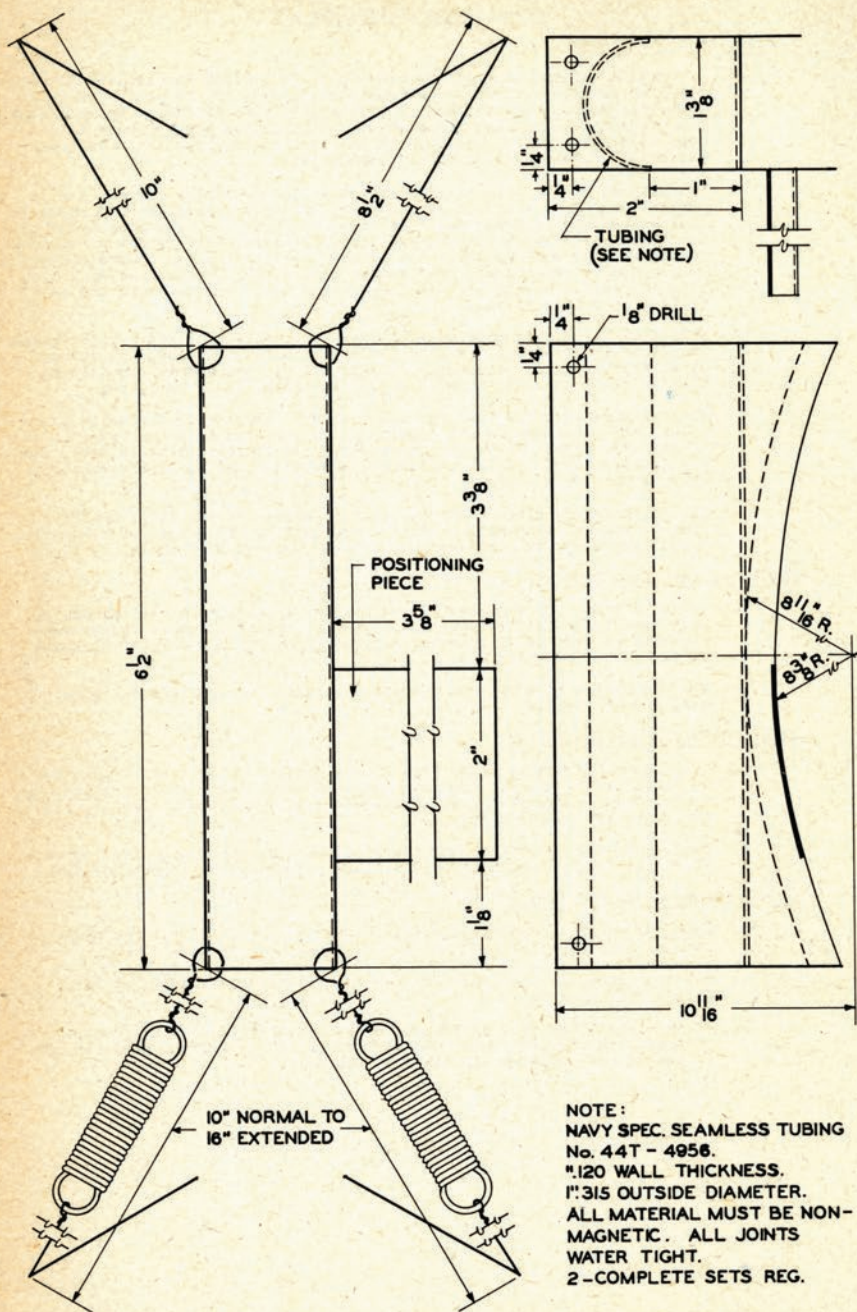


Fig-16 Cavity Charge Container Type 3

DISPOSAL BY EXPLOSIVE MEANS

(Linear Cavity Charges, Cont'd.)

Curvilinear Disposal Charges

1. A curvilinear cavity charge, consisting of a linkage of single linear charges may be used, when properly positioned about a mine case, to separate two sections of the case and thus render the mine inert. A charge made up of a number of single charges of the type described below may be used effectively on cylindrical cases. Specifications for making the individual liners for such a charge follow below:

Material - - - - -	Brass
Height of liner - - - - -	7/16"
Width of liner - - - - -	0725
Thickness of liner - - - - -	07016
Cavity angle - - - - -	120°
Stand-off - - - - -	0725-0775

Cable and Chain Cutter, Mk 1 Mod 1

1. This is a U-shaped linear charge, designed to cut cable of a diameter of 2" or less and chain of a diameter of 1 1/2" or less. It may be used underwater at depths up to 20 ft. as well as on land. Its charge is about 1.2 lbs. and must be supplied in the field.

Underwater Cutting

1. Linear Cavity Charges may be used to good effect in cutting steel plate underwater. Specifications for making liners for this purpose are given in the accompanying drawing and table.

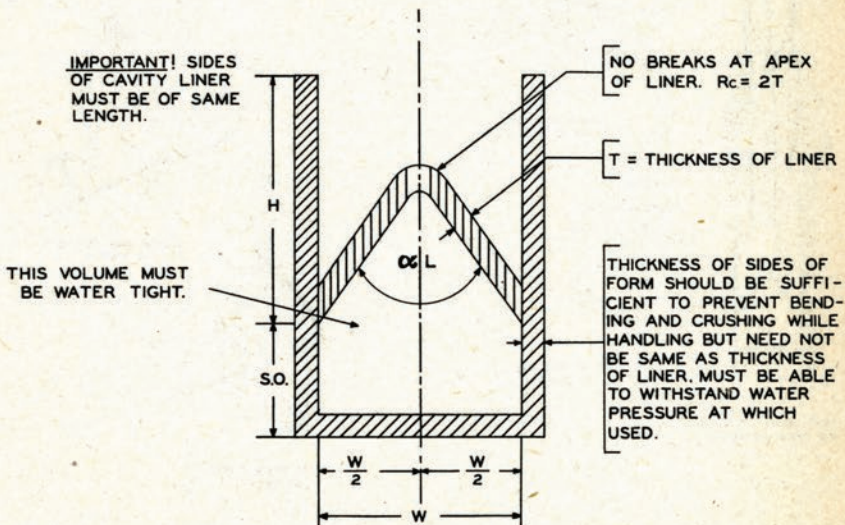


FIG. 17-LINEAR CAVITY CHARGE LINER FOR UNDERWATER CUTTING, SECTIONAL VIEW

DISPOSAL BY EXPLOSIVE MEANS

Thickness Steel to be cut	Charge Required					Charge Recommended				
	αL	W	T	H	S.O.	αL	W	T	H	S.O.
1/4"	80°	3/8"	0.021" 0.025"	7/8"	1/4"	80°	1/2"	0.021" 0.025"	1"	3/8"
3/8"	80°	1/2"	0.021" 0.025"	1"	3/8"	80°	3/4"	0.028" 0.032"	1 1/8"	1/2"
1/2"	80°	3/4"	0.028" 0.032"	1 1/8"	1/2"	80°	1"	0.048" 0.050"	1 1/4"	5/8"
1"	80°	1 1/4"	0.048" 0.056"	1 3/10"	3/4"	80°	1 1/2"	0.062"	1 3/8"	3/4"

TABLE I - SPECIFICATIONS FOR CONSTRUCTING LINEAR CAVITY CHARGE CONTAINERS FOR UNDERWATER CUTTING (SEE FIG.17)

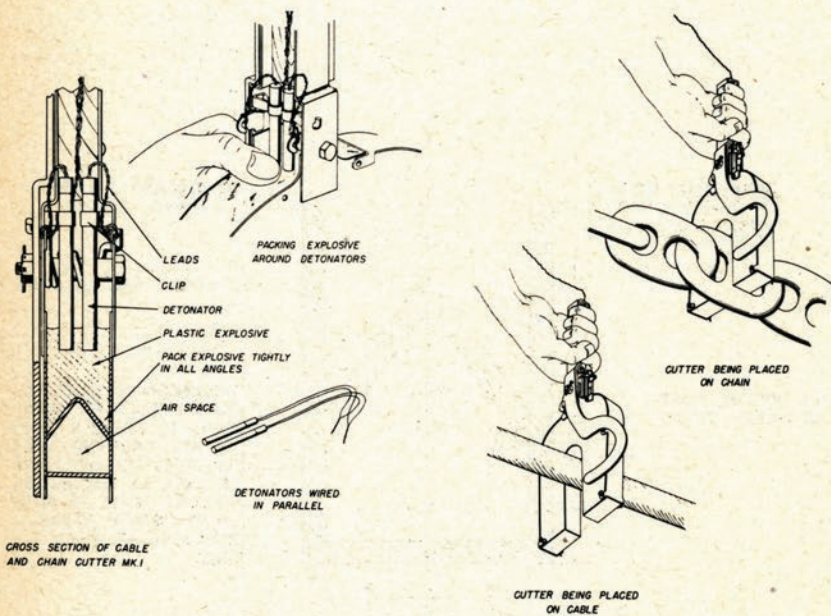


FIG.18 - CABLE & CHAIN CUTTER MK I-1

DISPOSAL BY EXPLOSIVE MEANS

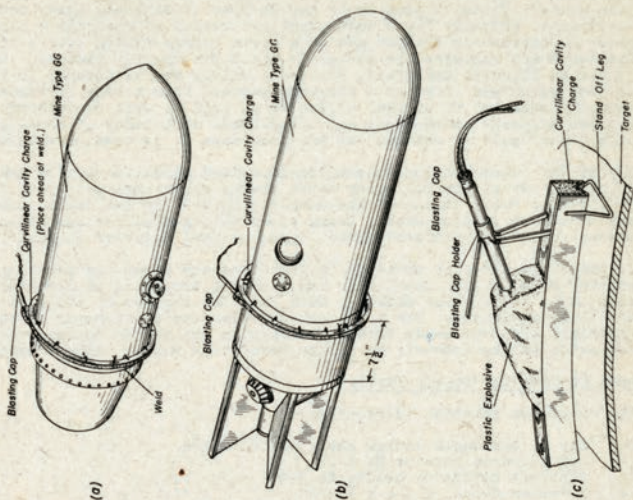


FIG.19 - DRAWINGS SHOWING USE OF CURVILINEAR DISPOSAL CHARGES ON CYLINDRICAL MINES

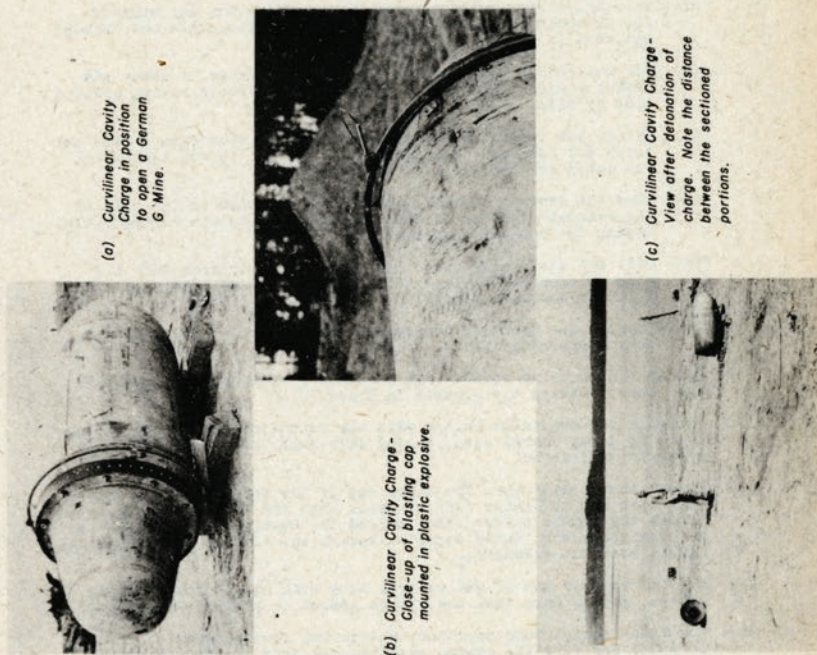


FIG 20- CURVILINEAR CAVITY CHARGE USED TO SECTION MINE TYPE GG

## DISPOSAL BY EXPLOSIVE MEANS

### Depth Charges as Countermining Agents

1. Instances often arise when it is necessary to countermine a large charge underwater. While various means may be used effectively under certain conditions, probably the surest practical method of assuring a high order detonation is through use of a depth charge fitted with a firing adapter which replaces the pistol in the depth charge assembly. When rigged as directed hereafter, the depth charge may be lowered to the desired point and fired by a blasting machine from a safe distance. Such a charge is, of course, effective on land as well as underwater, but its relative convenience and operational efficiency as compared with other types of charges are greatest when it is used underwater.
2. Any of the countermining assemblies described hereafter may be made up using any one of the following depth charge cases: Mks 2-2, 3-0, 6-0, 7-0, 8-0 or 9-0. Stocks of the obsolete Mk 2-2 and 3-0 depth charges are available in some areas, being especially marked for demolition purposes, and it is recommended that these be used whenever possible.
3. It will be noted that detailed instructions are given for adapting a booster extender for demolition use. Such a procedure is necessary only when using the booster extender Mark 2-2, the booster of which is soldered to the mechanism. The boosters used with the other marks of booster extenders are detachable from the mechanism and may be housed over the detonator during assembly as in the Demolition Outfit, Mark 7 below.

### Rigging Depth Charges for Static Firing

1. The following material is required:
  - (a) Any of the depth charge cases listed above.
  - (b) Depth charge booster Mk 6-0.
  - (c) Electric detonator holder Mk 2-0.
  - (d) A wooden block, 2 x 4 x 5 3/8".
  - (e) Standard demolition cable and blasting machine as needed.
2. To rig the depth charge for firing, proceed as follows:
  - (a) Install the detonator in the detonator holder as follows:
    - (1) Pass the firing cable through the stuffing box and stem of the detonator holder, fishing the end of the cable out through the slot in the side of the stem.
    - (2) Cut the end of the cable so that one conductor is about six inches longer than the other, in order to avoid having splices side by side.
    - (3) Insert the detonator in its socket and tighten down on the set screw and lock nut, taking care not to set up too tightly on the screw and thereby deform the detonator.
    - (4) Lead the detonator wires out through the slot in the side of the detonator holder stem and splice them to the firing cable, taping the splices thoroughly.
    - (5) Pull out the firing cable and retract the splices into the stem or secure all wires to the outside of the stem with tape or other suitable means.
    - (6) Tighten the stuffing box cap to compress the packing and insure a watertight fit.
  - (b) Remove the shipping covers from each end of the depth charge central tube, leaving the gaskets in place.
  - (c) Assemble the detonator holder with the detonator and firing cable into the depth charge case, making sure that the flange gasket is properly positioned.
  - (d) Insert the booster into the other end of the central tube, taking care that the detonator fits properly into the detonator envelope. Insert the wooden spacer block behind the booster and fill the remaining space with waste paper to insure the booster being securely housed over the detonator.
  - (e) Cap the booster end of the central tube with one of the shipping covers, making sure that the flange gasket is properly positioned.
  - (f) Lower the charge into position, attach the firing cable to a source of power and fire the charge electrically from a safe distance.
3. Further information may be obtained from Ordnance Pamphlet 1178.

DISPOSAL BY EXPLOSIVE MEANS

Rigging The Booster Extender Mk 2 Mod 2 for Demolition Firing

1. If a Mk 2-2 or Mk 3-0 depth charge is to be used as a demolition charge, in some cases the only booster available will be that attached to the Mk 2-0 booster extender. This booster is soldered to the booster extender and therefore cannot be housed over the detonator in assembly as is the case with the booster in the Demolition Outfit, Mk 7-0. Two possible methods of housing the booster over the detonator are as follows:
  - (a) If the depth of water in which the charge is to be fired is greater than 20 ft., the extender may be left intact and allowed to function as it would in an operative depth charge.
  - (b) If it is desirable to house the detonator in the booster prior to lowering the charge into position, proceed as follows:
    - (1) Remove the booster extender from the depth charge.
    - (2) Remove the safety fork, press in on the booster spindle and free the lock balls.
    - (3) Remove the booster carrying plate.
    - (4) Place a 2 1/2" length of 1" I. D. pipe over the booster spindle.
    - (5) Replace the booster carrying plate, thereby extending the bellows.
    - (6) Replace the booster extender in the central tube. If the Mk 2-0 detonator holder with detonator fitted is inserted in the other end of the central tube, the detonator will be fully housed in the booster.

# MINE DISPOSAL HANDBOOK

## PART I


### GENERAL INFORMATION

• • • • •

### CHAPTER 6

### THERMIT BURNING

APRIL 1, 1945





THERMIT BURNING

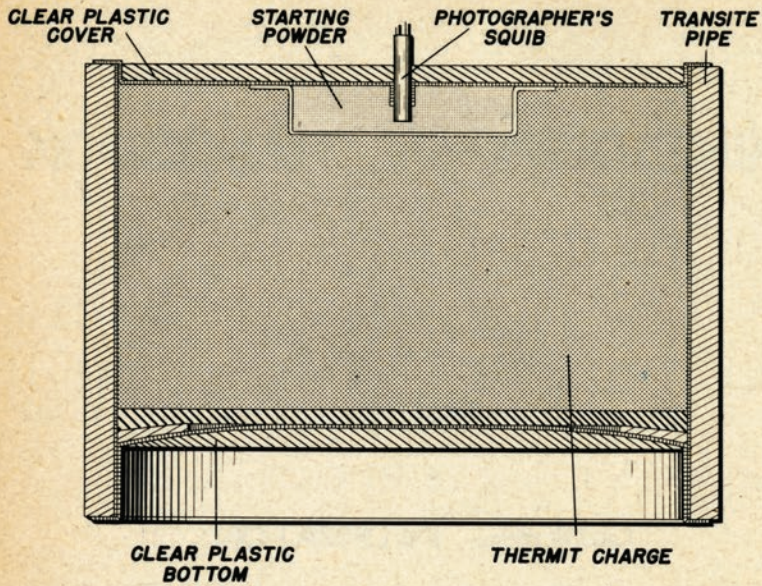


Fig. 1- Thermit Burning Charge, Mark 1, Sectional View

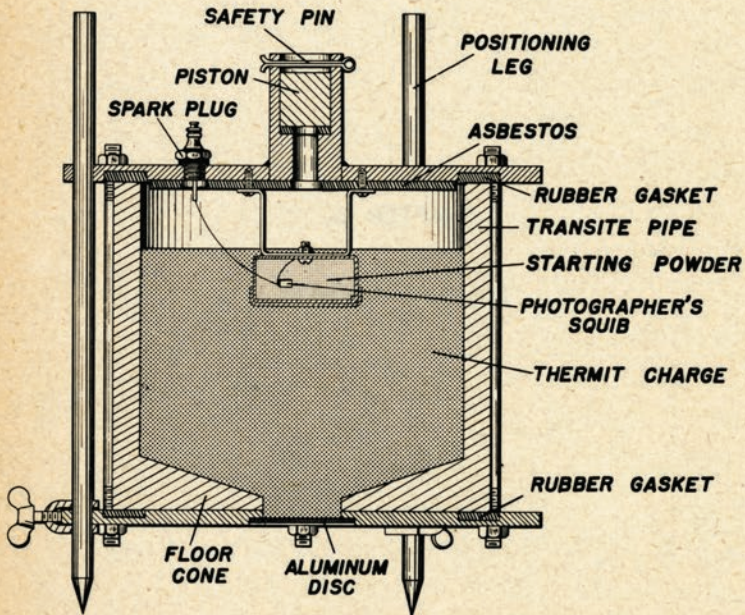


Fig. 2- Underwater Thermit Charge, Mark 2, Sectional View

## THERMIT BURNING

### Introduction

1. The thermit burning technique of disposal accomplishes case penetration and charge ignition in a single operation by allowing a pool of molten iron, obtained from thermit reaction, to contact the case of a piece of explosive ordnance, melt the case and ignite the charge beneath. This technique is particularly valuable to mine disposal personnel because it provides a means of charge disposal in cases where the charge is not accessible for steaming out or removal by hand, where it is impossible or inadvisable to move the piece of ordnance and where corrosive penetration gear is unavailable or impracticable. An additional advantage is that the technique may be employed both on land and underwater.
2. Since the main purpose of this technique is to burn explosive charges while avoiding detonation thereof, mine disposal personnel should familiarize themselves with the various types of explosives which may be expected to burn without detonation and, more specifically, the explosives which may be expected to burn without detonating after thermit ignition. TNT, Torpex, Hexanite, Amatol, Ammonal, Picric Acid and RDX may be expected to ignite and burn relatively quietly on land. Successful underwater burning has been carried out on Torpex, Minol, TNT-HMD and TNT-AL charges. It should be noted that pure TNT will not burn underwater.
3. It must be borne in mind that in operations of this kind, a high-order detonation is always possible for any one of the following reasons:
  - (a) The intense heat of the thermit reaction may raise the explosive to its detonating temperature.
  - (b) The thermit occasionally burns a relatively small hole in the charge container, thereby permitting critical pressures to develop within.
  - (c) Although the explosives listed above may be expected to burn without detonating, the boosters and detonators used with them may be more highly sensitive to heat, resulting in detonation if the charge is not sufficiently burned away or decomposed by the time the boosters or detonators are heated to their detonating temperatures. To counteract this last possibility, the burning should be initiated in the charge as far from the booster and detonator as possible.
4. In view of the above possibilities, adequate precautions which take into account the likelihood of a high order detonation should always be carried out before beginning operations of this kind.
5. The Thermit Burning Charge, Mark 1 and the Underwater Thermit Charges, Mark 2 and 2-1 are the units currently authorized for use by mine disposal personnel. Instructions for the use of each, together with a brief statement of their capabilities and limitations, follow in the body of the chapter.

### Thermit Burning Charge, Mark 1

#### Description

1. This charge, designed for use on land, consists of a cylindrical container about 8 1/2" in maximum diameter and 6" long. The outer shell is made of commercial transite pipe and the various linings are made of non-inflammable cellulose nitrate or acetate. The burning train is in three parts as follows:
  - (a) A standard commercial-type photographer's squib.
  - (b) Approximately 100 grams of starting powder, a mixture of silicon, lead dioxide and cupric oxide.
  - (c) Approximately 16 1/2 lbs. of non-magnetic, hematite-base thermit.

#### Use

1. The charge is designed primarily for use on spherical cases and will readily burn through 3/16" steel or 1/4" aluminum plate. It is most important that the charge be placed on the case with its sides in the vertical plane to make sure that the molten iron will impinge directly on the case surface and not run off to the side.
2. If the charge is to be used on a cylindrical case, it is most important that the spaces between the charge and the case be well-packed with mud or clay so that the molten iron will gather in a pool and not run off to the side. The weight of the charge is sufficient to keep it securely

THERMIT BURNING

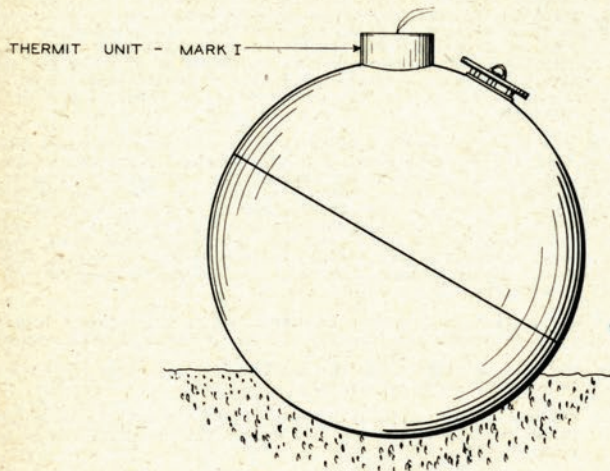


Fig. 3- Thermit Burning Charge, Mark I, on Spherical Mine Case

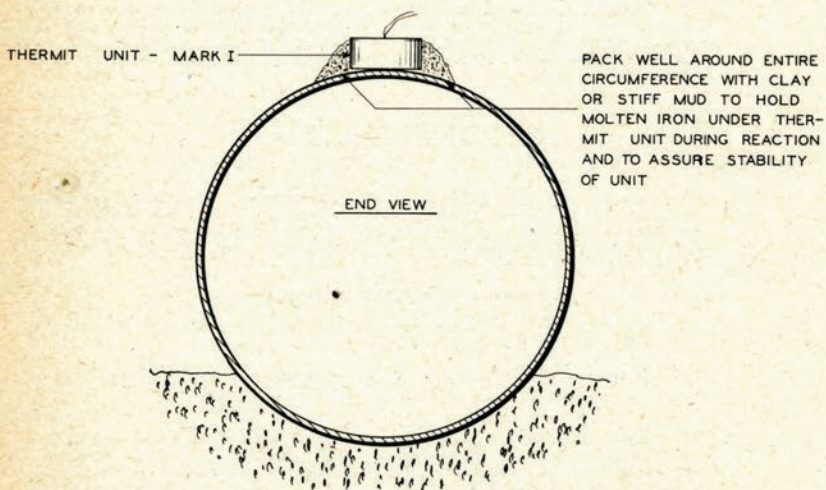


Fig. 4- Thermit Burning Charge, Mark I, on Cylindrical Mine Case

## THERMIT BURNING

### Thermit Burning Charge, Mark 1 (Cont'd.)

positioned on the case. The charge should be fired from a safe distance by means of a blasting machine or battery.

### Underwater Thermit Charge, Mark 2 (2-1)

#### Description

1. This charge has proved undependable in the field and should not be relied upon in emergencies. The source of the malfunction is not definitely known although, as noted hereinafter, deterioration in storage due to excess moisture is believed to be one of the main factors involved. It is recommended that upon receipt of a shipment of these charges, certain ones be tested experimentally with a view toward appraising the condition of the whole shipment.
2. This charge consists of a cylindrical container 7" in diameter and 6" long, fitted with brass top and bottom cover plates each 8 3/4" in diameter. Six tie rods join the top and bottom cover plates and adjustable positioning legs serve to give the correct stand-off distance from the case. The top cover plate is fitted with a cylindrical boss which contains a small piston and also with a single automobile spark plug. The container proper is made of commercial transite pipe and the other fittings, of half-hard commercial brass. The burning train is essentially the same as in the Thermit Burning Charge, Mark 1. The Mark 2-1 differs from the Mark 2 mainly in that the diameter of the cover plate is slightly greater, permitting use of the charge with the Kaplan clamp without attaching the finger clips.

#### Use

1. The charge is designed primarily for use on 26" diameter cylindrical mine cases such as GC and GD although satisfactory results may be obtained with smaller cases. The charge may be placed on the mine with or without a securing clamp. If the longitudinal axis of the mine case makes an angle of 10° or less with the horizontal and if the local current is believed not to be sufficient to displace the charge from the case, no clamp need be used. Under conditions where the angle is greater, the clamp must be used.
2. The charge is lowered to the diver by means of the firing cable after the pin has been removed from the safety plug and the two topside leads have been shorted together. The charge should be placed on the mine at the farthest possible point from the detonator and booster and in a position where, on burning through the case, the molten iron will ordinarily contact the explosive charge. The legs on the charge should be adjusted so that the bottom cover plate is as nearly horizontal as possible and from 1 1/2" to 2" from the case. The firing leads are then clipped to the spark plug and top cover plate respectively, no insulation from the sea water being necessary. A small weight (about 10 lbs.) should be secured to the firing cable about 10 ft. from the charge to prevent topside strain from being transmitted to the charge.
3. When using the Kaplan clamp, topside should attach the three finger clips furnished with the clamp under three of the nuts on the top cover plate (finger clips not used with Mark 2-1) and remove the pin from the safety plug before lowering the charge and clamp together on the firing cable. The diver then attaches the clamp as shown in Fig. 5, tightening it by means of the handwheel while keeping the metal ring on top of the clamp as nearly horizontal as possible. The charge is then lowered through the ring until the finger clips make contact with the ring, at which point it is properly positioned. Firing leads are then attached as in Par. 2 above.
4. It should be noted that this charge cannot be held on the mine even using the clamp in depths less than 20 ft. In shallow depths, the charge must be lashed down by some other means.

#### General Information and Precautions

1. Experience indicates that the most common cause of failure of these charges is excessive moisture content. This often causes a steam explosion after burning has been initiated and results in the charge being scattered. It is therefore imperative that thermit charges be stored in a dry place at all times. In many cases the charges become damp or even wet during shipment. If such is the case and if immediate use of the charge is indicated, dry the charge slowly by any means available. Slow drying is imperative because the Thermit is encased in thermo-plastic liners which sag when subjected to excessive heat. If sagging occurs, malfunction must be anticipated.
2. Improvised thermit charges for use on land may be made by filling a standard thermit welding crucible, available at most ship repair facilities, with a non-magnetic thermit mixture of the type described

THERMIT BURNING

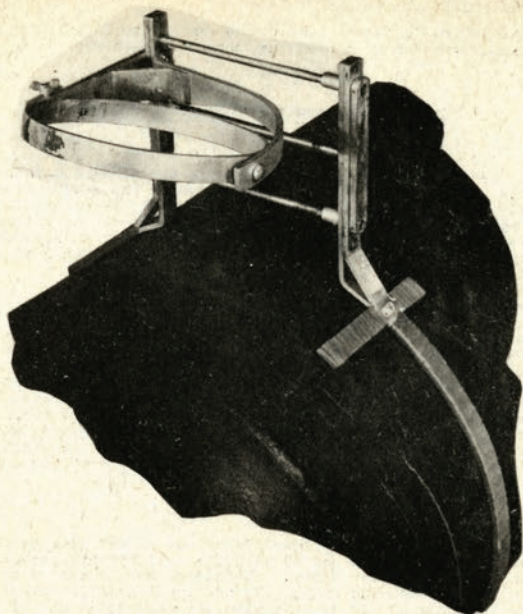


Fig. 5- Kaplan Clamp Mounted on Mine Case

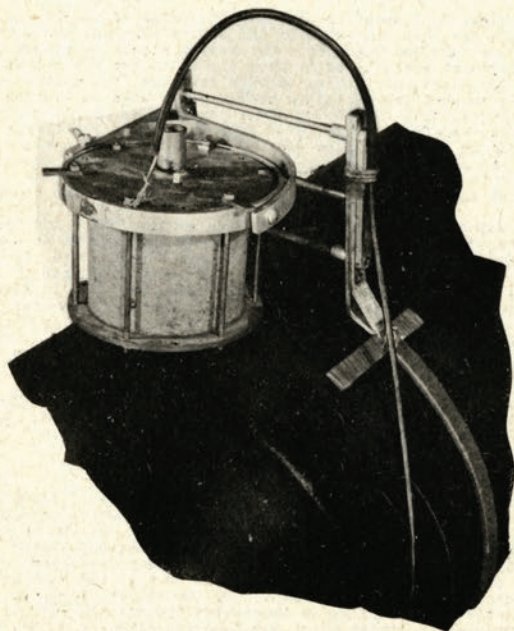


Fig. 6- Underwater Thermit Charge, Mark 2, Mounted in Kaplan Clamp

THERMIT BURNING

Underwater Thermit Charge, Mark 2 (2-1) (Cont'd.)

below:

- (a) Ferric oxide ( $\text{Fe}_2\text{O}_3$ ) - three parts by weight.
- (b) Powdered aluminum - one part by weight.

This mixture may be ignited by means of a small quantity of photographic flash powder and an electric squib. The welding crucible should be supported over the mine in such a manner as to allow the molten metal to impinge on a slanting surface.

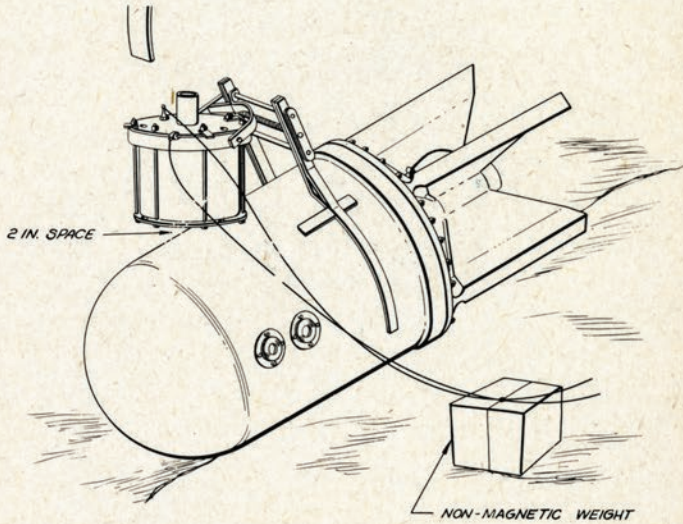


Fig. 7- Underwater Thermit Charge, Mark 2, with Clamp

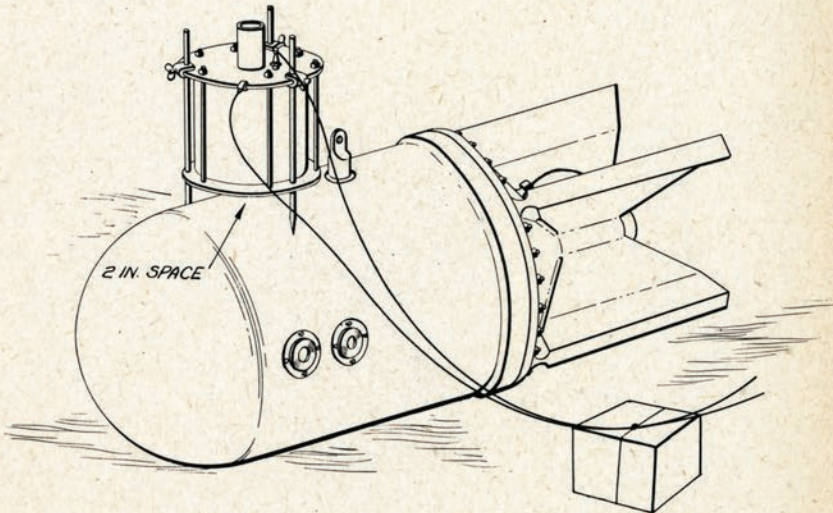


Fig. 8- Underwater Thermit Charge, Mark 2, without Clamp

# MINE DISPOSAL HANDBOOK

## PART I


### GENERAL INFORMATION

.....

### CHAPTER 7

#### CORROSIVE PENETRATION

APRIL 1, 1945



CORROSIVE PENETRATION

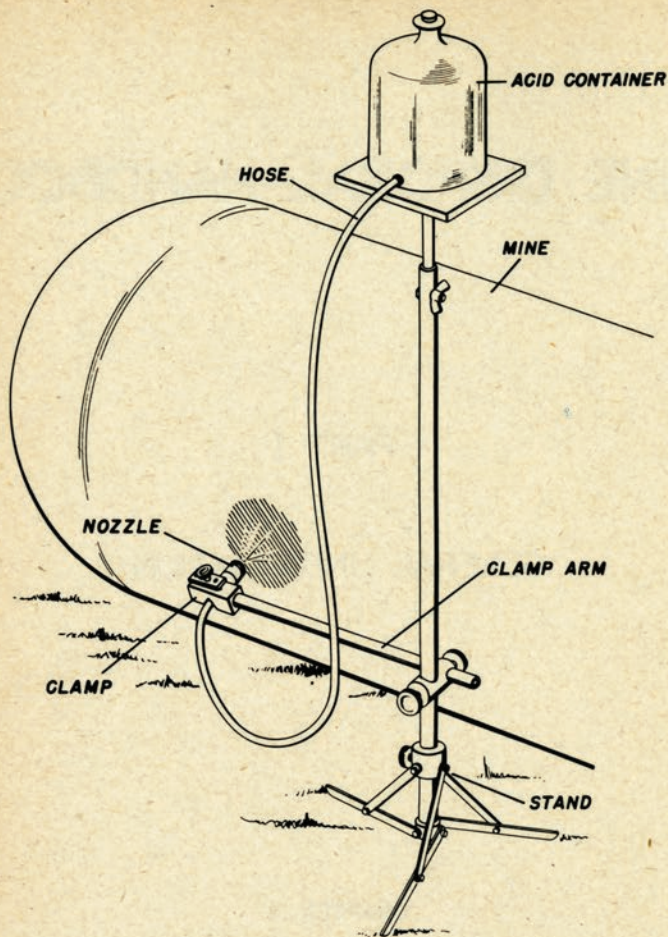


Fig. 1- Corrosive Penetration Gear with Non-Magnetic Stand

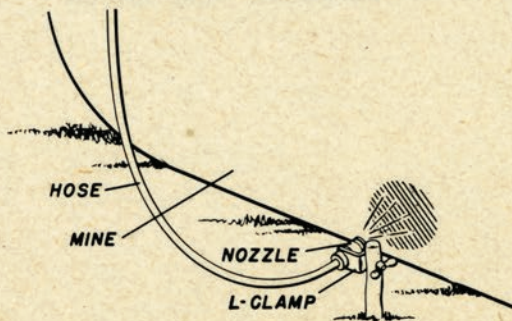


Fig. 2- Corrosive Penetration Gear with Non-Magnetic L Clamp



## CORROSIVE PENETRATION

### Introduction

1. The application of corrosive penetration to mine disposal was originally intended as a countermeasure for certain German influence mines which were believed to be booby-trapped at all obvious points of entry such as cover plates, etc. Although but one such mine was ever found, corrosive penetration is still in use as an effective means of entry into mine cases which, for various reasons, are otherwise inaccessible. Its chief virtues are that it is practically noiseless and non-magnetic, can be operated from a safe distance and can be set up readily even in remote forward areas due to the fact that the essential equipment is almost universally available.
2. All metal cases for underwater explosive ordnance have to date been made of aluminum, steel or alloys thereof and the procedures given herein are therefore chosen for their effectiveness on cases made of those materials.

### Equipment

1. The following equipment is standard for operations of this type:
  - (a) A plastic nozzle.
  - (b) Approximately six ft. of 5/16" I. D. Koroseal tubing or 1/4" I. D. Duprene tubing.
  - (c) A bottle stand.
  - (d) A nozzle holder.
  - (e) A large bottle.
  - (f) Reagents as follows:
    - (1) For aluminum, a cupric chloride solution composed of the following ingredients:
      - (i) 1000 grams (one lb.) hydrated cupric chloride, "purified" grade.
      - (ii) 100 cc (0.048 qts.) concentrated hydrochloric acid.
      - (iii) 1500 cc (0.722 qts.) water. It is of the utmost importance that this solution be mixed accurately. If the cupric chloride content is too high, clogging of the nozzle jets will probably result due to crystallization and, if too low, corrosive action will be slowed to a point of relative inefficiency. The solution must at all times be stored in a glass container and kept free from insoluble impurities.
    - (2) For aluminum, a satisfactory substitute for the above may be obtained by saturating concentrated hydrochloric acid (laboratory or commercial grade) with copper sulphate crystals. Use of this reagent is advised only where cupric chloride is unavailable because of the following disadvantages:
      - (i) Its corrosive properties are but half as great as the cupric chloride solution.
      - (ii) Its high acid content makes it more dangerous to handle.
    - (3) For steel, a nitric acid solution of an absolute concentration of 35% by volume which may be obtained in one of two ways as follows:
      - (i) By mixing three parts technical acid (58-60%) with two parts water or
      - (ii) By mixing one part laboratory acid (70%) with one part water. The strength of the solution may be checked with a storage battery type hydrometer. For best results, the hydrometer reading should be between 1.220 and 1.230.
2. The equipment listed above is normally issued to all Mine Disposal Units as standard gear and, as such, should be readily available. Except for the plastic nozzle, all gear is ordinarily obtainable even at advanced bases. It is advisable to keep four or five nozzles on hand because of their relative delicacy and scarcity.

### Operational Procedure

1. Prior to beginning actual operations, the following precautionary and preventative measures should be carried out:
  - (a) Wash all nozzles, hose and bottles.

CORROSIVE PENETRATION



Fig. 3- Corrosive Penetration Gear

CORROSIVE PENETRATION

Operational Procedure (Cont'd.)

- (b) Remove all paint from the surface to be cut. None of the various reagents will dissolve paint. The paint remover may be applied to the surface by means of a soft brush, cloth or sponge but should never be sprayed on using the plastic nozzle.
  - (c) Foreign matter such as rust or scale should be removed by a spray of hydrochloric acid, followed by a nitric acid spray.
  - (d) When dealing with steel at low temperatures, external application of heat may be necessary to initiate corrosion. Any means at hand may be used for this purpose (blow torch, steam, paper torch, etc.), but it should be borne in mind that steady application of heat to a case for a period of over one minute may be unsafe if explosive lies directly beneath.
2. Set up the gear as shown in Fig. 1. For best operation the reagent bottle should be placed 40-60" above the spraying nozzle which in turn should be placed about 8" from the surface of the case with its two orifices in the vertical plane.
  3. Raise the nozzle well above the level of the reagent bottle and then drop it to operating level, thereby making sure that no air is trapped in the hose.
  4. Adjust the nozzle so that the reagent comes out in small droplets, making sure that a fine spray does not result. Too fine a spray causes the reagent to evaporate and slow the reaction.
  5. If feasible, rig the nozzle so that the reagent is played against the side or bottom of the case. This will prevent undue amounts of reagent from entering the case, thereby lessening the possibility of excessive chemical reaction inside the case which might have explosive results.
  6. Check the corrosive action for proper operation as follows:
    - (a) If working on steel, proper action is indicated by the appearance of a yellow froth and strong, irritating, brown fumes. The solution given above will cut a 3" diameter hole in a 1/8" manganese steel plate in about 40 minutes using about seven quarts of reagent.
    - (b) If working on aluminum, proper action is indicated by the appearance of a brownish-green froth with spongy, dark red deposits of copper. These deposits are useful in preventing the reagent from entering the case and should not be removed. The solution given above will cut a 3" diameter hole in a German ground mine in about 35 minutes, using about six quarts of reagent.
  7. Retire to a safe distance for the duration of the operation, returning only when necessary to replenish the reagent.

# MINE DISPOSAL HANDBOOK

## PART I


### GENERAL INFORMATION

• • • • •

### CHAPTER 8

#### UNLOADING EXPLOSIVE CHARGES

APRIL 1, 1945



UNLOADING EXPLOSIVE CHARGES



Fig. 1-Portable Steam Boiler, General View

## UNLOADING EXPLOSIVE CHARGES

### Introduction

1. Occasions frequently arise when it is desirable or necessary to remove the main charges of mines, torpedo warheads and bombs in order to render them completely safe in situ without risking a high order explosion. For the most part, charges are cast in their respective cases or cast in various-shaped blocks which conform with case contours and internal irregularities. A notable exception is the Japanese explosive, Type 88, which is a granular, crystalline powder. Since charges of the latter type may be poured or scooped from their containers, taking due precautions, they present no particular problem and need not be discussed here. General instructions for steaming out cast charges and removing block-fitted charges are included in this chapter.

### Cast Charges

#### General

1. The best known method of unloading cast charges is to melt the charge by means of low-pressure steam and allow it to drain out of the warhead or charge container. This procedure is generally effective on all explosive mixtures and compounds whose melting point is 95°C or lower. Of the explosives in common use as main charges, TNT, Hexanit and certain grades of Torpex fall within this category and may be readily steamed out. If in doubt as to the advisability of steaming out any known charge, reference to Part I, Chapter 3 will give pertinent data which may be used as a basis for the decision.

#### Equipment

1. The following gear is that which will produce the most effective results, although similar gear may be employed with adequate results:
  - (a) A reasonably portable steam boiler which will deliver steam at a pressure of 80-100 lbs./in<sup>2</sup> at the boiler. The boiler now in use by various Units operates at a mean pressure of 85 lbs./in<sup>2</sup> and its heating capacity is 300,000 B. T. U. per hour.
  - (b) A 500 ft. length of 1/2" I.D. rubber or non-magnetic steam hose.
  - (c) A short length of 1/4" I.D. copper tubing for use as a nozzle. A two or three foot length is suitable in most cases although larger charges may require a greater length in order to apply steam to the most remote parts of the charge container.
2. The necessary capacity of the boiler in ft<sup>3</sup>/min. will vary with the size and length of the hose although, generally speaking, a large capacity boiler is not needed to produce sufficient steam for these operations. It is important, however, that sufficient steam be released into the hose in order to prevent condensation therein. The velocity of the steam at the outlet nozzle is comparatively unimportant from the standpoint of effective operation although it should be realized that the heat brought to bear on the charge is directly proportional to the head of steam at the nozzle. The rate of erosion of the charge is similarly proportional to the amount of heat applied and it is therefore obvious that the speed of the steaming-out process is governed in part by the pressure at the nozzle.

#### Operational Procedure

1. Set up the boiler at a safe distance upwind from the charge. Use the entire length of hose, if possible, leaving only enough slack to permit shifting the nozzle as the operation proceeds.
2. Place the charge container so that the steam entry hole is near the underside of the container. If the ground is sloping, be sure that the entry hole is on the downhill side. Take necessary steps to insure that the molten explosive will collect in a nearby hole and not scatter widely.
3. When the boiler has built up sufficient pressure, open the valve wide to force any condensation out of the hose.
4. Rig the nozzle by any means available so that the full flow of steam is directed against the explosive. Frequent nozzle adjustment will be necessary as the operation proceeds. Be sure that all corners of the container are clean before securing operations.

UNLOADING EXPLOSIVE CHARGES

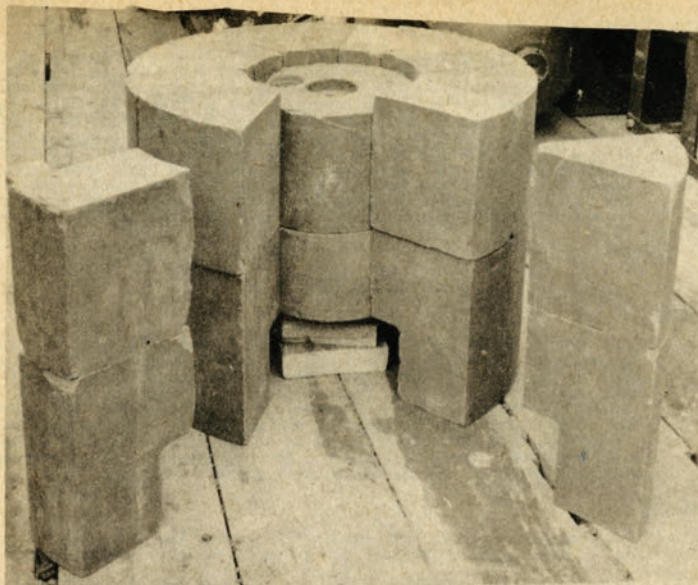


Fig.2-Block-Fitted Charge, Mine Type GO, Component Parts

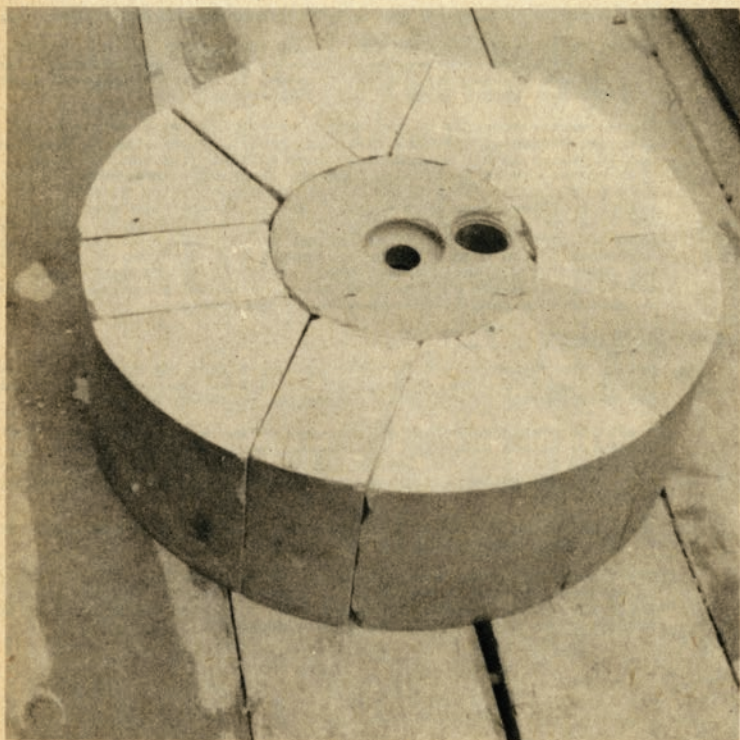


Fig.3-Block-Fitted Charge, Mine Type GO, Top View

## UNLOADING EXPLOSIVE CHARGES

(Cast Charges, Cont'd.)

5. Dispose of the molten explosive. This can be accomplished in most cases by burning, using oily rags or other suitable means to ignite the charge.

### Precautions

1. Allow no more than one person at a time in the immediate vicinity of the charge.
2. Allow no open flame or smoking within a radius of 150 feet of the charge.
3. Remain at a safe distance, preferably to windward, during steaming operation except when adjusting the nozzle. Similar precautions should be observed while burning the charge because the fumes evolved will probably be toxic.
4. Note that such explosives as HND and Torpex, while ordinarily relatively stable, may become extremely sensitive during steaming operations if various components segregate from the main body of the explosive.
5. Make sure that enough fuel and water is on hand to permit completion of the operation without stopping. At least one serious accident has occurred when operations were ceased and resumed again after a short period.

### Block-Fitted Charges

#### General

1. This method is used extensively by the Germans and Japanese for loading mines and torpedo warheads where the interior of the mine case or warhead shell is sufficiently regular to permit the use of mass-produced charge blocks. Removal of such charges offers no particular problem although no set rules can be established because of the individuality of each fitting. The following examples are presented as representative of the problems encountered in the past and to aid in future operations.

#### Mine Type GY\*

##### Description of Charge

1. The charge consisted of 33 blocks of cast Hexanite and weighed 672 lbs. It was loaded in three layers, each consisting of one cylindrical block in the center surrounded by ten blocks cast in the form of cuboids and annular segments. The individual blocks varied in length from 17" to 19" and were firmly positioned by 35 wooden wedges. A short, threaded tube was cast in the center of each central key block to facilitate loading.

##### Unloading Procedure

1. Each wedge was cut and removed, after which the key block of each layer was removed by screwing a bolt into the threaded tube and lifting the block out. The surrounding blocks were then removed by hand.

#### German Warhead, Type Ka

##### Description of Charge

1. The charge consisted of blocks of cast Hexanite and weighed 656 lbs. It was fitted much in the same manner as the charge in the Mine Type GY\* described above, being in three layers, with each layer consisting of a key block surrounded by various segments which formed an annular ring. Several plywood sections were used to replace charge blocks in the upper portion of the warhead in order to lower the center of gravity.

##### Unloading Procedure

1. Same as for Mine Type GY\* described above.



UNLOADING EXPLOSIVE CHARGES

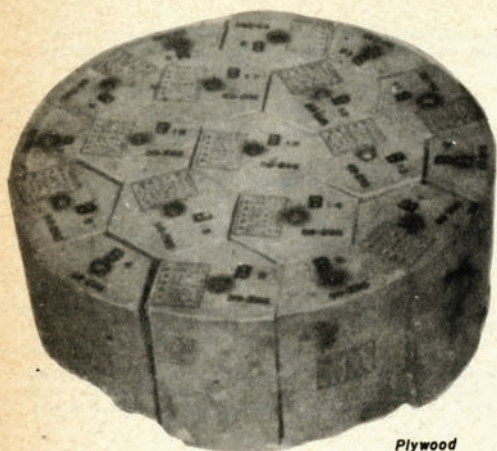


Fig. 4-Block-Fitted Charge,  
Mine Type JA

Fig. 5-Block-Fitted Charge,  
Fitted in German Ka Warhead

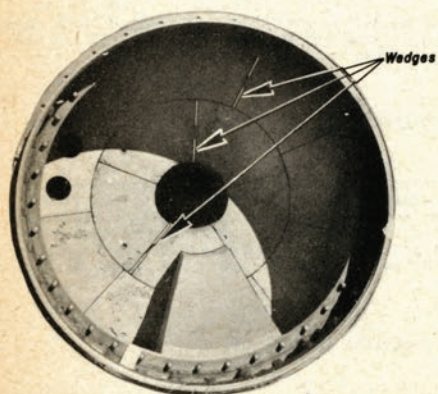
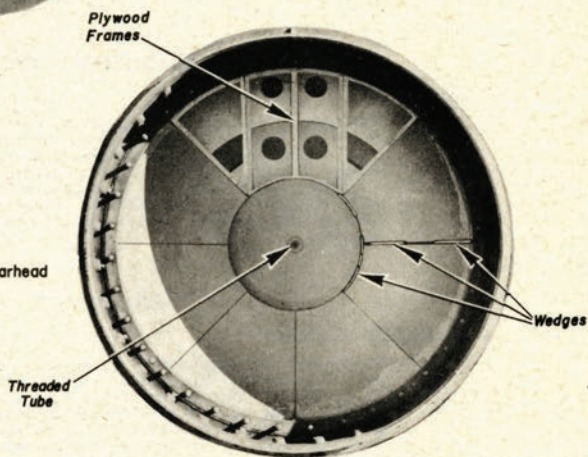


Fig. 6-Block-Fitted Charge, Second  
Layer, Fitted in German Ka Warhead

## UNLOADING EXPLOSIVE CHARGES

(Block-Fitted Charges, Cont'd.)

### Mine Type JA

#### Description

1. The charge consisted of 38 blocks of cast Shimose and weighed 396 lbs. It was fitted in two layers of 19 blocks each. A short threaded tube was cast in the center of each block to facilitate loading. The blocks were not wedged as in the German ordnance but were individually wrapped in waxed paper. No further wedging was necessary to insure a tight fit in the charge container.

#### Unloading Procedure

1. Each block was removed individually by screwing a rod into the threaded tube and lifting it out. In a charge of this type, the order of removal of the individual blocks is not important.

### Japanese Warhead, Type 97

#### Description of charge

1. The charge consisted of blocks of cast Shimose and weighed about 800 lbs. It was fitted in six layers, lettered "A" through "F" respectively, and each block in each layer was designated by a letter and number to facilitate loading. Each block was cast with a threaded tube in the center and individually wrapped in waxed paper, no wedges being necessary for fitting. Plywood sections were used, as in the German warhead, to lower the center of gravity.

#### Unloading Procedure

1. A threaded bolt was screwed into the tube of each block to aid in removal. The key block of each layer was removed first. An exploder pocket which penetrated the "E" layer presented some difficulties, and it was necessary to unscrew this pocket from the warhead before removing the remaining layers.

#### Precautions

1. Wear rubber gloves at all times while unloading charges.
2. If possible, have a respirator nearby during unloading to preclude the danger of inhaling dust from the explosive; wear goggles if available.
3. Upon completion of the operation all exposed parts of the body should be thoroughly washed with hot water and solvol (lava) soap.
4. Both Hexanite and Shimose are extremely toxic and may cause a serious form of Dermatitis. Following is a prescription for a Perborate Cream which has proved effective both as a preventative and as a cure for Dermatitis of this kind:

- (a) Ingredients, when mixed in the following proportions, will produce about one kilogram of cream.

H <sub>2</sub> O	750 cc.
Borax, Pure	50 g
Sodium carbonate (monohydrate)	4 g
Glycerine	72 cc.
Stearic acid	130 g
Gum tragacanth	4 g
Sodium perborate	100 g
Oil of lavender	4 drops.

All chemicals should be U.S.P. grade.

- (b) Place the distilled water, borax, sodium carbonate and glycerine in the top of a double boiler and heat, stirring constantly until all solids have dissolved. Add the stearic acid, stirring occasionally. When all reaction has ceased and the mixture is free from lumps, add the gum tragacanth and the oil of lavender. Remove from heat and stir constantly until cool. Add the sodium perborate and stir until a uniform, non-gritty mixture is obtained.

UNLOADING EXPLOSIVE CHARGES

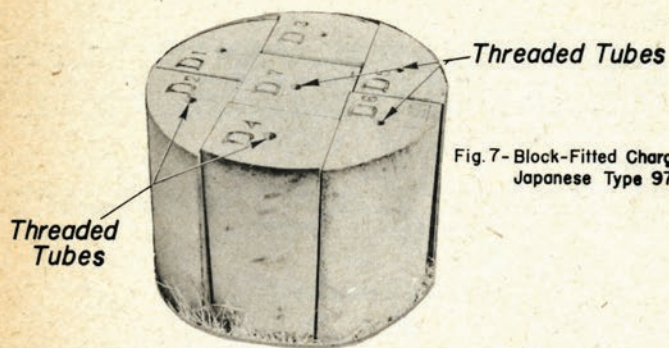
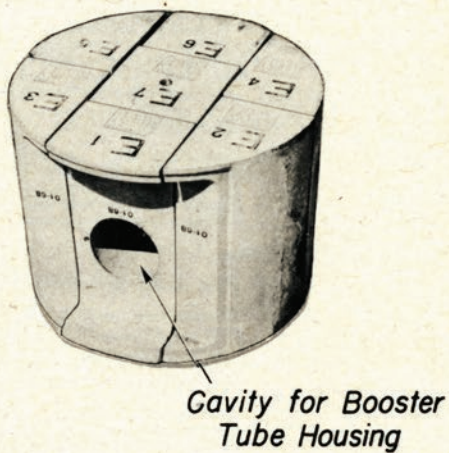


Fig. 7- Block-Fitted Charge, "D" Layer, Japanese Type 97 Warhead

Fig. 8- Block-Fitted Charge, "E" Layer, Japanese Type 97 Warhead



Threaded Tube

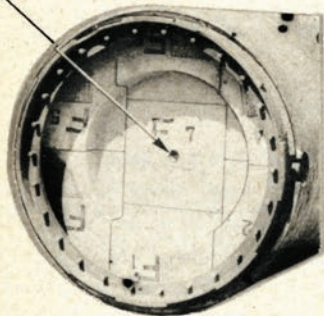


Fig. 9- Block-Fitted Charge, "F" Layer, Japanese Type 97 Warhead

# MINE DISPOSAL HANDBOOK

## PART I

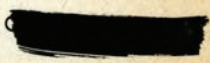
### GENERAL INFORMATION

• • • • •

### CHAPTER 9

#### THE BUIE RECIRCULATING DIVING SUIT

APRIL 1, 1945



THE BUIE RECIRCULATING DIVING SUIT, MARK 1 (1-1)

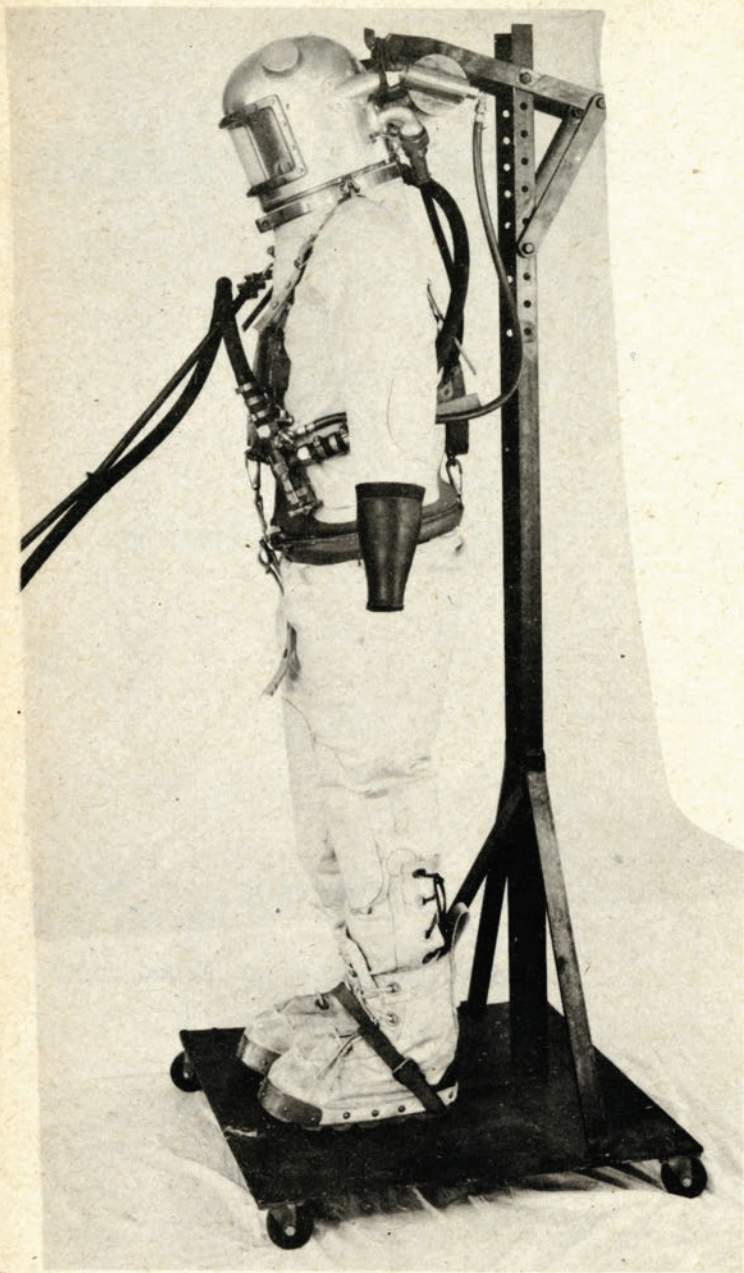


Fig. 1 - Buie Suit Assembled, Left Side View

THE BUIE RECIRCULATING DIVING SUIT, MARK 1 (1-1)

Introduction

1. As the Mine Disposal Organization developed and the scope of its activities became apparent, it was evident that the Navy standard diving outfit did not meet the requirements of mine disposal work for the following reasons:
  - (a) The emergency nature of the work to be performed necessitated a lightweight, portable outfit which could be operated by a small crew; especially needed was a readily portable air supply.
  - (b) The intricate and exacting nature of the work to be performed required that the diver have maximum mobility and visibility on the bottom under all conceivable diving conditions.
2. In addition to the above requirements, it was felt that the outfit to be used should be able to operate from any one of the various means of air supply; i.e. standard oxygen flask, air flask, compressor or hand pump, and that it should be non-magnetic insofar as possible.
3. It was thought at first that a self-contained diving suit would solve the problem, but extensive investigation indicated that the solution lay elsewhere. The subject diving suit and its modifications are the results of experiments by Lt. (jg) E. D. Buie, U.S.N. (Master Diver) assisted by the Experimental Diving Unit, Navy Yard, Washington, D.C.

General

1. The Buie suit combines a modified type of helmet, which uses the recirculating principle of the Navy standard helium-oxygen helmet, with a special lightweight dress made by the Diving Equipment and Supply Company, Milwaukee, Wisconsin. One complete outfit, exclusive of air supply, weighs less than 250 lbs. and may be packed readily in a single, large chest. Although this outfit was designed primarily for use with air bottles, other sources of air supply may be used with good results. The outfit meets all the requirements listed previously and has proven most satisfactory in exhaustive tests, both experimental and operational.

Description

1. The complete outfit consists of the following main parts:
  - (a) The helmet - spun copper, tin-plated. Fittings are non-magnetic and as follows:
    - (1) A large, curved, plastic window giving full vision to the diver.
    - (2) A standard telephone gooseneck.
    - (3) A standard air hose gooseneck with special non-return valve.
    - (4) An exhaust valve whose valve body and air escape channel differ from those on the standard helmet, all other parts being standard. The following changes and adjustments have been made to permit use of this valve with the Buie suit:
      - (i) One and one half turns have been cut off the primary spring to compensate for the lighter weight of the Buie suit. The valve was originally designed for use with the Navy standard outfit. Since the Buie suit is much lighter, (150 lbs. of gear on the diver as compared to 190 lbs. with the Navy standard outfit), it was necessary to weaken the primary spring so that the diver's dress would not be overinflated while diving on "open circuit" using the standard handwheel settings.
      - (ii) The length of the valve stem has been adjusted so that the end of the valve stem adjusting sleeve set screw barely makes contact with the secondary valve spring follower disc when the adjusting handwheel is one and one-eighth turns open. This adjustment makes it possible for the diver, while diving on "circulate" to retain all the air in his suit until he exhausts it with the chin button.
    - (5) Threaded tubular fittings for securing the recirculator canister assembly.

THE BUIE RECIRCULATING DIVING SUIT, MARK 1 (1-1)

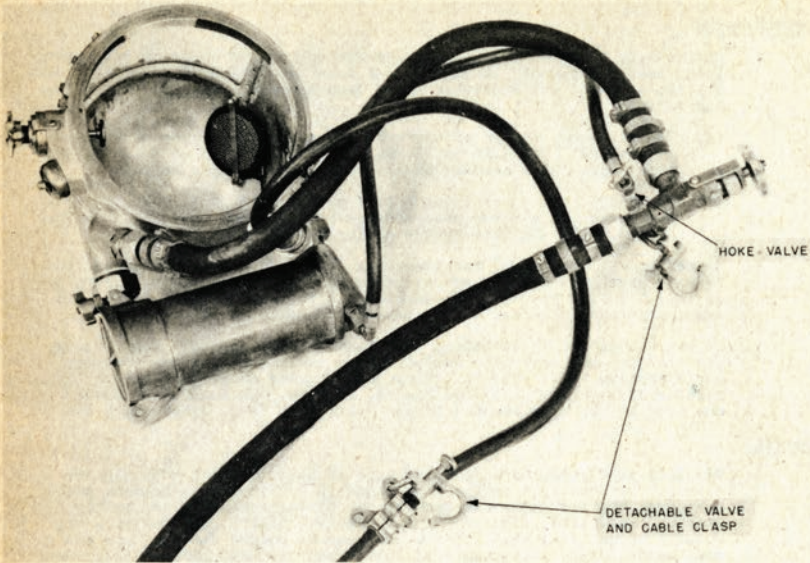


Fig. 2 - Buie Suit Helmet, Bottom View and Valve Assembly

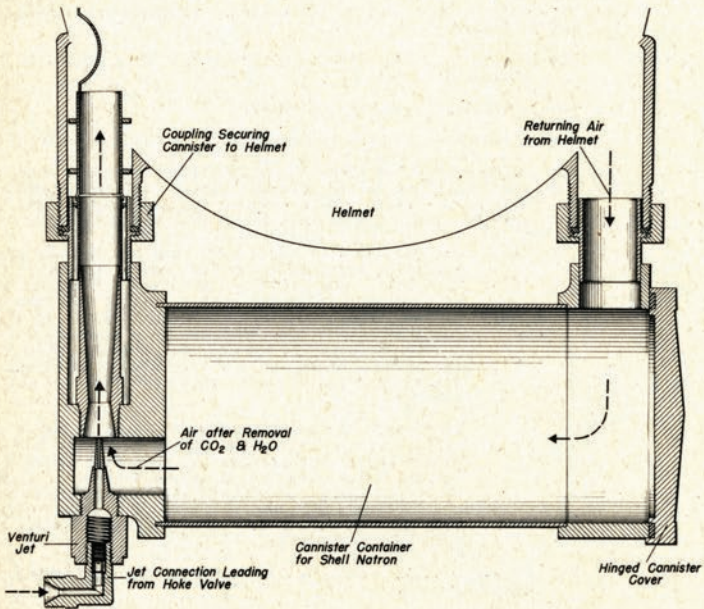


Fig. 3 - Air Recirculator Assembly, Sectional View

THE BUIE RECIRCULATING DIVING SUIT, MARK 1 (1-1)

(Description, Cont'd.)

- (6) A screw type helmet lock.
  - (7) A telephone recess.
  - (8) An interrupted screw joint for securing to the helmet ring.
  - (b) The helmet ring - replaces the breast plate used with the Navy standard outfit. A recessed fitting on the neck flange receives the helmet lock. Two fittings, one on either side, accommodate the shoulder straps. A rubber seat around the lower section receives the collar of the upper dress, the collar being secured by a brass clamp and double-ended machine screw to the seat. The inside of the ring is covered with a layer of sponge rubber for the protection of the diver.
  - (c) The dress - in two sections, upper and lower, made of a single layer of light, rubberized cotton fabric. The collar of the upper dress is secured to the helmet ring as noted above and a band of sheet rubber is vulcanized to the bottom of the dress fabric. Cuffs or gloves may be attached to the dress. The lower dress is reinforced with chafing patches and has a band of sheet rubber at the top which makes a watertight seal with the upper section of the dress.
  - (d) The waist band, wire strap and clamp assembly - joins the two sections of the dress.
  - (e) The weights - two, lead, heart-shaped weights are secured, with the large ends up, to the diver's chest and back respectively. The chest weight has four eyes cast in it and the back weight three.
  - (f) The recirculator canister - a cylindrical, brass housing fitted with two recirculating tubes, each of which is equipped with a coupling nut for securing the canister to the recirculator fittings on the helmet.
  - (g) The shellatron canister - cylindrical, designed to fit inside the recirculator canister. The ends of the canister are perforated to allow free passage of the recirculating air. One end is fitted with a removable self-locking cover to which a spring-type spacer ring is attached.
  - (h) The shoulder straps - two, adjustable canvas straps with snap hooks on each end for supporting the lead weights.
  - (i) The underarm straps - two, adjustable canvas straps with snap hooks on each end. These straps are secured to the eyes of the weights to prevent excessive lateral motion.
  - (j) The jock strap-canvas - in two parts. The short part has a snap hook on one end and a buckle on the other. The long part has a snap hook on one end and grommet holes in the other.
  - (k) The shoulder pad - standard helmet cushion or football type.
  - (l) The shoes - canvas topped, with a single strap and buckle.
2. The Buie Recirculating Suit Mk. 1-1 differs from the Mk. 1 as follows:
- (a) A splicock has been installed on the lower right hand side of the face plate.
  - (b) A top window has been installed in the helmet.
  - (c) The shape of the recirculating tubes has been changed slightly.

Standard Accessories

- 1. The following accessories are standard for use with the Buie suit:
  - (a) A Marine Diving Telephone Amplifier set, manufactured by the Diving Equipment and Supply Company, Milwaukee, Wisconsin, complete with power leads and transceivers.
  - (b) A six-volt battery for use as a power source for the amplifier.
  - (c) A standard air control valve fitted with a Hoke valve on its pressure side.



THE BUIE RECIRCULATING DIVING SUIT, MARK 1 (1-1)

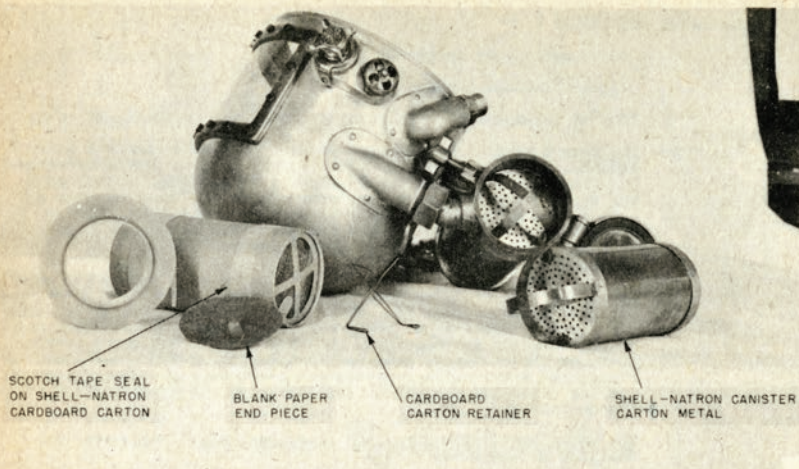


Fig. 4 - Buie Suit Helmet and Canister Assemblies, Side View



Fig.5- Buie Suit: Dressing, 1st Step

THE BUIE RECIRCULATING DIVING SUIT, MARK 1 (1-1)

(Standard Accessories, Cont'd.)

- (d) A 200 ft. length of air hose plus an additional three ft. length.
- (e) A 200 ft. length of standard telephone and life-line cable.
- (f) A two and a half ft. length of 3/8" air hose fitted with female oxygen couplings at each end for use between the Hoke valve and the jet connection.
- (g) Two special clamps for securing the air control valve and the telephone and life-line cable to the diver's harness.
- (h) A manifold fitted with couplings for two standard oxygen bottles and with a regulating valve, a bypass valve and line and the necessary valves for controlling each part of the air supply line.
- (i) A double clamp for binding together the two air bottles.
- (j) Reducers and adapters as follows:
  - (1) One fitted with a female oxygen hose coupling on one end and a male diving coupling on the other.
  - (2) One fitted with a male oxygen coupling on one end and diving threads on the other.
  - (3) One standard "S" and one standard "T" reducer.
  - (4) One double female and one double male diving hose coupling.

Rigging the Gear

1. Check all gear for completeness and readiness.
2. If the recirculator canister is not already attached to the helmet, check to make sure that the leather washers are in place in the locking nuts and couple the canister to the recirculator tubes. In tightening the locking nuts, tighten each a little at a time to prevent breaking the soldered joints on the recirculator tubes.
3. Secure the collar of the upper dress to the helmet ring by means of the clamp and machine screw.
4. Lay out the air hose and telephone and life-line cable. If air bottles and a manifold are employed, clamp the bottles together, connect them to the manifold and connect the topside end of the air hose to the manifold outlet. If another type of air supply is used, connect an oxygen regulating valve between the air hose and air supply.
5. Connect the topside end of the telephone and life-line cable to the amplifier and rig the leads between the amplifier and storage battery.
6. Connect the diver's end of the telephone and life-line cable to the telephone gooseneck on the helmet.
7. Connect the helmet end of the three foot length of air hose to the air gooseneck on the helmet.
8. Connect one end of the length of 3/8" air hose to the Hoke valve and the other end to the venturi jet connection on the left side of the recirculator assembly.
9. Before dressing the diver, test the telephones, set the diver's air pressure at 50 lbs./in<sup>2</sup>. Test the control valve, exhaust valve and non-return valve in the same manner as with the Navy standard outfit.
10. Place a piece of blotting paper, previously cut to size, in the shellatron container to absorb excess moisture. This paper should completely cover the sides of the container.
11. Fill the container completely. Do not, however, tamp or pack the shellatron to the point where the shells break down into powder.
12. Insert the container into the canister with the spring retainer toward the open end and lock the canister cover plate tightly. When placing the container in the canister, check to see that the canister is clean and that the rubber gasket is in place on the cover plate.
13. As soon as the container is in place and all fittings are checked for tightness, test the recirculator by setting the diver's air pressure at



Fig. 6-Buie Suit: Dressing, 2nd Step



Fig. 7-Buie Suit: Dressing, 3rd Step

THE BUIE RECIRCULATING DIVING SUIT, MARK 1 (1-1)

(Rigging the Gear, Cont'd.)

2

50 lbs./in., closing the control valve, opening the Hoke valve and placing the hand or a piece of paper over the recirculator intake opening. If the recirculator is operating properly, a distinct suction will be detected.

Dressing the Diver

1. Put on underwear or socks as needed
2. Put on lower dress; lace up flaps.
3. Put on shoes.
4. Place the waist band around the rubber band of the lower dress and fold the rubber band over the waist band, taking care to make a good overlap and yet not to get the dress fabric in the groove.
5. Put on shoulder pad(s).
6. Put on upper dress as follows:
  - (a) Insert the diver's arms in the sleeves. If cuffs are fitted, soap the diver's hands and wrists to facilitate insertion.
  - (b) Bend the diver's head forward and work the dress over his shoulders, guiding his head through the helmet ring.
7. Stretch the rubber band of the upper dress over the rubber band of the lower dress with the waist band beneath.
8. One dresser now steadies the waist band while the other secures the wire strap and clamp around the waist band so that the rubber bands of the upper and lower dress are compressed tightly in the waist band groove. As the clamp is applied, place a piece of snapper rubber beneath the point where the cable and the clamp housing meet in order to prevent pinching the dress. When the strap and clamp are in place, screw the safety lock home.
9. Put on wrist snapper rubbers or wrist straps as applicable.
10. Attach the chest and back weights simultaneously, large ends up, by means of the snap hooks.
11. Attach the underarm straps (one under each arm) to the upper or lower eyes on the respective weights. If the diver is of average size or smaller than average, the straps should be secured to the upper eyes. If the diver is larger than average, secure the straps to the lower eyes to avoid binding.
12. Secure the diver's knife to the right underarm strap.
13. Secure the long section of the jock strap to the bottom eye of the back weight and the short section to the bottom eye of the chest weight. Pass the long section between the diver's legs, adjust it for length and buckle it to the short section. The jock strap need not be adjusted as tightly as with the Navy standard outfit.
14. Turn on the air supply.
15. Place the helmet over the diver's head and secure it to the helmet ring in the same manner as with the standard helmet and breast plate. One of the tenders should steady the helmet by holding the shoulder straps tightly so that it will not slip or turn as the helmet is seated.
16. Tighten the screw lock and insert the cotter pin.
17. Lead the three foot length of air hose under the diver's left arm. Secure the control valve to the eye on the left side of the chest weight by means of the clamp linked to the valve.
18. Lead the telephone and life-line cable under the diver's right arm. Secure the cable to the ring on the right shoulder strap by means of the special clamp attached to the cable.
19. Test the telephones and valves.
20. Put the diver over the side. When his helmet is completely submerged, have him exhaust the excess air in the suit and pull in the chin button. Check for leaks. If water is entering the suit or if leaks are

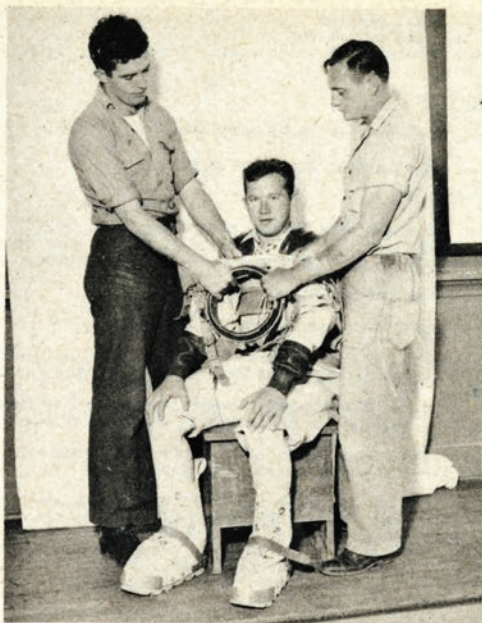


Fig. 8 - Buie Suit: Dressing, 4th Step



Fig. 9 - Buie Suit: Dressing, 5th Step

THE BUIE RECIRCULATING DIVING SUIT, MARK 1 (1-1)

(Dressing the Diver, Cont'd.)

apparent around the recirculator canister, the diver must be brought back and the leaks remedied.

Operation

1. The Buie suit, rigged as directed above, can be used in two ways as follows:
  - (a) "Circulate" - when used in this manner, the control valve is closed, the Hoke valve is fully opened and the exhaust valve handwheel is closed. The air supply, which must at all times be maintained at a pressure of at least 50 lbs./in<sup>2</sup> over bottom pressure, bypasses the control valve through the Hoke valve and then passes through the 3/8" air hose to the venturi jet connection on the recirculator canister. The air then passes through the jet orifice and into the helmet via the recirculator tube, creating a suction which draws air from the opposite side of the helmet through the shell natron container. In this manner, constant recirculation of air through the recirculator and helmet is maintained with the shell natron removing excess moisture and carbon dioxide from the used air. If the recirculator is operating properly and if no appreciable leaks are present in the dress, excess air must be exhausted by the diver about once per minute.
  - (b) "Open circuit" - when used in this manner, the outfit operates much in the same manner as the Navy standard outfit. The control valve is opened according to the diver's needs, the exhaust valve handwheel is opened three or four turns and the Hoke valve may either be opened or closed at the diver's discretion. The air supply flows through the control valve, the three foot length of air hose, the non-return valve, the helmet and out through the exhaust valve. Air pressure and supply are computed in the same manner as with the Navy standard outfit. If desired, the recirculator canister can be removed and the helmet used as with the Navy standard outfit. Upon removal of the canister, the recirculator tubes on the helmet are capped, the length of 3/8" air hose is removed and the Hoke valve is closed.

General Information and Instructions

1. When diving on "circulate" with air pressure at the source of 50 lbs./in<sup>2</sup> over bottom pressure, air input to the helmet via the Hoke valve and venturi is 12-13 liters per minute. If no appreciable leaks are present in the dress, this gradual increase in air volume may be exhausted by depressing the chin button about once per minute. The diver should carry himself as heavy as comfort and safety will allow because the recirculator operates most efficiently with a comparatively low air pressure in the dress. It should be noted that readjustment of the exhaust valve stem removes the non-blowup feature found in the standard exhaust valve. Removal of this feature will allow the dress to fill with excess air and blow the diver up unless he is careful to exhaust at regular intervals.
2. When diving on "circulate", the volume of air flowing through the helmet varies from six to seven cubic feet per minute on the surface. Circulation drops slightly on a curve as the diver descends, becoming almost constant at a depth of 165 ft. and never dropping below 4.5 cubic feet per minute. When the diver is descending on "circulate", he may find it necessary to open the control valve slightly from time to time to equalize the pressure, especially if he is descending rather rapidly.
3. If, for any reason, the recirculator should fail while the diver is on the bottom, warning will be provided by cessation of the slight roar which accompanies recirculator operation and by the early symptoms of CO<sub>2</sub> poisoning, some of which are headaches, excessive panting and fogging of the face plate. In such a case, the diver should immediately notify topside and then switch to "open circuit" by opening the control valve as desired and by opening the exhaust valve three or four turns. The Hoke valve may be closed or left open at the diver's discretion. The diver should always notify topside before changing from "circulate" to "open circuit" so that the tender in charge of air supply may be prepared to make the proper adjustments. This is especially important in flask diving.
4. The shell natron air purifier is a CO<sub>2</sub> absorbent, hygroscopic, highly caustic compound which is commercially manufactured in white or pink-white shells. When exposed to the air, it dissipates rapidly, taking the form of a moist, gray powder. For this reason, it should be tightly sealed and kept dry when not in use. When diving on "circulate", a

THE BUIE RECIRCULATING DIVING SUIT, MARK 1 (1-1)

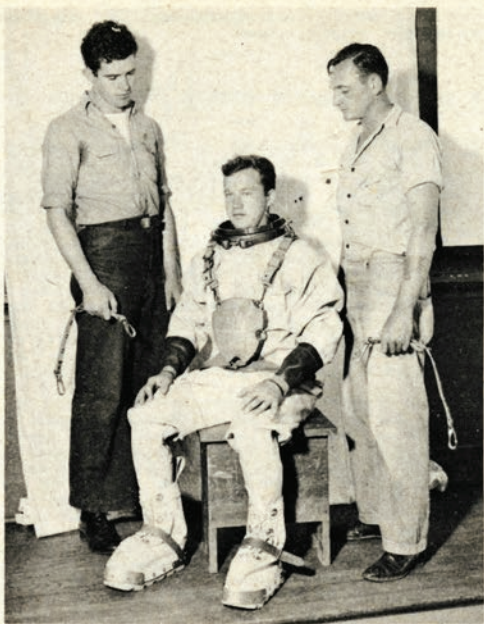


Fig. 10 - Buie Suit: Dressing, 6th Step

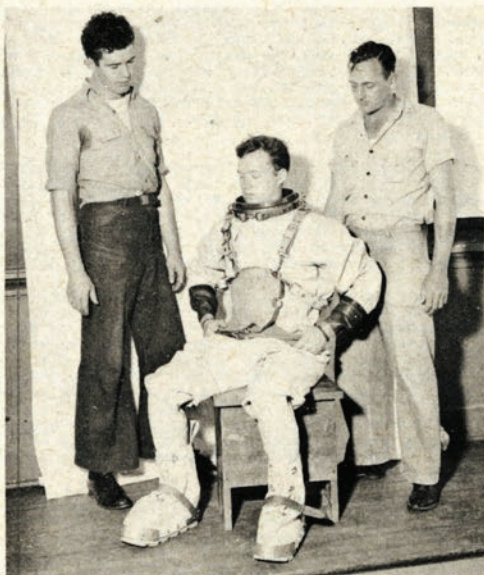


Fig. 11 - Buie Suit: Dressing, 7th Step

THE BUIE RECIRCULATING DIVING SUIT, MARK 1' (1-1)

(General Information and Instructions, Cont'd.)

single shell natron container is effective for about three hours if high-pressure air (about 1800 lbs./in<sup>2</sup>) is being used. If comparatively low-pressure air (400-500 lbs./in<sup>2</sup>) is being used, the life of the shell natron will be somewhat shorter due to the higher moisture content of this type of air.

5. The caustic properties of shell natron make it highly injurious to skin tissues. When checking the diver's dress prior to descent, always check carefully for leaks around the recirculator canister. Never allow the diver to descent if such leaks are apparent.
6. The venturi jet orifice is 0.0225 in diameter and is protected from fouling by a wire screen placed over the elbow leading to the jet. It is possible, however, that the jet may become fouled by corrosion or some other means, necessitating periodic cleaning. A #74 drill, mounted either in an automatic pencil or on a metal rod may be run through the jet orifice from the pressure side to remove foreign matter. This should be done prior to each diving operation and oftener if use of the suit is infrequent. Attention is invited to the fact that even a minute change in orifice diameter may impair the efficiency of the recirculator. Extreme care, therefore, must be exercised while cleaning.
7. If the Buie suit is to be used for salvage work or in any instance where snagging is likely, a pair of heavy canvas coveralls should be worn for protection. It may also be advisable to wrap the jock strap with cloth to prevent chafing the dress.
8. When diving at depths of more than 90 ft. in a tideway, additional weights are advised in order to insure the diver adequate negative buoyancy for maximum mobility on the bottom.
9. Oxygen may be used as a breathing medium but only within the time and depth limits elsewhere prescribed. Its use is not recommended where an adequate air supply is available.
10. Buie recirculating suits are assembled, tested and shipped by the Mine Disposal School. Parts which are not standard diving gear are also stocked by the Mine Disposal School. Shell natron is also used in aviation rebreather outfits and may be obtained at most aviation facilities.



Fig.12- Buie Suit: Dressing, 8th Step



THE BUIE RECIRCULATING DIVING SUIT, MARK 1 (1-1)

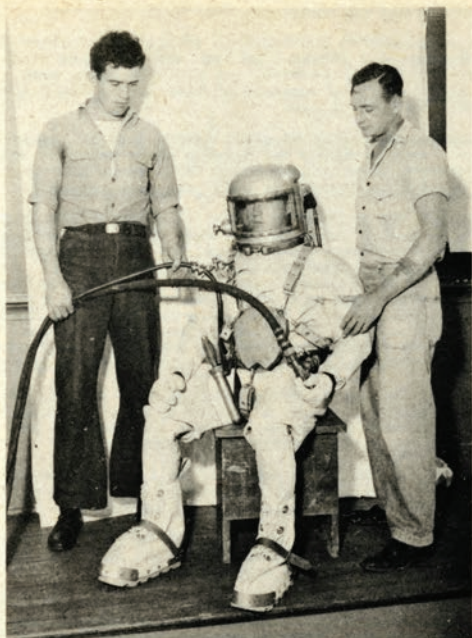


Fig.13-Buie Suit, Diver Completely Dressed, Front View

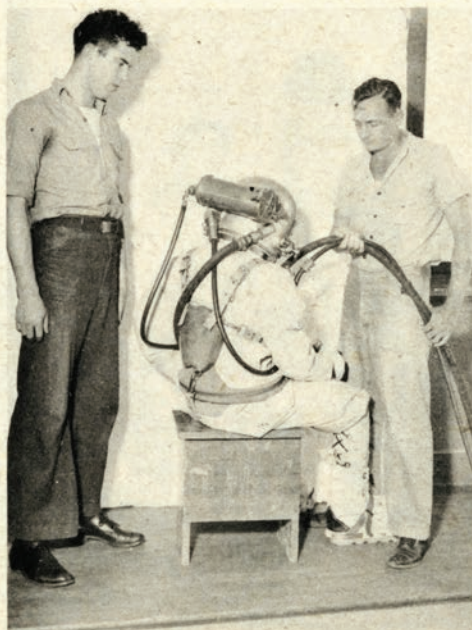


Fig.14-Buie Suit, Diver Completely Dressed, Back View

# MINE DISPOSAL HANDBOOK

## PART I

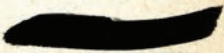
### GENERAL INFORMATION

.....

### CHAPTER 10

#### MINE WATCHING

APRIL 1, 1945



## MINE WATCHING

### Introduction

1. All locations do not need Mine Watch Systems, but the importance of Mine Watching in areas subject to aerial mining should not be underestimated. Practical experience has shown that prompt and orderly action after an air raid prevents much serious damage to shipping and installations. Such action is largely dependent upon rapid and accurate collection of information through an effective Mine Watch System.
2. The following outline presents minimum requirements for an adequate skeletal Mine Watch System. Points to be noted are the emphasis upon simplicity of organization and operation - with a view to allowing for rapid expansion in case of need - and the utilization of existing facilities wherever possible.

### Air Raid Mine Watch System

#### General

1. This will consist of posts at selected strategic locations which together provide complete coverage of all navigable portions of vulnerable harbors and waterways. From these posts, dropped mines will be reported as outlined below:

#### Organization

1. Establishment of posts.
  - (a) Considerations in selecting sites: (1) Does the spot overlook a channel, anchorage, or other waters used by ships? (2) Is that water of suitable depth for aircraft mining - i.e. 40 fathoms or less? (3) Is the view from the spot adequate in terms of visual obstructions, distance to channel, etc.? (4) Is personnel available nearby to man the post during an air raid?
  - (b) Posts need not be closer together than 400 yards, and should not be closer than 50 yards to an anti-aircraft battery.
  - (c) Tentative selection of sites can be made from charts of the locality. Inspection of them from land and water will eliminate some and suggest others.
  - (d) Posts at varying elevations in the same area are desirable. Distance can be judged more accurately from a high point of vantage; more accurate bearings can be obtained from a lower point.
  - (e) A pelorus ("splash spotter"), available through the Bureau of Ordnance, should be mounted in each post, with the 180° point of the azimuth circle toward true north. Mounting considerations should be simplicity, durability, and protection from elements.
  - (f) Written instructions, report forms, watch, pencil, and flashlight should be furnished to the watcher assigned each post.
  - (g) Each post could well be furnished with a table of distances from the post to several prominent objects to assist watchers in judging distance to mine splashes.
  - (h) Personnel may in most localities be drawn from Army, Navy, Coast Guard, or civilian personnel habitually stationed in the vicinity of the Mine Watch posts. It is to be understood that posts are manned only during an air raid or alert; if necessary, one person can man a post.
  - (i) Familiarity with written instructions plus a brief training in the use of the splash spotter will suffice for watchers. Need for accuracy in observing and recording time and bearing of splashes and in routing reports should be stressed. Brief talks on pertinent facts regarding enemy mines, delivered by the Mine Disposal Officer, will generally increase interest in mine watching.
  - (j) The area covered by the Mine Watch System should be divided into its natural geographic sections, assigning each a number. Each post within a section should also be numbered. The designation of each post will then be a hyphenated number, e.g., "Post 1-1" (1st section, Post No. 1), "Post 6-3" (6th Section, Post No. 3), etc.

## MINE WATCHING

### Report Procedure

1. In establishing procedure, primary consideration should be given to ease and rapidity of reporting and to the greatest feasible use of existing communications facilities.
  - (a) A report central should be established to which all posts report by the fastest possible means after an air raid and from which countermeasures are directed.
  - (b) Personnel should be assigned to the report central on the air raid bill and instructed in advance in filling out reports and in the method of plotting locations of reported mines on charts.
  - (c) Where mine watching personnel is divided among several organizations - Army, Coast Guard, etc. - it will probably be found desirable to have each group report to its own headquarters through its existing reporting system and to have the report relayed from there to the report central.
  - (d) In lieu of telephone communications, isolated posts may have to be contacted by messenger after a raid. All oral reports should be confirmed both by a check-back call and by a written report forwarded by mail.
2. For determination of countermeasures a board of competent officers should be designated in advance to study locations of suspected mines and to decide which will be swept, which recovered, and in what order. Advance arrangements should be made for patrol of danger areas and control of shipping.

### Records

1. Essential records consist of:
  - (a) A chart upon which locations of all Mine Watch posts are plotted accurately. Designation numbers of posts and boundary lines of sections should be indicated. The scale of the chart should be large enough so that bearings of splashes can be plotted accurately and their relation to existing structures studied.
  - (b) A card record, kept up to date, containing the number of each post, the type of personnel assigned, and the name and address of the watcher and/or person in charge of post.
  - (c) A card record of trained personnel, including officers, available to the report central and relay points to facilitate replacements necessitated by transfers.

### Assignment of Organization and Operational Responsibility

1. Even though the Mine Watch System overlaps several commands, it should be made the responsibility of a single officer. The Mine Disposal Officer's duties in the event of an air raid will preclude his assuming this responsibility, but his services and knowledge should be utilized in establishing the system.

### Operation

1. As reports come in during an air raid, locations of suspected mines will be plotted on the large chart. The board of officers will decide the order in which the mines should be disposed of and whether they will be swept or recovered.
  - (a) Naval policy in general is to recover samples of all enemy mines when this is feasible, the purpose being to gain intelligence information.
  - (b) Necessary channels should in general be swept; remaining suspected areas may be restricted and patrolled until mine disposal personnel have had an adequate chance at recovery.
  - (c) Whenever serious materiel damage would result from detonation of a mine, recovery or disposal without detonation should be attempted.
  - (d) Final disposition of a reported mine should be recorded on the report form and in such other records as may be established.

### Drills

1. Periodic drills, with mine splashes simulated in any of various possible ways (exploding small charges on floats, dropping sand bags, briefly displaying signals from boats, etc.), will increase interest and efficiency. The complete procedure, from sighting and reporting the splashes to the final decision as to disposition, should be carried out. Accuracy of watchers' reports should be checked by recording exact time

## MINE WATCHING

### (Drills, Cont'd.)

and location of simulated splashes.

### Maintenance

1. Periodic inspections, at least quarterly, should be made of all posts to insure that equipment is in order, that personnel understand their duties, and that instructions and report forms are on hand.

### Beach Mine Watch System

#### General

1. This should be superimposed upon existing coastal patrol and lookout organizations and should consist of instructions to all beach patrols, lookout stations, and patrol boats - Army, Navy, and Coast Guard - on the general appearance of mines and how to deal with and make reports of objects suspected of being mines or other explosive ordnance.

#### Organization

1. This can be accomplished in most cases by the circulation among coastal observers, through appropriate channels, of letters containing the following information:
  - (a) A description of the characteristic appearance of the most common types of mines (shape, range of sizes, important external fittings, color), and, near our own Mark 6 fields, of the D-4 antenna float.
  - (b) The necessity of guarding any beached object (or keeping watch on floating object) to keep personnel away pending arrival of trained recovery personnel. The possibility of magnetic or acoustic actuation should be emphasized.
  - (c) Where the nearest Mine Disposal Unit may be located.
  - (d) Facts to be reported to the Mine Disposal Unit, including; location of object; time of discovery; accurate description of object: name, address, telephone number of persons sighting and reporting object.
  - (e) Publicity relative to mines or suspicious objects is prohibited.
2. OP-898 (Mine Identification Manual) should be widely distributed - probably to each recipient of the above-mentioned letters.
3. Where appropriate, the public should be warned by press and radio to beware of unknown objects afloat or ashore and should be given instructions for reporting such objects.

#### Operation

1. Wherever possible, reported descriptions should be verified by telephone conversation with the person discovering and reporting the object in order to eliminate needless traveling.
2. A procedure should be established for quarterly reminders to all personnel associated with the Beach Mine Watch System concerning the salient facts of the system. Where the rapidity of turnover of personnel warrants it, the reminders should be more frequent.

MINE DISPOSAL HANDBOOK

**E.C.HADERLIE**

PART II

UNITED STATES UNDERWATER ORDNANCE

TABLE OF CONTENTS

PART II - UNITED STATES UNDERWATER ORDNANCE

CHAPTER 1

U. S. INFLUENCE MINES

	Page
Mine Chart (Table I) .....	2
Introduction .....	3
Mk 10-3 (10-6, 10-7, 10-8 & 10-9) .....	5
Mk 12-0 .....	9
Mk 12-1 .....	11
Mk 12-3 & 12-4 .....	13
Mk 13-0 (13-3 & 13-4) .....	13
Mk 13-5 (13-6) .....	15
Mk 16-2 .....	160
Mk 18-0 .....	17
Mk 21-0 .....	19
Mk 25-0 .....	21
Mk 25-1 .....	25
AN Mk 26-1 (Mk 36-0 & 36-1) .....	27
Mk 27-0 .....	31

CHAPTER 2

U. S. CONTACT MINES

Mine Chart (Table II) .....	2
Introduction .....	3
Mk 5-0 .....	3
Mk 6-0 .....	5
Mk 6-2 .....	7
Mk 6-3 .....	9
Mk 6-4 .....	9
Mk 7-0 .....	11
Mk 10-1 .....	11
Mk 11-1 .....	13
Mk 16-1 .....	17
Mk 19-0 (19-1 & 19-2) .....	19
Mk 23-0 .....	23

CHAPTER 3

U. S. TORPEDOES

Torpedo Chart (Table I) .....	2
Warhead Chart (Table II) .....	2
Warhead Extensions Chart (Table III) .....	2a
Exploders Chart (Table IV) .....	3
Introduction .....	2b
Identifying Features .....	2b
General Precautions .....	2b
Torpedo Mk 8 Mods 3C and 3D .....	2d
Torpedo Mk 13-0 .....	2e
Torpedo Mk 14-3A (Mks 23-0 and 23-1) .....	2k
Torpedo Mk 15 Mods 1 and 2 (Mk 15-3) .....	2o
Torpedo Mk 18-1 (Mk 18-2) .....	2q
Exploders Mk 3-1, 3-2, 3-3, 3-4 .....	3
Exploders Mk 4-0 & 8-0 & Mods .....	7
Exploders Mk 6-0 & Mods (except Mk 6-5 & 6-6) .....	9
Exploders Mk 6-5 & 6-6 .....	11
Exploder Mk 5-0 & Mods .....	11
Exploder Mk 10-3 .....	13

CHAPTER 4

U. S. DEPTH CHARGES

Depth Charge Chart (Table V) .....	2
Introduction .....	3
Depth Charges Mk 6-0, 6-1 6-2, 7-0, 7-1 & 7-2 .....	3
Depth Charge Mk 8-0 .....	7
Depth Charges Mk 9-0, 9-1, 9-2 & 9-3 .....	11
Depth Charge Mk 10-0 .....	13
Depth Charge Sling .....	17

CHAPTER 5

U. S. DEPTH BOMBS

Depth Bomb Chart (Table VI) .....	2
Depth Bomb Fuzes (Table VII) .....	2
Introduction .....	3
Nose Fuze Mk 219-0 .....	3
Nose Fuze AN-M 103 .....	5
Transverse Fuze AN-Mk 224 .....	5



TABLE OF CONTENTS

(U. S. DEPTH BOMBS, CONT'D.)

	Page
Transverse Fuze AN-Mk 234 .....	7
Tail Fuze Mk 229-0 .....	7
Tail Fuze AN-Mk 230 .....	7
Tail Fuze Mk 231-0 .....	9

CHAPTER 6

U. S. AHEAD-THROWN ANTI-SUBMARINE WEAPONS

Introduction .....	3
7T2 Rocket (Mousetrap) .....	3
Nose Fuze Mk 131-0 .....	3
Nose Fuze Mk 135-0 .....	5
Nose Fuze Mk 140-0 .....	7
7T2 Projector Charge (Hedgehog) .....	7
Nose Fuze Mk 136-0 .....	9
Nose Fuze Mk 140-0 .....	9
Nose Fuze Mk 142-0 .....	9

CHAPTER 7

U. S. CONTROLLED MINES

Introduction .....	3
Mk 20-0 .....	3
Army Ground Mine M4 .....	5



# MINE DISPOSAL HANDBOOK

## PART II

### UNITED STATES UNDERWATER ORDNANCE

#### CHAPTER 1

#### U. S. INFLUENCE MINES

October 1, 1944

-1-



U. S. INFLUENCE MINES

Mine Type	Laid By	Nature	Firing Mechs	Diameter (in.)	Case Length (in.)	Base Diameter (in.)	Depth (ft.)	Type & Wt. of Charge (lb.)	Total Wt. (lb.)	Extender	Clock Starter	Clock	Other Fittings	Remarks
10-Moored	Sub	Needle	M5-0, M5-1	92 1/2	220 1/2	16	40	420 TNT	820	Ex 12 ModCS-1 Mod 5, Ex 14 5	CD-9	AC-1, 10-3 Anchor, AR-1, sw, B-4-1, SD 4 or 4-1	Field	
10-6	"	Aircraft	"	"	"	"	"	"	"	Ex 14 ModCS-1 Mod 2	"	AC-1, 10-5 Anchor, AR-1, sw, B-4-1, Para 3, 2, SD 4, or 4-1	Obsolescent	
10-7	"	P.T. Boat	"	"	"	"	"	"	"	Ex 14, EACS-1 Mod 14 Mod 2 5	"	AC-1, 10-4 Anchor, AR-1, sw, B-4-1, SD 4 or 4-1	"	
10-8	"	Aircraft	"	"	"	"	"	"	"	Ex 14 ModCS-1 Mod 2	"	AC-1, 10-5 Anchor, AR-1, sw, B-4-1, Para 3-2, SD 4, or 4-1	"	
10-9	"	"	"	"	"	"	"	"	"	"	"	"	"	"
12-Ground	Sub	"	M3 Mods 0, 1, 2, or 3	94 1/4	"	"	16 - 125 (500)	1095 TNT 1225 TFX	1115 or 1345	Ex 12, EACS-1, CS-CD-1, Mod 5 1 Mod 4, CD-9	CD-1B-3-1, SD-5	Field	Obsolescent	
12-1	"	Aircraft	"	131	"	"	"	"	1595 or 1725	Ex 12 ModCS-1 Mod 4, Ex 12 1, CS-1 Mod 4, CD-Mod 0, Para 5-0 or 5-1, SD-5	"	"	"	"
12-3	"	Sub	M3 Mod 2 or M3 Mod 4	94 1/4	"	"	"	1065 TNT 1195 TFX 1515	1305 or 1515	Ex 12 ModCS-1 Mod 5, Ex 14 5	CD-9	B-3-1, SD-4 or 4-1	Field	"
12-4	"	Aircraft	"	131	"	"	"	1065 TNT 1195 TFX 1695	1695	Ex 12 ModCS-1 Mod 4, Ex 14 4	"	B-3-1, Para Mk 1 Mod 0, Para 5-0, or 5-1, SD 4, or 4-1	"	"
13-0	"	"	Induc-M4, M4 Mod 1, or M4 Mod 2	68	19 7/8	"	"	640 TNT 700 TFX 1090	1030 or 1090	Ex 12 ModCS-1 Mod 2, Ex 12 2, CS-1 1, CD-6 Mod 4	"	"	"	"
13-3	"	"	"	"	"	"	"	"	"	"	"	"	"	None issued
13-4	"	"	"	"	"	"	"	"	"	Ex 12 Mod 2, Ex 12 Mod 4, Ex 14 Mod 2	"	"	"	Same as 13-0 for shal-low water.
13-5	"	"	Acous-A-3 of A-3 Mod 1	"	"	40 - 100	"	430 TNT 490 TFX 1000 or 1060	1000 or 1060	Ex 12 Mod 2, Ex 12 Mod 4	CD-5, CD-7B-15, B-18, SD-4 or 4-1	Field	"	"
13-6	"	"	A-3, A-3 Mod 1, or A-3 Mod 2	"	"	"	"	"	"	"	"	"	Para Mk 2 Mod 0, SD-4 or 4-1	Same as 13-5 for high alt.
16-Moored	Surface Craft	Induc-M-6 or M-6 Mod 1	"	51	36	40 - 240	"	600 TNT	2020	Ex 12 ModCS-1 Mod 3, Ex 14 3 Mod 1	CD-1 Mod 1, CD-6 B-6	AG-1, Anchor 16, B-6	None issued	"
16-2	"	"	Acous-A-3 Mod 1	"	"	"	"	"	"	Ex 12 Mod 3	"	CD-5, CD-7	Attenuator Mk 1 Mod 0, Anchor 16, B-15, B-18, SD-4 or 4-1, M1-2	Field

Table I - U.S. Influence Mines

U. S. INFLUENCE MINES

Mine	Type	Laid By	Nature of Induction	Firing Mechs.	Length (in.)	Diameter (in.)	Case Depth (ft.)	Type & Wt. of Charge (lb.)	Total Wt. (lb.)	Extender	Clock Starter	Clock	Other Fittings	Remarks
18-0	Ground Surface Craft	"	"	M-9	70	42	35 - 150 (500)	1350 TNT	2050	Ex 14 ModCS-1 Mod 1, Ex 12 3 Mod 3	CD-4	AC-1, B-6	Field	
21-0	"	"	"	SRA 1	"	Random	"	"	Random	"	"	HS-1, SC-1 or SC-1 DB-1	May use any charge or case	
25-0	Aircraft	"	"	M-11, or M-11 Mod 1, or Mod 2	82 1/2	7/16	40 - 100 (400)	1120 TNT 1250 TFX	1850 or 1980	Ex 12 ModCS-1 Mod 4, Ex 14 4 Mod 2	CD-1, CD-8	B-17, B-18, Circuit Breaker Mk 1-0, Para 2-0, SD-4-1	Field	
25-1	"	"	Acoustic	A-5	"	"	40 - 150 (400)	"	1790 or 1930	"	"	B-21, Para 3-3 or Para 3-4, SD-4-1, M-4	"	
25-2	"	"	See MDIB 1-S-45	A-6	86	"	"	1120 TNT 1275 TFX	1885 or 2015	"	"	CD-8 and B-6, Para 3-3 or Para 3-4, SD-4-1	"	
AN Mk 26-0	Ground Aircraft	"	Induction	M-9 Mod 1	68	18 5/8	16 - 120 (500)	465 TNT 525 TFX	1000 or 1060	Ex 12 ModCS-1 Mod 4, Ex 14 4 Mod 2	CD-10	B-6, SD-4 or 4-1	Superseded by AN 26-1	
AN Mk 26-1	"	"	"	"	"	"	"	"	"	"	"	B-6, Para 2-0, SD-4 or 4-1, Field	"	
27	"	Sub	"	"	20.2	20 13/16	30 - 140	880 TFX	2630	Ex Mk 14 CS-1 Mod 9	"	SD-4 or SD-4 Mod 1 TB 10, TB 11, 2 RC's, SR 7 or SR 7 Mod 1	Field	
36-0	"	Aircraft	"	"	74	18 5/8	16 - 120 (500)	510 TNT 635 TFX	1020 or 1085	Ex 12 ModCS-1 Mod 4, Ex 14 4 Mod 2	"	B-6, Para 2-0, SD-4 or 4-1	"	
36-1	"	"	"	"	"	"	"	"	"	"	"	"	"	

Table I (Cont'd.)

Added 1 July 1945  
(Change No. 8)

U. S. INFLUENCE MINES

Faint, illegible table with a grid structure, likely containing technical data or survey information. The text is too light to transcribe accurately.



## U. S. INFLUENCE MINES

### Introduction

1. This chapter includes information on the U. S. influence mines now in service. Since most of these mines are laid offensively and become inert after a set period, few disposal operations are necessary.
2. The mine cases are made of either aluminum or steel, are usually cylindrical, and have charges varying from 400 to 1400 lbs. of TNT or Torpex. Granular TNT boosters and mercury fulminate detonators are used in all cases.
3. The devices or mechanisms installed in these mines can be grouped with regard to their specific function in the four main stages of mine operation which are:
  - (a) Mooring
  - (b) Arming
  - (c) Firing
  - (d) Scuttling or sterilizing(a) and/or (d) above may not be pertinent depending on the type of mine, and the judgment of the Officer in Charge of the mine assembly detail.
4. Mooring devices
  - (a) Moored influence mines which are laid from surface craft (except the Mk. 10-7) take their mooring depth by the plummet method.
  - (b) Moored influence mines laid from submarines take their mooring depth by the loose-bight hydrostat method.
5. Arming devices
  - (a) Extenders (EX)

All the extenders now in service are hydrostatically operated, and fall into two classifications; the "lazy tong" type and the direct action type. Those fitted on mines laid from surface craft all have soluble washers, and those fitted in mines laid by aircraft have ~~arming wires~~ *arming wire*, and either a soluble washer or a spacer sleeve. Extenders fitted on submarine-laid mines have a special safety bar and locking ball arrangement to prevent premature arming. All extenders now in service are designed to retract upon release of hydrostatic pressure except when fitted with devices which lock the extender in.
  - (b) Clocks (CD) and clock starters (CS)

Clock starters are simply hydrostatically operated plungers which, when depressed, remove a stop from the escapement of the arming clock. The various Marks and Mods. are equipped with the same safety devices as the extenders with which they are used. The clocks are all spring-wound, and serve to arm the firing mechanism after a set period which may vary from 45 minutes to three hours, depending on the particular Mark and Mod. of clock used. As with the extenders the clock starter will retract upon release of hydrostatic pressure, will stop the clock if it is still in its run-off period, and thus prevent arming of the mine.
  - (c) Soluble washers

Although these are usually classed as safety devices, they also provide an arming delay. They are fitted on extenders and clock starters as noted above, and consist of five types, designed to provide 10-minute, 45-minute, one-day, two-day, and three-day delays respectively.
6. Firing devices
  - (a) Magnetic dip-needle device

This type of firing device operates when the total change in the surrounding magnetic field is sufficient to force a compass type needle down onto an electric contact, closing the firing circuit.
  - (b) Magnet induction device

This type of firing device operates when the rate of change of the surrounding magnetic field is sufficient to generate current in a search coil, and close the firing circuit through an electrical relay system.

U. S. INFLUENCE MINES

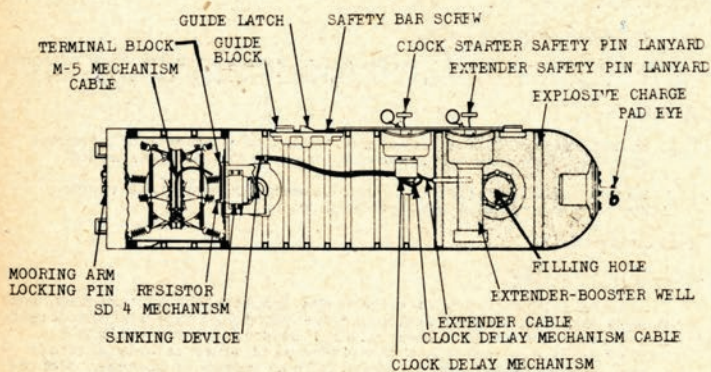


Fig. 1-- Mk. 10-3 Mine, Sectional View

U. S. INFLUENCE MINES

(c) Acoustic device

This type of firing device operates when sound waves impinge on a microphone and are converted into electrical energy, closing the firing circuit through an electrical relay system.

Any of the three types of firing devices listed above could be fitted with a ships-counter, although no acoustic units now in service are so fitted. The ships-counters fitted in the various magnetic devices may be set from 0 to maximum of 8 or 10, depending on the Mark and Mod. fitted.

7. Scuttling of sterilizing devices (SD)

Scuttling devices, of which there is but one type in service, render the mine inert by blowing a small hole in the mine case, causing it to sink. They operate by means of an anti-recovery switch fitted on the extender.

Sterilizing devices, the most common of which are the SD-4 and SD-5, consist of an electrolytic cell, which reacts on a copper plate. This plate holds back a spring-loaded plunger which is allowed to fly forward when the electrolyte has eaten away a sufficient amount of the copper. When the plunger fires, it closes switches which short circuit the mine detonator and battery, and fires the scuttling detonator (if fitted). If any one of these operations should not be completed, one of the others would make the mine a dud. The sterilizer may be set for periods varying from five to 100 days by varying the resistance in the cell circuit.

8. The life of these mines depends on whether they are the moored or ground type, and whether or not there is a constant drain on the battery after the mine has armed. The life of a moored mine is generally dependent on the life of its mooring cable, while the life of those which have the constant battery drain will vary directly with the amount of current used. A ground magnetic mine with no constant battery drain must be considered to be alive for a period of eight years after laying if no sterilizing device is fitted.

Mark 10-3 (10-6, 10-7, 10-8 & 10-9)

General

1. Moored, magnetic dip-needle mine.
2. Laid by submarine.
3. Laid offensively in depths of water from 100 to 500 ft. against surface craft. Case depth is normally 40 ft.

Description

1. Case

Shape	Cylindrical, with hemispherical nose
Color	Black
Material	Aluminum
Diameter	20 13/16"
Length	92 1/2"
Charge	420 lbs. TNT with granular TNT booster
Total weight in air	820 lbs.
2. External Fittings

Extender	Mk. 12-5 or 14, on top center line, 22" aft nose
Clock starter	Mk. 1-5 on top center line, 34" aft nose
Guide block and latch	On top center line, 46" aft nose
Filling hole	18" aft nose, 270 degrees from top center line
Lifting eye	On nose

U. S. INFLUENCE MINES

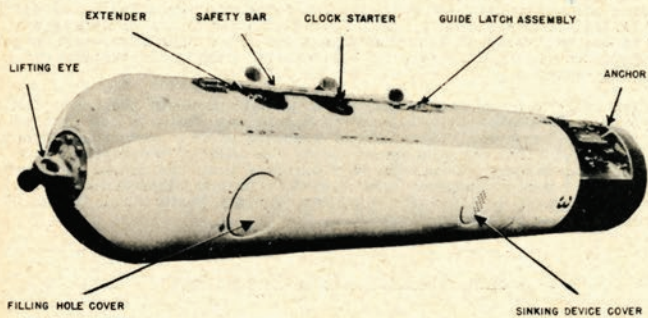


Fig. 2-- Mk. 10-3 Mine



## U. S. INFLUENCE MINES

Flooder cover	26" forward of tail, 270° from top center line
Inspection bung	27" forward of tail, 10° from top center line
Mooring eye	On tail (Mk. 10-3 anchor is used)

3. The Mk. 10-6 mine differs from the Mk. 10-3 as noted below:
  - (a) It is laid from aircraft, and fitted with a Mark 3 parachute and parachute release on its tail.
  - (b) The safety bar and guide latch are removed.
  - (c) It is fitted with a Mk. 14-2 extender and a Mk. 1-4 clock starter.
  - (d) Minor changes have been made in the wiring circuit.
  - (e) A Mk. 10-5 anchor is fitted.
4. The Mk. 10-7 mine differs from the Mk. 10-6 as noted below:
  - (a) The firing circuit is the same as that in the Mk. 10-3.
  - (b) It is laid from PT boat without parachute.
5. The Mk. 10-8 is a production design of the Mk. 10-6.
6. The Mk. 10-9 mine differs from the Mk. 10-8 as noted below:
  - (a) The wiring circuit is the same as the Mk. 10-3.
7. The changes noted above are not the only differences between the various modifications of the Mk. 10. The other changes, however, are minor and do not affect recovery or disposal techniques.
8. The Mk. 10-6 and 10-8 were only produced in limited quantities, both being superseded by the Mk. 10-9. The Mk. 10-3, 10-7, and 10-9 are the only service models, although a few Mk. 10-6 and 10-8 mines have been laid.

### Operation

1. Mine takes depth by a loose-bight hydrostat system. Extender and clock starter operate in 16 ft. of water. Clock (CD-9) runs off in 170 min. and the mine is armed.
2. Firing device (M-5) operates when subjected to a sufficient change in the surrounding magnetic field to force the firing needle down onto its contacts, firing the detonator. A mechanically operated anti-countermining device (AC-1) prevents the mine from firing when subjected to sudden shock or motion. An anti-recovery switch fitted on the extender fires a flooder, consisting of a Mk. 1-1 electric detonator covered by a plastic bung, if the extender retracts, thereby sinking the mine. An SD-4 mechanism may be fitted to render the mine inert after a set period.
3. Extender is designed to retract upon release of hydrostatic pressure, but the anti-recovery switch on the Mk. 12-5 will not allow it to retract fully.

### Precautions

1. Do not attempt RMS unless absolutely necessary.
2. Allow no movement of magnetic material near the mine.
3. Do not move or jar the mine except from a safe distance.
4. When the Mk. 12-5 extender starts to retract, it closes its anti-recovery switch and locks with scuttling circuit closed and the mine detonator housed in the booster. The Mk. 14 extender, however, retracts completely and closes its anti-recovery switch only momentarily during retraction. Keep clear of the flooder cover when performing RMS.
5. Do not attempt underwater RMS. If the mine is found floating or submerged, pull it ashore from a safe distance.

### RMS

1. Remove the clock.
2. Slit the clock cable, and cut and tape each lead separately. There are six leads. Cut the blue, brown and purple leads first in that order. If the cable cannot be cut, wind the clock if a key is available.

U. S. INFLUENCE MINES

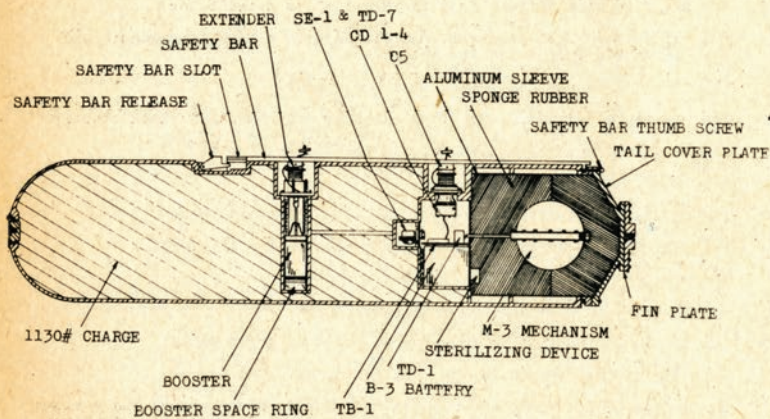


Fig. 3-- Mk. 12 Mine, Sectional View

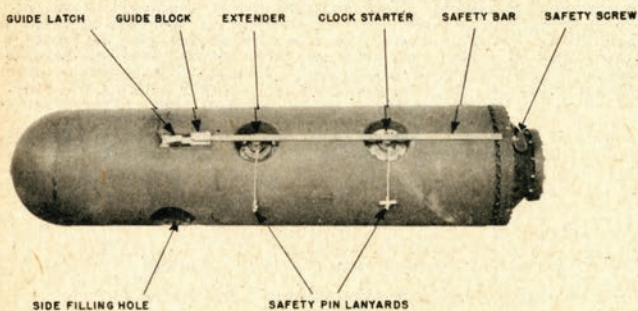


Fig. 4-- Mk. 12 Mine

## U. S. INFLUENCE MINES

3. Remove the extender.
4. Cut and tape the detonator leads separately.
5. Slit the extender cable, and cut and tape each lead separately.
6. Remove the scuttling detonator as prescribed below:
  - (a) Remove the flooder cover.
  - (b) Remove the flooder bung.
  - (c) Cut and tape the detonator leads.
  - (d) Remove the large brass screw from the inner side of the flooder bung and **shake** or pull out the detonator.
7. Dispose of both detonators, booster, and charge.

### Mark 12

#### General

1. Ground, magnetic dip-needle mine.
2. Laid by submarine.
3. Laid offensively in depths of water from 16 to 125 ft. against surface craft, and up to 500 ft. against submarines.

#### Description

1. Case

Shape	Cylindrical with hemispherical nose and tail cap
Color	Black
Material	Aluminum
Diameter	20 13/16"
Length	94"
Charge	1095 lbs. TNT, or 1225 lbs. Torpex
Total weight in air	1415 lbs. or 1545 lbs.
2. External Fittings

Extender	Mk. 12 or 12-5, in pocket on top center line 49" forward of tail cap
Clock starter	CS-1 or 1-5 in pocket on top center line 27" forward of tail cap
Filling holes	2, one in nose and one 270° from top center line, 25" aft the nose
Spring guide and latch on top center line, 8" forward of the extender.	

#### Operation

1. Extender and clock starter operate in 15 ft. of water. The clock runs off in 45 min. (CD-1) or 170 min. (CD-1-5 or 9) and the mine is armed.
2. Firing device (M-3, 3-1, 3-2) operates when subjected to a change of the surrounding magnetic field sufficient to force the firing needle down onto its contacts, firing the detonator or advancing the 10-place ships-counter (SE-1) one **step**. An SD-5 mechanism may be fitted to render the mine inert after a set period.
3. Extender is designed to retract upon release of hydrostatic pressure.

#### Precautions

1. Do not attempt RMS unless absolutely necessary.
2. Allow no movement of magnetic material near the mine.

U. S. INFLUENCE MINES

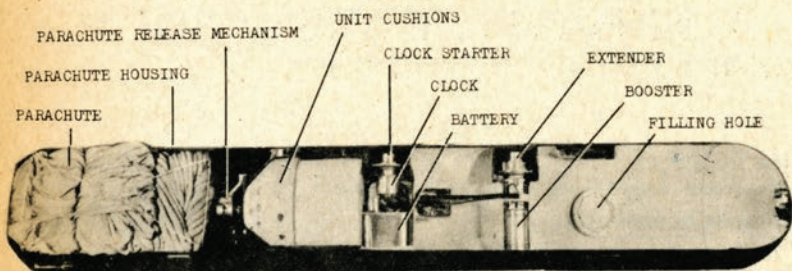


Fig. 5-- Mk. 12-1 Mine, Cutaway View

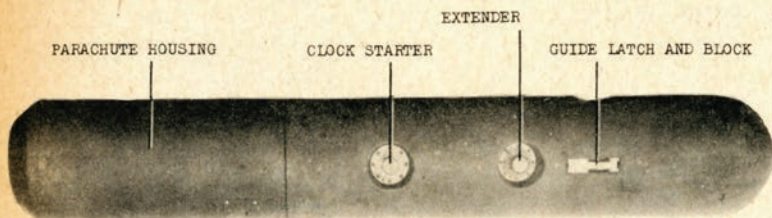


Fig. 6-- Mk. 12-1 Mine

## U. S. INFLUENCE MINES

3. Do not move or jar the mine except from a safe distance.
4. Extender may fail to retract upon release of hydrostatic pressure.

### RMS

1. Cut retaining wire and remove plastic cap and spring from extender.
2. Check the extender. If it is retracted, an extender safety pin (7/32" in diam.) inserted into the hole in the spindle housing will lock it out. If it is not retracted, insert pin into the ball-retaining holes and pry the spindle out. The pin will now fit through the safety-pin hole. (See note) If the mine is underwater, it must be raised before removing the clock.
3. Remove the clock.
4. Slit the clock cable and cut and tape all leads separately.
5. Remove the extender.
6. Cut and tape the detonator leads separately.
7. Dispose of detonator, booster and charge.

### Mark 12-1

### General

1. Same as the Mk. 12, except that it is aircraft laid, and fitted with a parachute and parachute release Mk. 1 or 1-1.

### Description

1. Case

Shape	Cylindrical, with hemispherical nose. Cylindrical parachute housing attached to the tail
Length	130" (with parachute housing)
Total weight in air	1595 lbs. or 1725 lbs.
All other data	same as in Mk. 12.
2. External fittings

Extender	Mk. 12-1 or 12-4 pocket on top center line 45" aft nose
Clock starter	CS1-1 (with 12-1 extender) or 1-4 (with 12-4 extender) in pocket on top center line 67" aft nose
Key band and Key	Band extends circumferentially around case, 50" aft nose. Key on band, 180° from extender
Filling holes	Two, one in nose and one 28" aft nose, 270° from top center line.

### Operation

1. The mine operates in the same manner as the Mk. 12, except that the clock starter and extender may be fitted with soluble washers, causing an additional delay in arming. (EX. 12-1 and CS 1-1 have washers)
2. Safety features are the same as in the Mk. 12.

### Precautions

1. Same as Mk. 12.

### RMS

1. Retract and lock out the extender, using the extender wing nut and the wooden washer from the Mk. 6 tool kit for the 12-1, and the wooden washer and safety nut from the tool kit for the 12-4. If the mine is underwater, it must be raised before removing the clock.

U. S. INFLUENCE MINES

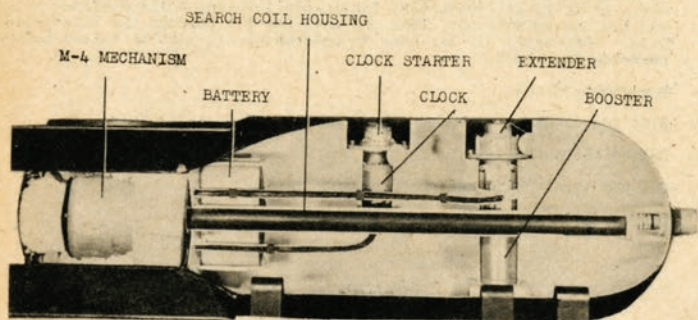


Fig. 7-- Mk. 13 Mine, Cutaway View

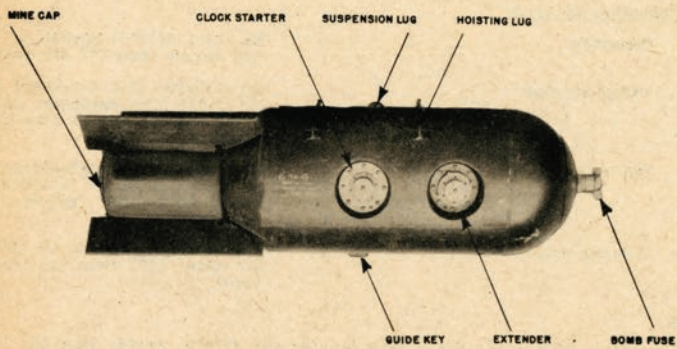


Fig. 8-- Mk. 13 Mine

U. S. INFLUENCE MINES

2. The remaining steps in RMS are the same as for the Mk. 12.

Mark 12-3 & 12-4

General

1. The Mk. 12-3 and 12-4 mines are improved designs of the Mk. 12 and 12-1 respectively, differing chiefly in that all electrical connections are of the plug-socket type, making for easier assembly. The Mk. 12-3 may be fitted with a Mk. 14 extender.
2. The external appearance, safety features and operational characteristics of these mines are not materially altered from the Mk. 12 and 12-1, although the charge weight and total weight are each 30 lbs. less than in the Mk. 12 and 12-1 respectively.
3. RMS is the same as for the Mk. 12 and 12-1.

Note: The Mk. 12 and 12-5 extenders used in Mk. 12 mine can be retracted by the above procedure only in shallow water. The Mk. 12-3 mine uses Mk. 12-5 and 14 extenders. No proven underwater procedure is available for the Mk. 14 extender. Although the possibility of recovery of Mk. 12 and 12-3 submarine-laid ground mines underwater is remote, satisfactory procedures are being developed for such an eventuality.

Mark 13 (13-3, 13-4)

General

1. Ground, magnetic induction mine.
2. Aircraft laid, without parachute.
3. Laid offensively in depths of water from 16 to 75 ft. against surface craft, and up to 500 ft. against submarines.
4. May be used as a bomb if fitted with Mk. 219, 221 or AN-M 103 impact nose fuses.
5. The Mk. 13-4 differs from the Mk. 13 in that it is designed to be laid in waters as shallow as 10 ft. by removing the extender and clock starter springs. The Mk. 13-3 is a Mk. 13 mine fitted with Mk. 2 parachute.

Description

1. Case
 

Shape	Cylindrical, bomb-shaped with fins
Color	Black
Material	Steel
Diameter	
Forward section	19 7/8"
Tail Section	15 1/4"
Fins (span)	25 1/2"
Length	68 3/4"
Charge	640 lbs. TNT, or 700 lbs. Torpex, with granular TNT booster
Total weight in air	1030 lbs. or 1090 lbs.
2. External fittings
 

Bomb fuse	Mk. 219, 221, or AN-M 103 in pocket in nose
Extender	Mk. 12-2 or 12-4, in pocket 17" aft nose
Clock starter	Mk. 1-2 (with 12-2 extender) or Mk. 1-4 (with 12-4 extender) in pocket 30" aft nose
Filling hole	180 degrees from clock.

U. S. INFLUENCE MINES

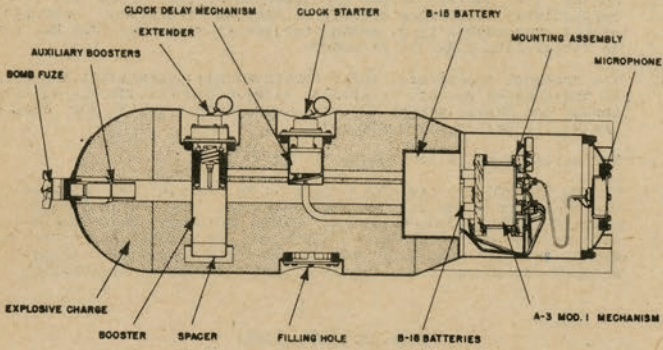


Fig. 9-- Mk. 13-5 Mine, Sectional View

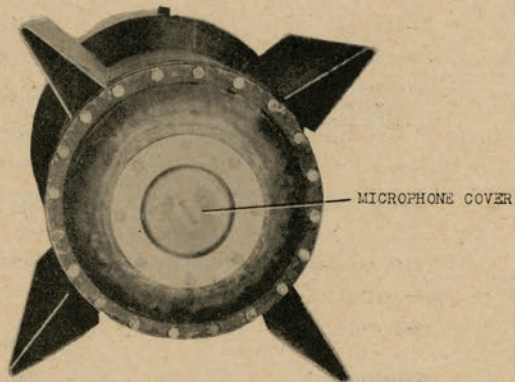


Fig. 10-- Mk. 13-5 Mine, Rear View



## U. S. INFLUENCE MINES

### Operation

1. When the soluble washers dissolve (EX 12-4 and CS 1-4 do not use soluble washers), extender and clock starter operate in 16 ft. of water. The clock (CD-1-1 or CD-6) runs off in 45 min., and mine is armed.
2. The firing device (M-4-1 or M-4-2) operates upon receipt of the proper number of "looks" properly spaced, either firing the detonator, or advancing the eight-place ships counter (SS-1) one step. An SD-4 mechanism may be used to render the mine inert after a set period. If the unit is faulty, the mine will destroy itself upon arming.
3. Extender is designed to retract upon release of hydrostatic pressure.

### Precautions

1. Do not attempt RMS unless absolutely necessary.
2. Do not move or jar the mine except from a distance.
3. Allow no movement of magnetic material near the mine.
4. Extender may fail to retract upon release of hydrostatic pressure.
5. At one time, anti-recovery switches, used only as mechanical detents to lock in the extender, were issued. No extenders so fitted are now being issued.

### RMS

1. See Part II, Chapter 5 for rendering safe fuzes.
2. Retract and lock out the extender using the cap and wing nut from the extender with a wooden plug for the Mk 12-2, and the wooden plug and safety nut from the Mk 6 tool kit for the 12-4. If the mine is underwater, it must be raised before removing the clock. If the extender cannot be retracted, RMS must not be attempted. Dispose of the mine by other means.
3. Remove the clock from a safe distance.
4. Slit the clock cable, and cut and tape each lead separately.
5. Remove the extender from a safe distance.
6. Cut and tape the detonator leads separately.
7. Dispose of detonator, booster and charge.

### Mark 13-5 (13-6)

### General

1. Ground, acoustic mine, laid by aircraft.
2. Laid offensively in depths of water from 40 to 100 ft. against surface craft. May be used as a bomb if fitted with Mk 219, 221, or AN-M 103 nose fuzes.

### Description

1. Case

Charge	430 lb. TNT or 490 lb. Torpex with granular TNT booster
Total weight in air	1000 lb. or 1060 lb.
All other data and dimensions are the same as in the Mk 13.	
2. External fittings

Microphone pocket	On tail cover plate of mine, inside 8" cover plate ring. Microphone is covered by a 5" rubber diaphragm, which is stamped with the word "BRUSH."
All other external fittings are the same as on the Mk 13.	
3. The 13-6 differs from the 13-5 in that it is designed for laying from high altitudes with parachute.

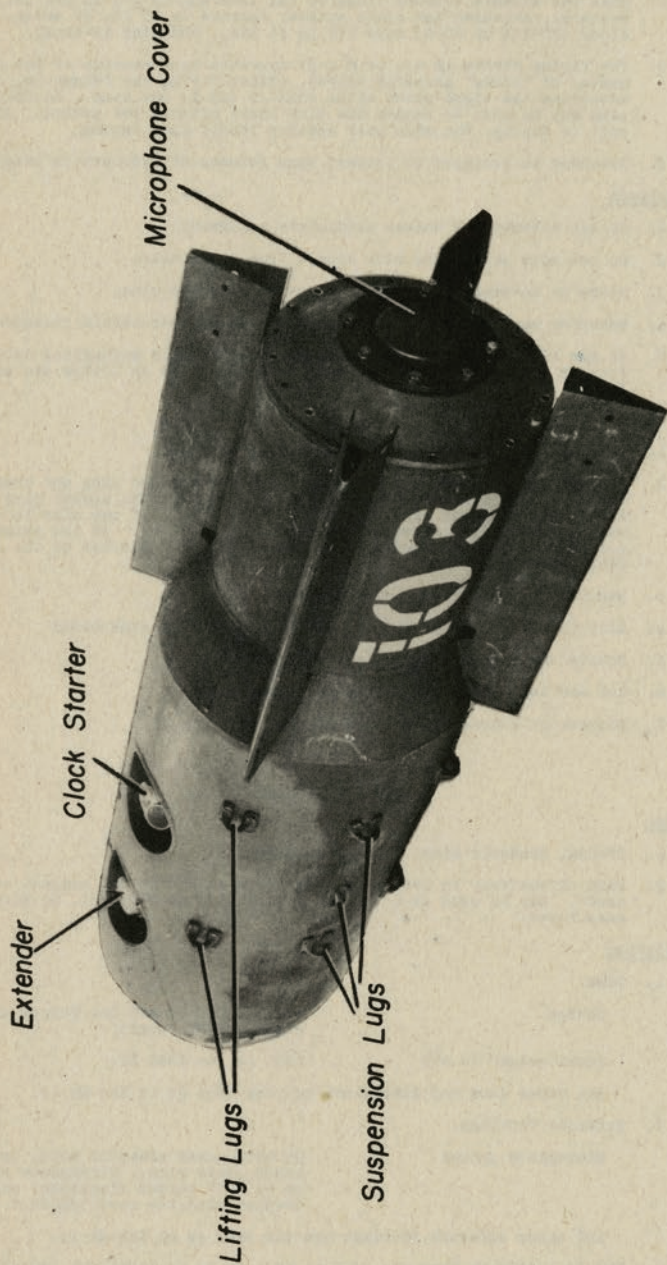


Fig. 11-Mk 13-5 Mine

U. S. INFLUENCE MINES

(Mk 13-5 (13-6), Cont'd.)

Operation

1. After soluble washers dissolve, (may not be used) extender and clock starter operate in 16 ft. of water. Clock (CD-1, 5, or 7) runs off in 45 min., and the mine is armed.
2. Firing device (A-3, A-3-1, or A-3-2) operates when microphone receives a sound of proper frequency, intensity and duration, firing the detonator. An anti-countermining device, built into the A-3 unit, prevents the mine from firing when subjected to sudden noise or shock.
3. Extender is designed to retract upon release of hydrostatic pressure.

Precautions

1. Do not attempt RMS unless absolutely necessary.
2. Keep all noise to an absolute minimum. The firing device, although designed to operate by a sound of two second's duration, will often fire when this time interval has been cut to less than 1/2 second.
3. Extender may fail to retract upon release of hydrostatic pressure. DO NOT ATTEMPT TO RETRACT IT.
4. See Part II, Chapter 5 for rendering safe fuzes.

RMS

1. On land
  - (a) Prepare Cavity Charge Liner Type 1, (Part I, Chapter 5) and pack it with 1/3 lb. plastic explosive C or C-2. Place the filled liner between any two fins on the tail in an athwartships position, 9 1/2" from the after end of the cover plate, and centered between the two fins. A 1" stand-off from the case must be used, an empty C or C-2 box being handy for this purpose.
  - (b) Insert the detonator in the charge, secure the detonator leads and firing leads, and fire the charge from a safe distance.
  - (c) Inspect the interior of the mine case to insure that all leads to the unit have been severed.
  - (d) Remove the extender from a safe distance.
  - (e) Dispose of detonator, booster and charge.
2. Underwater
  - (a) Prepare Cavity Charge Container Type 2 (Part I, Chapter 5) and pack it with 1/3 lb. C or C-2 plastic explosive. Place the filled liner on the mine case as described in Par. (a) above, using the distance pieces to facilitate positioning.
  - (b) Insert the detonator in the charge, secure the detonator leads and firing leads, and fire the charge from a safe distance.
  - (c) Wait at least 12 hours for the battery to become inert.
  - (d) Raise or beach the mine, and remove the extender.
  - (e) Dispose of detonator, booster and charge.

U. S. INFLUENCE MINES

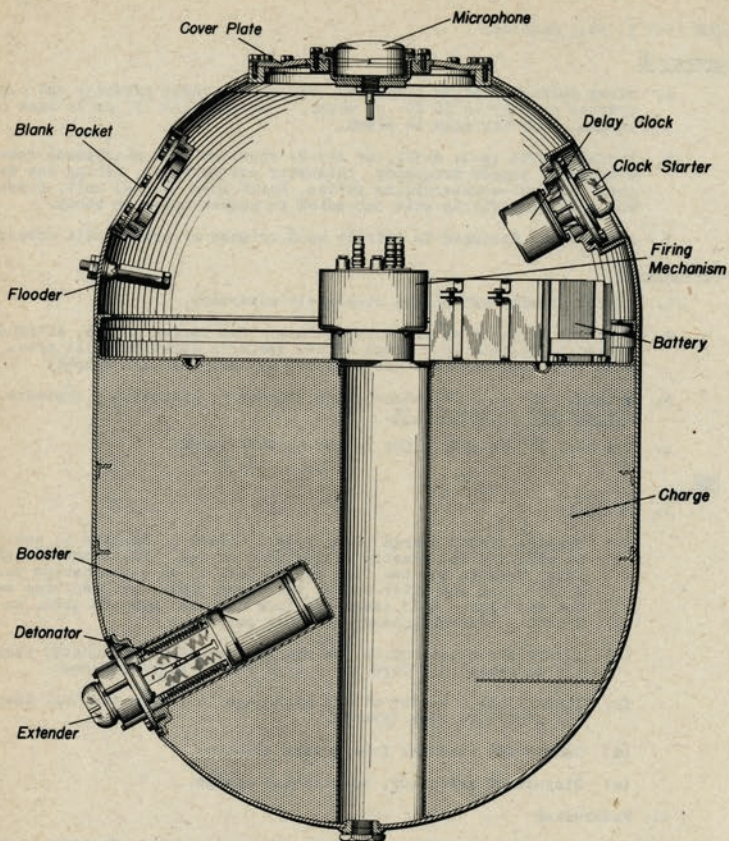


Fig. 12- Mk. 16-2 Mine Sectional View

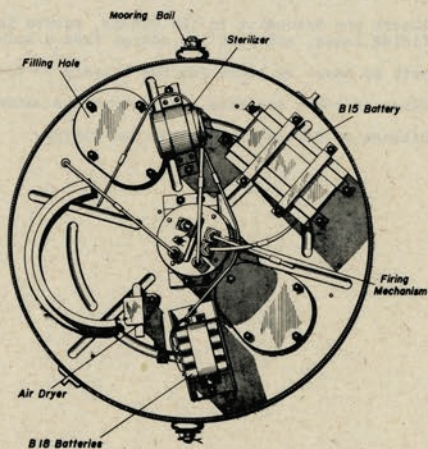


Fig. 12a - Mk 16-2 Mine, Top View, Cover Plate Removed

U. S. INFLUENCE MINES

Mark 16-2

General

1. Moored, acoustic mine, laid by surface craft.
2. Offensive or defensive mine, for use in maximum depth of water of 2800 ft. Maximum depth of case when moored is 240 ft.

Description

1. Case
  - (a) Same as Mk 16-1 (Part II, Chapter 2) except that its total weight in air is 1070 lb.
2. External fittings on the case differ from those on the Mk 16-1 as follows:
  - (a) The horns are not fitted and the respective horn pockets are blanked off. A scuttling detonator may be fitted in place of one of the horn plugs.
  - (b) One of the blank pockets on the upper hemisphere contains the clock starter Mk 1-3.
  - (c) A microphone, MI-2, is fitted to the center of the cover plate and replaces the K-device.
  - (d) A Mk 14-1 extender may be fitted.

Operation

1. Mine takes depth by plummet. Dissolution of soluble plugs allows the extender and clock starter to operate in 16 ft. of water. The clock (CD-5 or 7) runs off in 45 min. and the mine is armed.
2. The firing device (A3-2) operates when sound of the proper frequency and amplitude build-up is incident upon the microphone, firing the detonator. An anti-countermining device built into the firing device prevents the mine's firing when subjected to sudden noise or shock.
3. The extender is designed to retract upon release of hydrostatic pressure.

Precautions

1. Do not attempt RMS unless absolutely necessary.
2. Keep all noise to an absolute minimum. The firing device is designed to be operated by a sound of two second's duration, but will often fire on a sound of less than 1/2 second's duration.
3. Note that the extender may fail to retract upon release of hydrostatic pressure.

RMS

1. Under development.

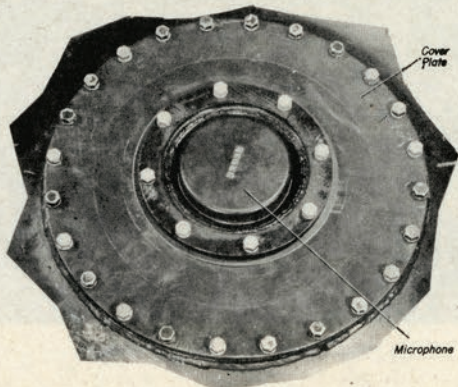


Fig. 12b - Mk 16-2 Mine, Cover Plate, Showing Microphone .

Added 15 April 1945  
(Change No. 3)

U. S. INFLUENCE MINES

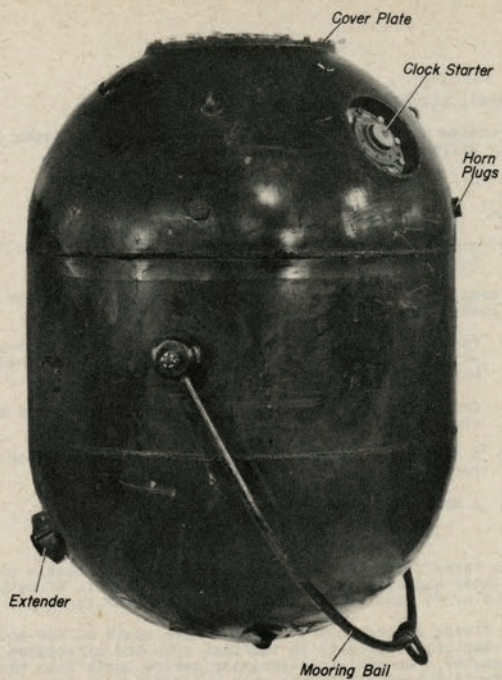


Fig. 13- Mk 16-2 Mine

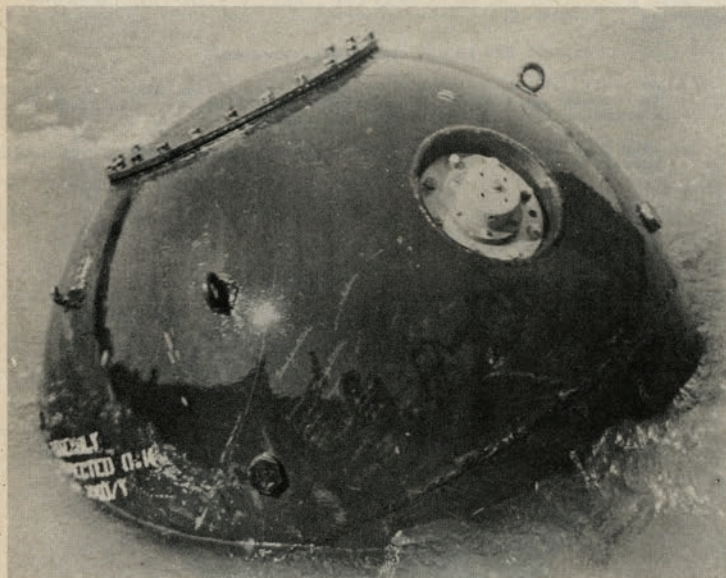


Fig. 14- Mk 16-2 Mine, Floating

U. S. INFLUENCE MINES

(Mark 16-2, Cont'd.)

RMS

1. After the mine has positively been identified, prepare a Cavity Charge Container Type 2 (Part I, Chapter 5, Page 17) and pack it with 1/3 lb. Composition C, C-2 or C-3 plastic explosive.
2. Place the charge container on the mine as follows:
  - (a) Locate the lifting eye on the upper hemisphere which is most nearly in line with the extender pocket on the lower hemisphere.
  - (b) Position the charge container so that its longitudinal axis is parallel to and 1 1/2" below the upper transverse weld on the mine case and its right extremity is bounded by an imaginary line which runs parallel to the longitudinal axis of the case through the above-mentioned lifting eye.
3. Secure the charge in place by any means available, observing the acoustic precautions stated above.
4. Insert an Army Engineer Special detonator in the charge, secure the detonator leads and firing leads, and fire the charge from a safe distance.
5. Return to the mine after waiting a five minute safety period and inspect the interior of the case through the hole cut by the charge. The firing leads should be completely severed.
6. Remove the extender and booster.
7. Dispose of detonator, booster and charge.

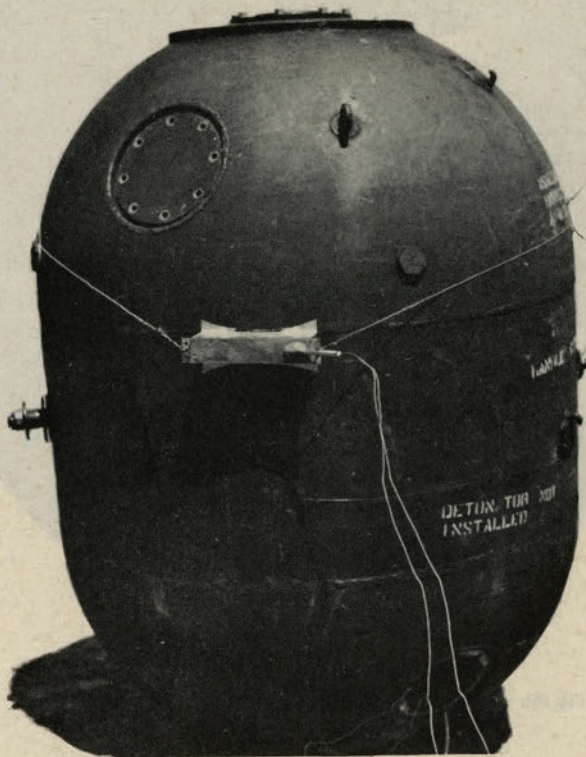


Fig. 14a - Mk 16-2 Mine, Charge Container in Place for RMS

CONFIDENTIAL

U. S. INFLUENCE MINES

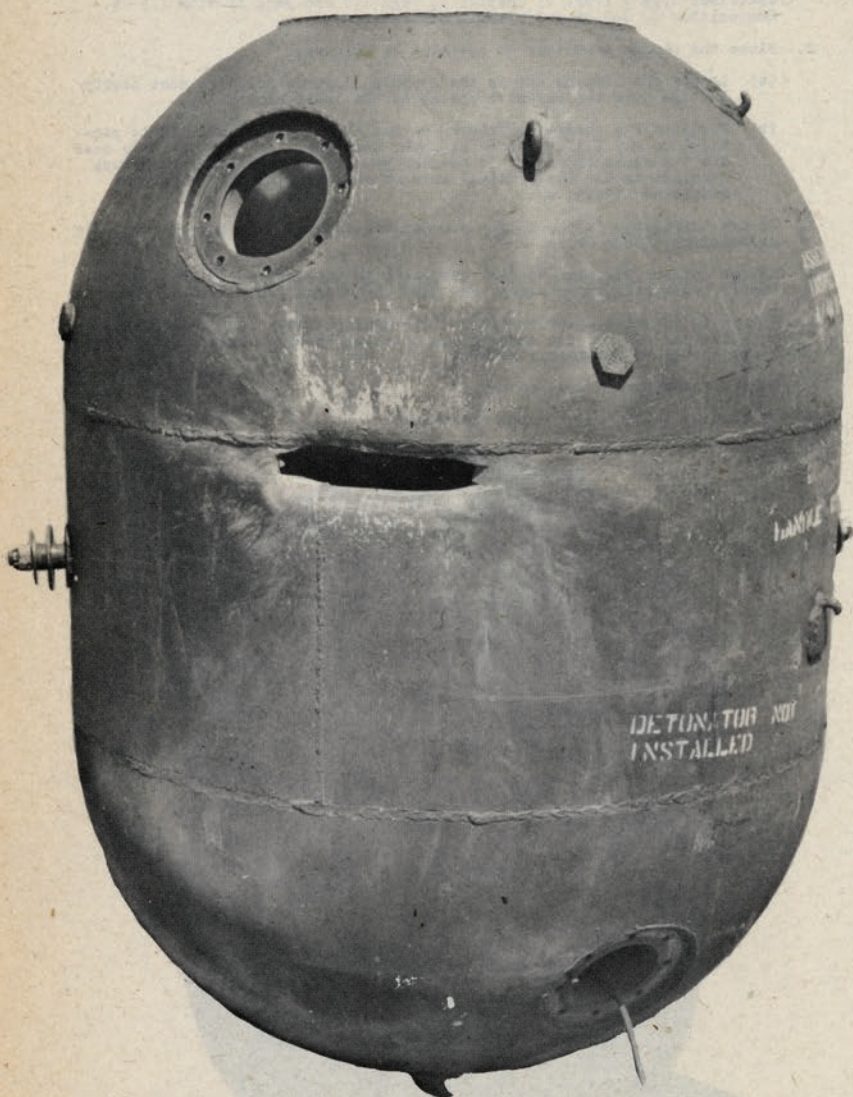


Fig. 14b - Mk 16-2 Mine, Cut Made by Cavity Charge During RMS



U. S. INFLUENCE MINES

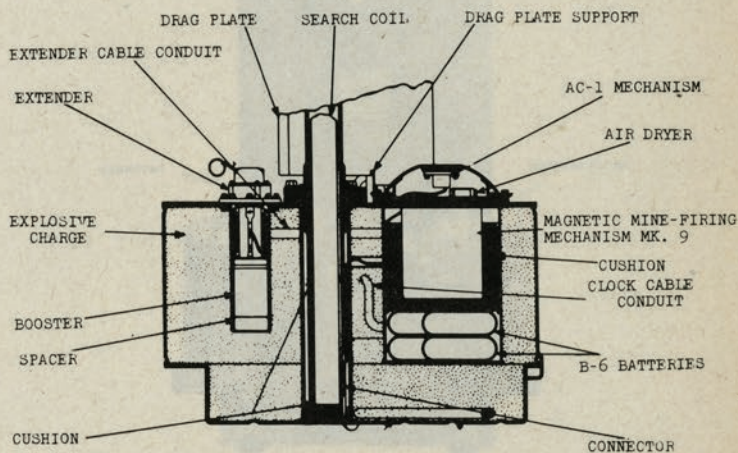


Fig. 15- Mk 18 Mine, Sectional View

Mark 18

General

1. Ground, magnetic induction mine.
2. Laid by surface craft.
3. Laid offensively or defensively in depths of water from 35 to 150 ft. against surface craft, and up to 500 ft. against submarines.

Description

1. Case

Shape	Flat cylinder with search coil, projecting vertically from top
Color	Black
Material	Steel
Diameter	42"
Height	
Including search coil	70"
Less search coil	28"
Charge	1350 lb. TNT with granular TNT booster

U. S. INFLUENCE MINES

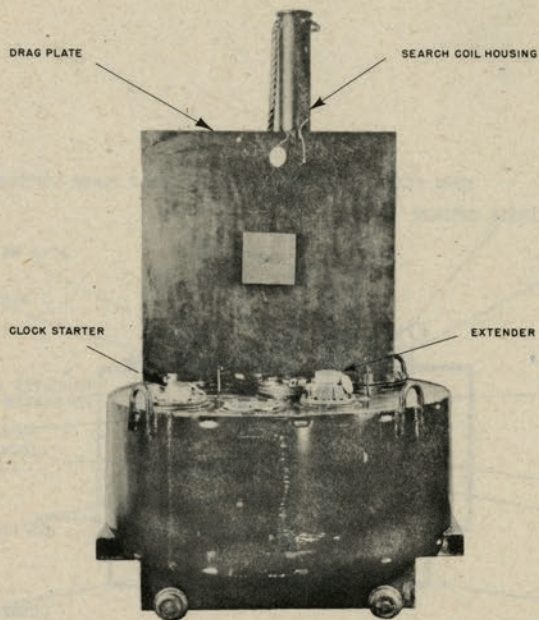


Fig. 13-- Mk. 18 Mine

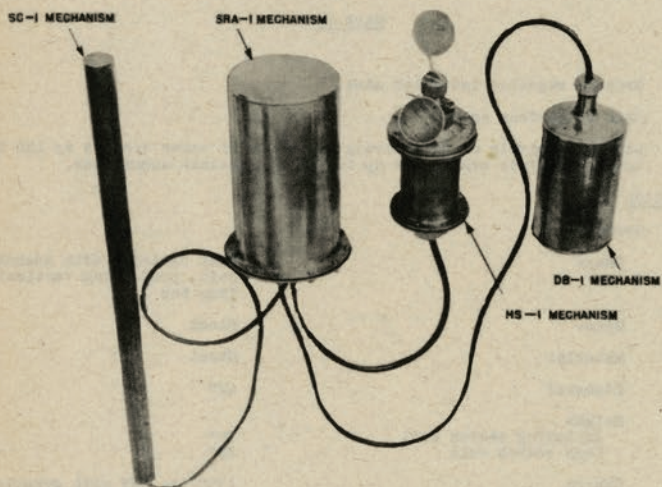


Fig. 14-- Mk. 21 Mine Assembled

U. S. INFLUENCE MINES

Total weight in air	2050 lb.
2. External fittings	
Drag plate and release mechanism	Mk 3-3, on search coil housing
Launching wheels	Four, beneath case
Extender	Mk 12-3 or 14-1, in pocket on top of case
Clock starter	Mk 1-3, in pocket on top of case
Filling holes	One large and one small, on top of case
Firing device	M-9, in hole on top of case

Operation

1. Drag plate keeps the mine upright during descent until it is cast off at a depth of 30'. When soluble washers dissolve, clock starter and extender operate in 16' of water. The clock (CD-4) runs off in 45 min., and the mine is armed.
2. The firing device operates upon receipt of two "looks" of opposite polarity within a set time limit, firing the mine. An impact-operated anti-countermining device (AC-1) prevents the mine from firing when subjected to sudden shock or motion.
3. Extender is designed to retract upon release of hydrostatic pressure.

Precautions

1. Do not attempt RMS unless absolutely necessary.
2. Do not move or jar the mine except from a distance.
3. Allow no movement of magnetic material near the mine.
4. Extender may fail to retract upon release of hydrostatic pressure.

RMS

1. Retract and lock out the extender. Use the wooden washer and safety nut from the Mk 6 tool kit for the 12-3. For the 14-1, use the Type 2 non-magnetic extender retractor. When using the Type 2 extender retractor with the Mk 14-1 extender, the metal extender cap, with its transparent plastic cover, must be removed in order to remove the soluble washer retainer nut and cotter pin from the threaded extender spindle. The plastic cover should then be unscrewed from the metal cap and the cap replaced on the spindle in order to provide leverage for the retractor tool. If the mine is underwater, it must be raised before the clock is removed.
2. Remove the clock from a safe distance.
3. Slit the clock cable, and cut and tape each lead separately.
4. Remove the extender from a distance.
5. Cut and tape the detonator leads separately.
6. Dispose of detonator, booster and charge.

Note: Because the mine is extremely sensitive, and may be actuated by the diver's telephone, diving should be attempted only under excellent bottom conditions and visibility, and with shallow water gear.

Mark 21

General

1. Ground, magnetic induction mine (mechanism assembly)
2. Not a complete mine in the usual sense. In its entirety it consists only of the simple internal parts of a magnetic induction mine. It is designed to be used by operational units in remote or isolated areas where transport is limited. May be planted from surface craft or manually.

U. S. INFLUENCE MINES

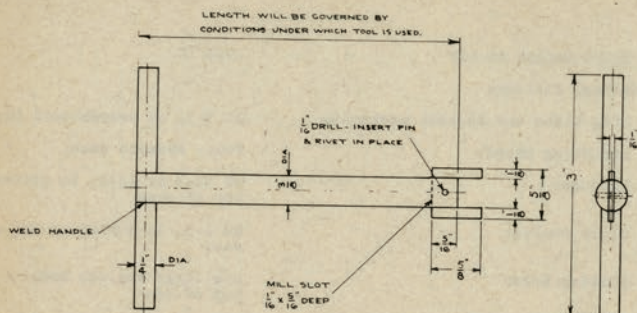


Fig. 15-Non-magnetic spanner for use in rendering safe procedure in Mine Mark 21. This tool may be used to remove the small castellated nut on the outer end of the hydrostat spindle of the HS-1 mechanism in Mine Mk. 21.

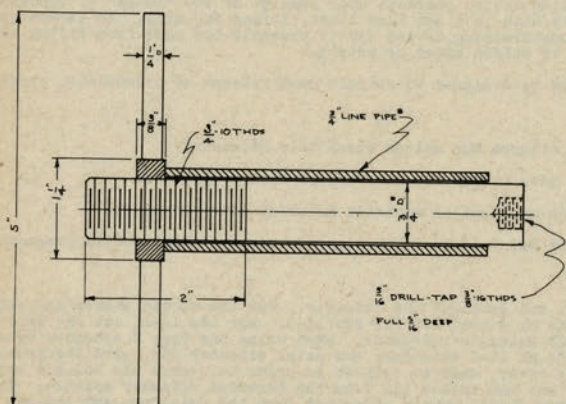


Fig. 16-Non-magnetic retracting tool for rendering safe procedure in Mine Mk. 21. This tool is used to retract and lock out the hydrostat spindle of the HS-1 mechanism in the mine Mk. 21.

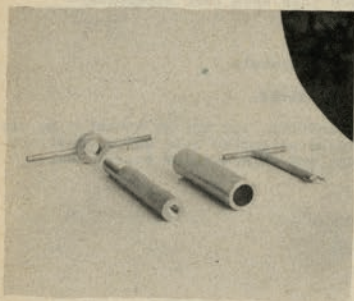


Fig. 17-Three components of the retracting tool. Spanner wrench on right.

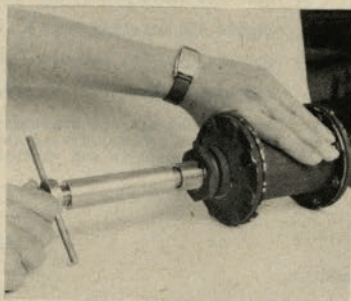


Fig. 18-Shows retracting tool being inserted into the HS-1 mechanism.

U. S. INFLUENCE MINES

Total weight in air	2050 lb.
2. External fittings	
Drag plate and release mechanism	Mk 3-3, on search coil housing
Launching wheels	Four, beneath case
Extender	Mk 12-3 or 14-1, in pocket on top of case
Clock starter	Mk 1-3, in pocket on top of case
Filling holes	One large and one small, on top of case
Firing device	M-9, in hole on top of case

Operation

1. Drag plate keeps the mine upright during descent until it is cast off at a depth of 30'. When soluble washers dissolve, clock starter and extender operate in 16' of water. The clock (CD-4) runs off in 45 min., and the mine is armed.
2. The firing device operates upon receipt of two "looks" of opposite polarity within a set time limit, firing the mine. An impact-operated anti-countermining device (AC-1) prevents the mine from firing when subjected to sudden shock or motion.
3. Extender is designed to retract upon release of hydrostatic pressure.

Precautions

1. Do not attempt RMS unless absolutely necessary.
2. Do not move or jar the mine except from a distance.
3. Allow no movement of magnetic material near the mine.
4. Extender may fail to retract upon release of hydrostatic pressure.

RMS

1. Retract and lock out the extender. Use the wooden washer and safety nut from the Mk 6 tool kit for the 12-3. For the 14-1, use the Type 2 non-magnetic extender retractor. When using the Type 2 extender retractor with the Mk 14-1 extender, the metal extender cap, with its transparent plastic cover, must be removed in order to remove the soluble washer retainer nut and cotter pin from the threaded extender spindle. The plastic cover should then be unscrewed from the metal cap and the cap replaced on the spindle in order to provide leverage for the retractor tool. If the mine is underwater, it must be raised before the clock is removed.
2. Remove the clock from a safe distance.
3. Slit the clock cable, and cut and tape each lead separately.
4. Remove the extender from a distance.
5. Cut and tape the detonator leads separately.
6. Dispose of detonator, booster and charge.

Note: Because the mine is extremely sensitive, and may be actuated by the diver's telephone, diving should be attempted only under excellent bottom conditions and visibility, and with shallow water gear.

Mark 21

General

1. Ground, magnetic induction mine (mechanism assembly)
2. Not a complete mine in the usual sense. In its entirety it consists only of the simple internal parts of a magnetic induction mine. It is designed to be used by operational units in remote or isolated areas where transport is limited. May be planted from surface craft or manually.

U. S. INFLUENCE MINES

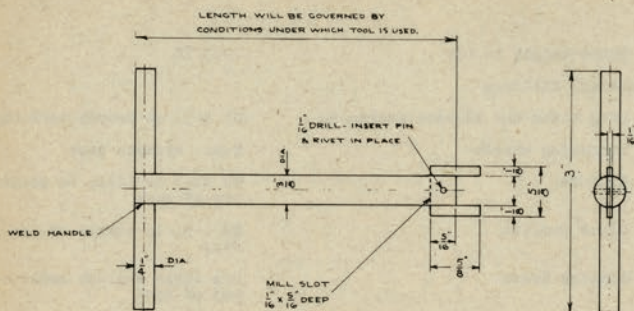


Fig. 15-Non-magnetic spanner for use in rendering safe procedure in Mine Mark 21. This tool may be used to remove the small castellated nut on the outer end of the hydrostat spindle of the HS-1 mechanism in Mine Mk. 21.

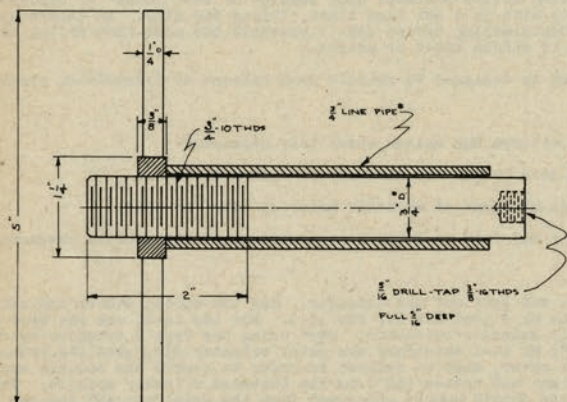


Fig. 16-Non-magnetic retracting tool for rendering safe procedure in Mine Mk. 21. This tool is used to retract and lock out the hydrostat spindle of the HS-1 mechanism in the mine Mk. 21.

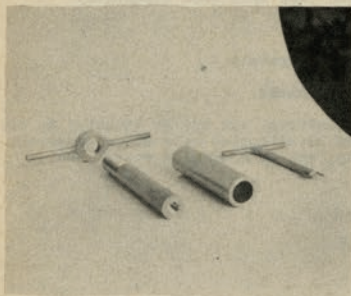


Fig. 17-Three components of the retracting tool. Spanner wrench on right.

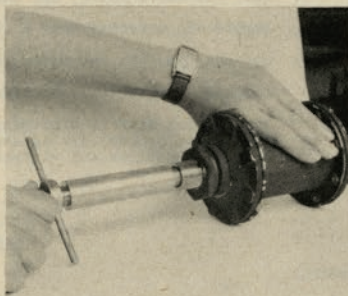


Fig. 18-Shows retracting tool being inserted into the HS-1 mechanism.

U. S. INFLUENCE MINES

Diameter	42"
Height	
Including search coil	70"
Less search coil	28"
Charge	1350 lbs. TNT with granular TNT booster
Total weight in air	2050 lbs.
2. External fittings	
Drag plate and release mechanism	Mk. 3-3, on search coil housing
Launching wheels	Four, beneath case
Extender	Mk. 12-3 or 14-1, in pocket on top of case
Clock starter	Mk. 1-3, in pocket on top of case
Filling holes	One large and one small, on top of case
Firing device	M-9, in hole on top of case.

Operation

1. Drag plate keeps the mine upright during descent until it is case off at a depth of 30'. When soluble washers dissolve, clock starter and extender operate in 16' of water. The clock (CD-4) runs off in 45 min., and the mine is armed.
2. The firing device operates upon receipt of two "looks" of opposite polarity with in a set time limit, firing the mine. An impact-operated anti-countermining device (AC-1) prevents the mine from firing when subjected to sudden shock or motion.
3. Extender is designed to retract upon release of hydrostatic pressure.

Precautions

1. Do not attempt RMS unless absolutely necessary.
2. Do not move or jar the mine except from a distance.
3. Allow no movement of magnetic material near the mine.
4. Extender may fail to retract upon release of hydrostatic pressure.

RMS

1. Retract and lock out the extender. Use the wooden washer and safety nut from the Mark 6 tool kit for the 12-3. For the 14-1, use the Type 2 non-magnetic extender retractor. If the mine is underwater, it must be raised before removing the clock.
2. Remove the clock from a safe distance.
3. Slit the clock cable, and cut and tape each lead separately.
4. Remove the extender from a distance.
5. Cut and tape the detonator leads separately.
6. Dispose of detonator, booster and charge.

Note: Because the mine is extremely sensitive, and may be actuated by the driver's telephone, diving should be attempted only under excellent bottom conditions and visibility, and with shallow water gear.

Mark 21

General

1. Ground, magnetic induction mine (mechanism assembly)
2. Not a complete mine in the usual sense. In its entirety it consists only of the simple internal parts of a magnetic induction mine. It is designed to be used by operational units in remote or isolated areas where transport is limited. May be planted from surface craft or manually.

U. S. INFLUENCE MINES

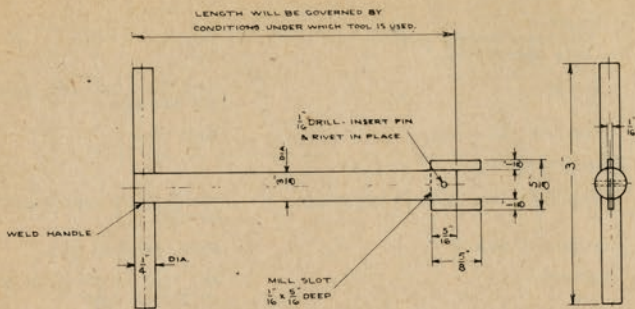


Fig. 15-Non-magnetic spanner for use in rendering safe procedure in Mine Mark 21. This tool may be used to remove the small castellated nut on the outer end of the hydrostat spindle of the H3-1 mechanism in Mine Mk. 21.

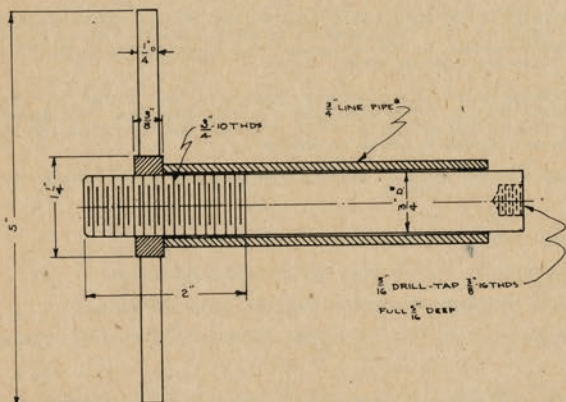


Fig. 16-Non-magnetic retracting tool for rendering safe procedure in Mine Mk. 21. This tool is used to retract and lock out the hydrostat spindle of the H3-1 mechanism in the mine Mk. 21.

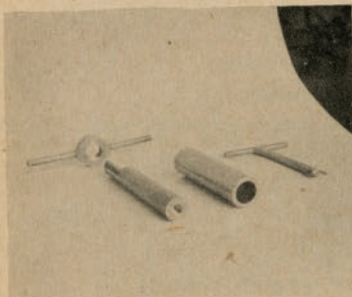


FIG. 17-Three components of the retracting tool. Spanner wrench on right.

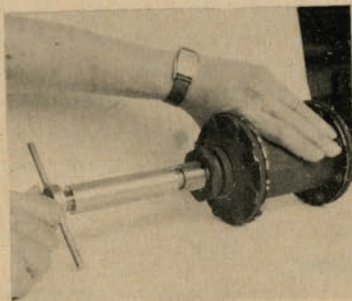


FIG. 18-Shows retracting tool being inserted into the H3-1 mechanism.



## U. S. INFLUENCE MINES

3. Laid offensively or defensively in depths of water from 10 to 100 ft. against surface craft. May be used as a land mine.

### Description

1. Mine is issued in four parts with connecting cables, but without case or charge. The four parts issued are:
  - (a) Firing mechanism (SRA-1) consisting of a moving coil relay and eight  $1\frac{1}{2}$  volt flashlight batteries housed in a cylindrical container  $8\frac{1}{2}$ " long and 5" in diameter. Weight is  $8\frac{1}{2}$  lbs.
  - (b) A search coil  $3\frac{1}{2}$ " or  $4\frac{1}{2}$ " long, sealed in a bakelite tube.
  - (c) Detonator-booster assembly, (DB-1) including a Mk. 1-1 detonator and a Mk. 6-3 booster, permanently married, and housed in a cylindrical container,  $6\frac{1}{2}$ " long and  $4\frac{1}{2}$ " in diameter.
  - (d) Hydrostatic switch (HS-1) consisting of a diaphragm-type hydrostat housed in a cylindrical container 5" long and 3" in diameter. The plunger of the hydrostat, operates three arming switches.
2. All parts, including the connecting cables, are water-tight.

### Operation

1. After soluble plug dissolves, the three switches on the hydrostat will operate in 10' of water. One switch operates resetting jaws which center the firing needle, another removes a short from the firing relay, and the third places the detonator in the firing circuit.
2. The firing device operates when subjected to a sufficient rate of change of the surrounding magnetic field, firing the detonator. There is no delay in firing, nor is there any anti-countermining feature.
3. Hydrostat is designed to retract upon release of hydrostatic pressure.

### Precautions

1. Mine may be difficult to identify because of its nondescript appearance. Substitutions for standard parts should be anticipated.
2. Never move or jar the mine except from a distance. If parts are found scattered, be especially careful not to move the search coil.
3. Allow no movement of magnetic material near the mine.
4. Hydrostat may fail to retract upon release of hydrostatic pressure.
5. Never attempt RMS unless absolutely necessary.

### RMS

1. If possible, cut and tape any and all cables to the firing device. If the detonator or hydrostatic switch cables are cut, the mine is safe. If the mine cannot be rendered safe by these measures, follow the procedure listed below.
  - (a) Locate the hydrostatic switch.
  - (b) Remove, by means of a non-magnetic spanner, (see drawing for specifications) the small castellated nut from the outer end of the hydrostatic spindle.
  - (c) Retract and lock out the hydrostatic spindle with the special non-magnetic retracting tool (See drawing for specifications).
  - (d) Insert a safety pin in the hole  $\frac{3}{4}$ " from the outer end of the spindle housing. If the mine is underwater, it must be raised before further stripping is attempted.
  - (e) Dispose of detonator, booster and charge.

### Mark 25

### General

1. Ground, magnetic induction mine.
2. Aircraft laid, with parachute.
3. Laid offensively in depths of water from 40 to 100 ft. against surface craft, and up to 400 ft. against submarines.

U. S. INFLUENCE MINES

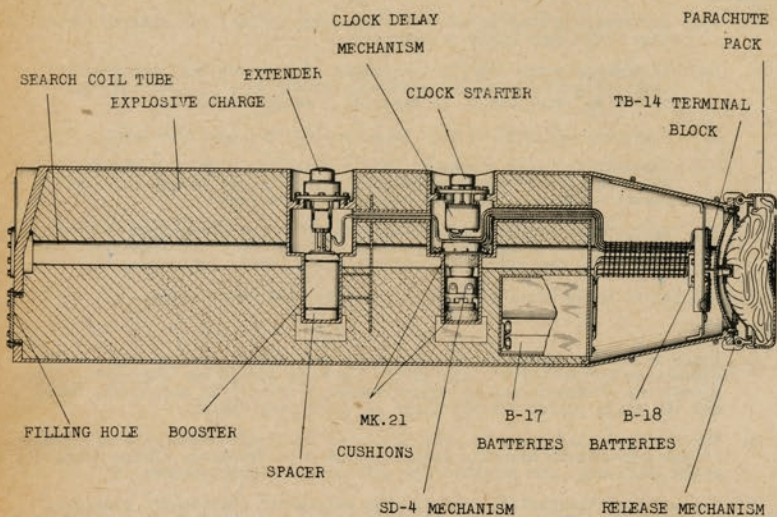


Fig. 19-- Mk. 25 Mine, Sectional View

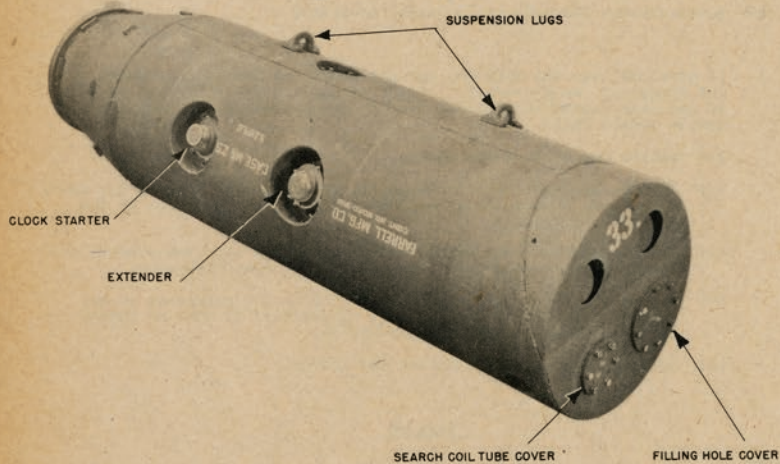


Fig. 20-- Mk. 25 Mine

U. S. INFLUENCE MINES

Description

1. Case

Shape	Cylindrical, with truncated cone tail section
Color	Black
Material	Steel
Diameter	
Case	22 7/16"
End of tail	16"
Length overall	86"
Case (without parachute pack)	
Cylindrical	82 1/2"
Section	64 3/4"
Tail section	17 3/4"
Charge	1120 lb. TNT or 1250 lb. Torpex with granular TNT booster
Total weight in air	1850 or 1980 lb.

2. External fittings

Extender	Mk 12-4 or 14-2, in pocket 32" aft nose
Clock starter	Mk 1-4, in pocket 49" aft nose
Parachute	Mk 2-0 secured to tail
Filling holes	Two, one on flat section of nose, and one 270° from and 8 1/2" aft extender
Suspension lugs	Three, two standard type, 18.5" and 48.5" aft nose respectively, and 90° from the extender. One British type 34.5" aft nose and 270° from extender

Operation

- CD-14 in 3-100 days*
- After soluble washers dissolve (may not be used), extender and clock starter operate in 16 ft. of water. The clock runs off (CD-1 in 45 min., CD-8 in 170 min.) and mine is armed. One or two CD-14 clocks (maximum arming delay of 100 days) may be used in conjunction with the CD-8 to further delay arming.
  - Firing device (M-11) operates upon receipt of two "looks" of opposite polarity and proper magnitude (separated by a period varying inversely with the strength of the first "look") within a set period. This fires the detonator or advances the eight-place ships counter (SE-3) one step. An SD-4-1 or one or two CD-14 clocks (maximum sterilizing delay of 145 days) may be fitted to render the mine safe after a set period.

Precautions

- Do not attempt RMS unless absolutely necessary and unless the mine has positively been identified as the Mk 25-0 rather than the Mk 25-1 (Page 25). Examine all markings closely and never attempt RMS in any case unless the mine can positively be identified.
- Do not move or jar the mine except from a safe distance.
- Allow no movement of magnetic material near the mine.
- Note that the extender may fail to retract upon release of hydrostatic pressure.
- Note that the firing device is extremely sensitive and may be actuated by a diver's transceiver. Diving on this mine should be attempted only under ideal conditions, using shallow water diving gear if available.
- Handle all electrical leads with great care. The mine battery may have a potential as high as 270 volts.

U. S. INFLUENCE MINES

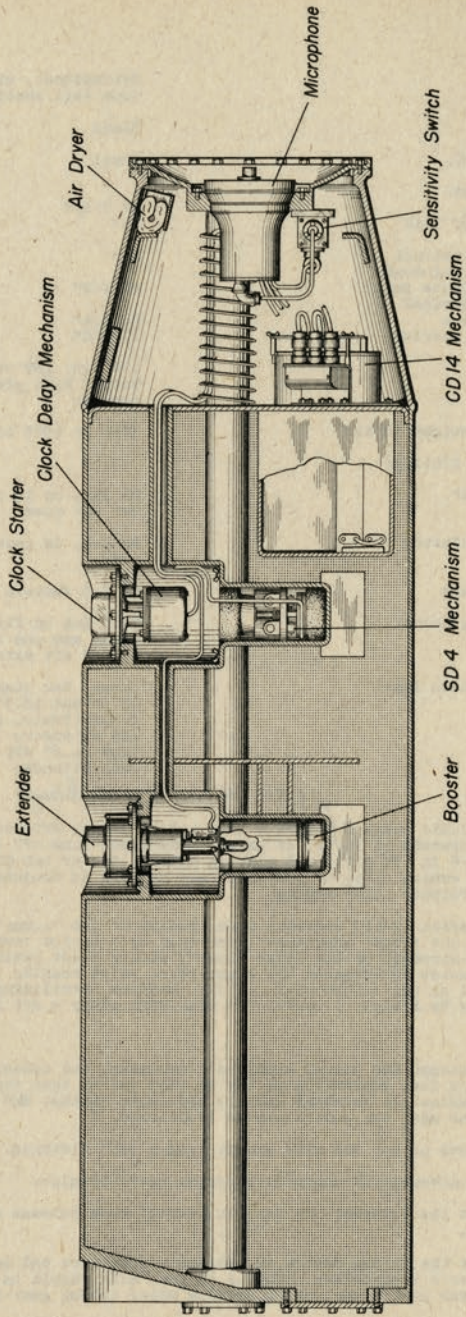


Fig. 21- Mk 25-1 Mine, Sectional View

## U. S. INFLUENCE MINES

### RMS

1. Prepare two Cavity Charge Containers Type 3, and pack them with 1/4 to 1/3 lb. C or C-2 plastic explosive.
2. Place one of the charges on the tail of the mine so that the projecting spacer rests against the left side of the after of the two fin supports (which are 45° from the extender and clock starter) and flush against the tail flange.
3. Hook the two fixed wire lengths into the two fin supports nearest them.
4. Hook the two variable wire lengths into the two fin supports nearest them to complete the securing of the charge.
5. In the same manner, hook the other charge to the tail 180° from the first charge.
6. Insert the detonators in the charges, hook up the firing leads and detonators leads in series, and fire the charge from a safe distance.
7. Allow a safe period to elapse before returning to the mine. If the mine is underwater, wait about 24 hours to allow the battery to discharge completely.
8. Ascertain whether or not the leads marked "F" and "A" respectively have been cut. If convenient, tape them. If the mine is underwater, it must be raised before removing the extender.
9. Remove the extender.
10. Remove and dispose of detonator, booster and charge.

### Mark 25-1

### General

1. Ground, acoustic mine.
2. Aircraft laid, with parachute.
3. Laid offensively in depths of water from 30 to 120 ft. against surface craft.

### Description

#### 1. Case

- (a) Same as Mk 25-0 except that the overall length is slightly greater (91 1/8") due to the use of a different parachute and parachute pack.

#### 2. External fittings

Microphone	MI-3 or MI-4, in center of tail cover plate.
Parachute	Mk 3-3, secured to tail.
All other external fittings are the same as on the Mk 25-0.	

### Operation

1. After soluble washers dissolve (may not be used), extender and clock starter operate in 16 ft. of water. The clock runs off (CD-1 in 45 min., CD-8 in 170 min.) and mine is armed. One or two CD-14 clocks (maximum arming delay of 100 days) may be used in conjunction with the CD-8 to further delay arming.
2. Firing device (A-5) operates when sound of proper frequency, intensity, and duration impinges on the microphone, firing the detonator or advancing the eight-place ships counter (SE-3) one step. An SD-4-1 or one or two CD-14 clocks (maximum sterilizing delay of 145 days) may be fitted to render the mine safe after a set period.

### Precautions

1. Never attempt RMS under any conditions. The sensitivity of the mine firing mechanism is so great that the dangers involved in any RMS procedure are prohibitive.

### RMS

1. None known.

Added 1 May 1945  
(Change No. 4)

U. S. INFLUENCE MINES

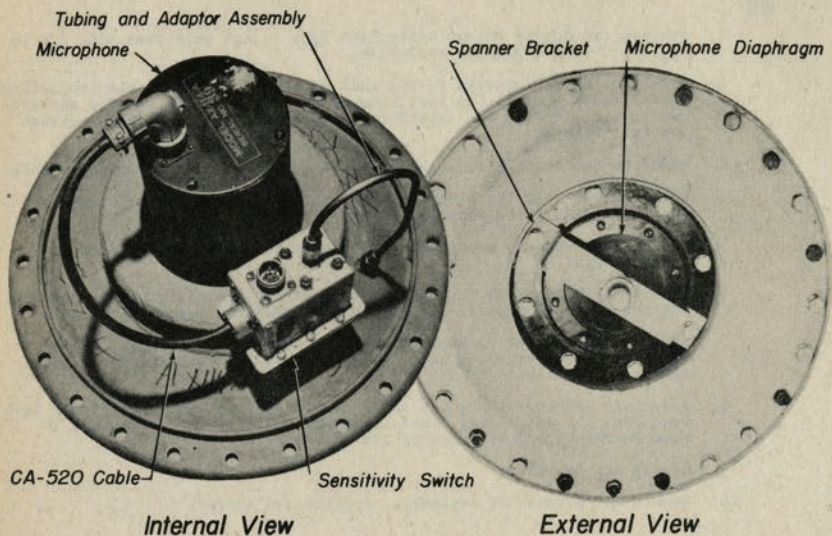


Fig. 23-Mk 25-1 Mine, Tail Plate Assembly

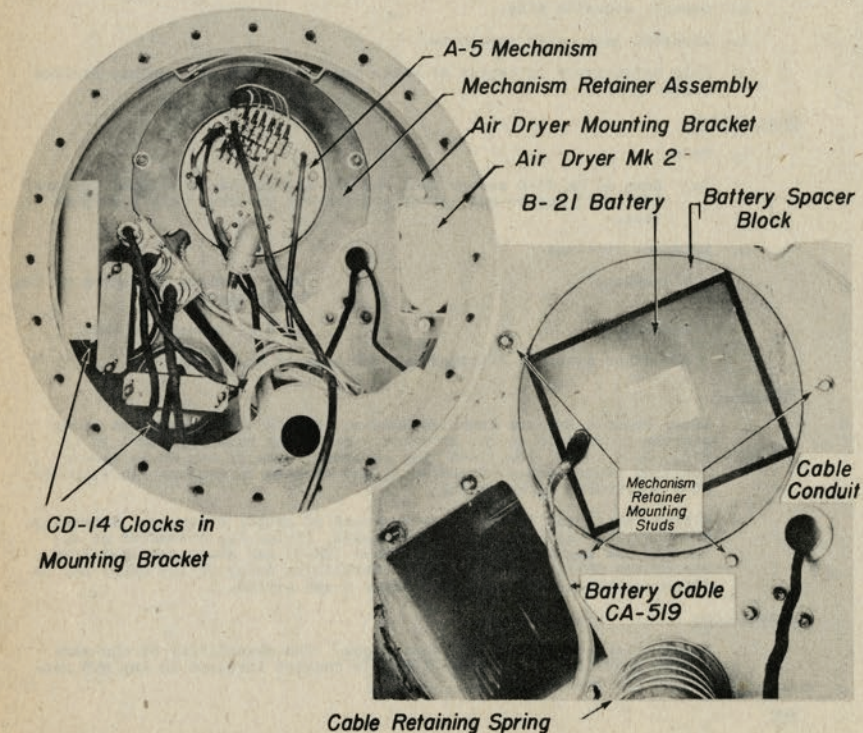


Fig. 24-Mk 25-1 Mine, Mechanism Compartment Assembly

U. S. INFLUENCE MINES

Mark 25-2

General

1. Ground, magnetic-pressure mine.
2. Aircraft laid, with parachute.
3. Offensive mine for use in maximum depth of water of 150 ft. against surface craft.

Description

1. Case

Shape	Cylindrical with truncated cone tail section and half slant nose.
Color	Black
Material	Steel
Diameter	
Case	22745
End of tail	18725
Length overall	9171
Charge	1120 lb. TNT or 1275 lb. Torpex
Total weight in air	1885 lb. or 2015 lb.

2. External fittings

Firing mechanism plate	Recessed in center of tail cover plate.
------------------------	---

All other external fittings are the same as on the Mark 25-0.

Operation

1. After soluble washers dissolve (not always used), extender and clock starter operate in 16 ft. of water. The clock runs off (CD-8 in 170 min., CD-14 in up to 145 days) and mine is armed.
2. Firing device (A-6) operates upon receipt of the proper combination of magnetic and pressure actuations, firing the detonator. Two CD-14's or an SD-4 mechanism may be fitted to render the mine inert after a set period.
3. Extender is designed to retract upon release of hydrostatic pressure.

Precautions

1. Do not attempt RMS unless absolutely necessary.
2. Even under emergency conditions, do not attempt RMS unless the mine has been positively identified. Diving on the mine should be attempted only if visibility is excellent and with the transceiver removed from the diving helmet.
3. Do not move or jar the mine except from a safe distance.
4. Allow no movement of magnetic material near the mine.
5. Bear in mind that the extender may fail to retract upon release of hydrostatic pressure. The mine incorporates no anti-recovery switch but the nature of the firing mechanism is such that recovery operations will probably actuate the mechanism and fire the detonator.

RMS

1. Remove the threaded plastic cap from the extender.
2. Remove the washer or castellated nut from the extender.
3. Screw the extender retracting tool (Fig. 25c) onto the extender stem.
4. Retract the extender by turning the lower cross bar of the tool.
5. If the mine is underwater, it should now be raised to the surface using remote lifting gear.

U. S. INFLUENCE MINES

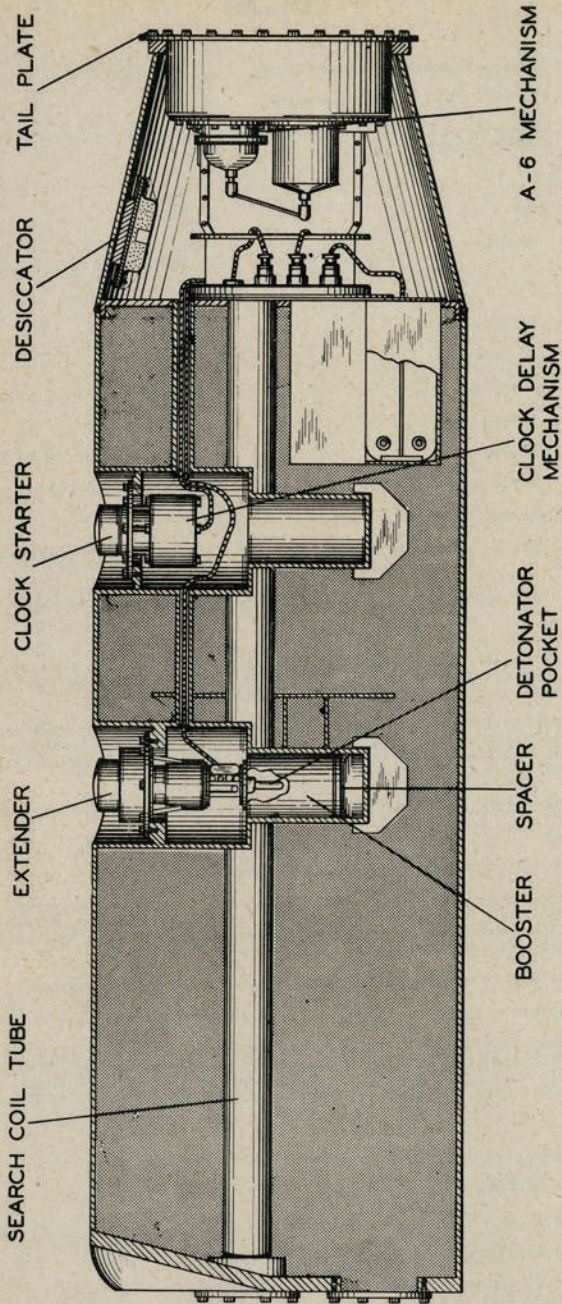


Fig. 25a - Mine Mk 25-2, Sectional View



U. S. INFLUENCE MINES

(Mark 25-2, Cont'd.)

6. Having brought the mine ashore, remove the clock and cut and tape the leads separately in the following sequence:
  - (a) Green and yellow.
  - (b) Red and white.
  - (c) Blue and black.
7. Remove the extender and cut and tape the detonator leads separately.
8. Dispose of detonator, booster and charge.

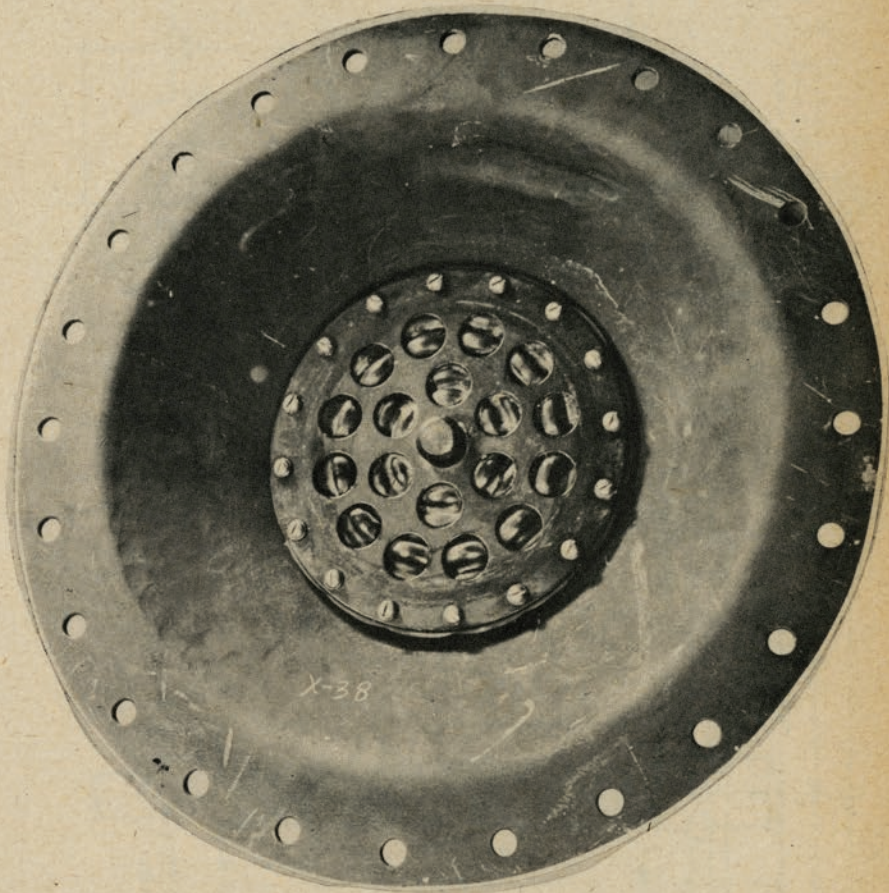


Fig. 25b - Mine Mk 25-2, Tail Cover Plate showing Firing Mechanism A-6-O



U. S. INFLUENCE MINES

AN Mark 26-1 (Mark 36 & 36-1)

General

1. Ground, magnetic induction mine.
2. Aircraft laid, with parachute.
3. Laid offensively in depths of water from 16 to 120 ft. against surface craft, and up to 500 ft. against submarines.
4. The Mk 36 differs from the AN Mk 26-1 in that its case is slightly longer, has a half slant nose, and carries a larger explosive charge. The Mk 36-1 differs from the Mk 36 in that it has removable suspension and hoisting lugs.

Description

1. Case

Shape	Cylindrical, with hemispherical nose and truncated cone tail section
Color	Black or olive drab
Material	Steel
Diameter	
Case	18 5/8"
Tail section	15 3/4"
Length overall	68" (70 11/16" for 36 & 36-1)
Case (without parachute pack)	64 1/2" (66 9/16" for 36 & 36-1)
Cylindrical section	44 3/4" (46 7/8" for 36 & 36-1)
Tail section	19 1/2"
Charge	465 lb. TNT or 525 lb. Torpex with granular TNT booster. (36 & 36-1 have 570 lb. TNT or 635 lb. TPX)
Total weight in air	1000 lb. or 1060 lb. (1020 or 1085 lb. for 36 & 36-1)

2. External fittings

Extender	Mk 12-4 or 14-2, in pocket 32" aft nose
Clock starter	Mk 1-4, in pocket 16" aft nose
Fuze pocket	In nose
Suspension lugs	Three, two standard type 270° from extender 19 1/2" and 34" aft nose respectively and one British type 45° from extender and 29" aft nose
Parachute	Mk 2, secured to tail of mine

Operation

1. Extender and clock starter operate in 16 ft. of water. Clock (CD-10 runs off in 170 min. and mine is armed. *CD-14 in 3-100 days.*
2. Firing device (M-9-1) operates on receipt of two "looks" of opposite polarity and proper magnitude within a set time limit, either firing the detonator, or advancing the eight-place ships counter one step. An SD-4 device may be fitted to render the mine inert after a set period.
3. Extender is designed to retract upon release of hydrostatic pressure.

Precautions

1. Do not attempt R.M.S. unless absolutely necessary.
2. Do not move or jar the mine except from a safe distance.
3. Allow no movement of magnetic material near the mine.

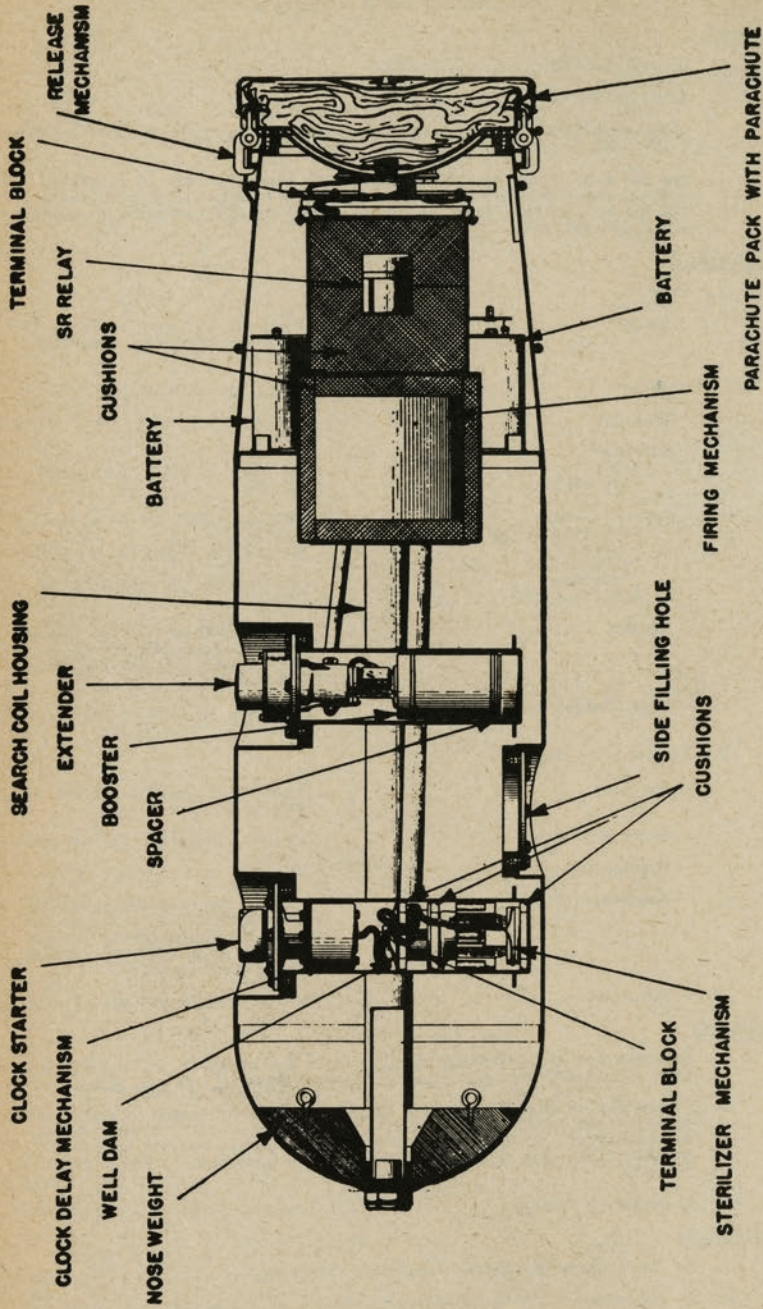


Fig. 25- AN-Mk 26-1 Mine, Sectional View

U. S. INFLUENCE MINES

(AN Mk 26-1 (Mk 36 & 36-1), Cont'd.)

4. Extender may fail to retract upon release of hydrostatic pressure.

RMS

1. Retract and lock out the extender. Use the wooden washer and safety nut from the Mk 6 tool kit for the 12-4, and the Type 2 non-magnetic extender retractor for the 14-2. If the mine is underwater, it must be raised before removing the clock.
2. Remove the clock from a safe distance.
3. Slit the clock cable, and cut and tape each lead separately.
4. Remove the extender from a safe distance.
5. Cut and tape the detonator leads separately.
6. Dispose of detonator, booster & charge.

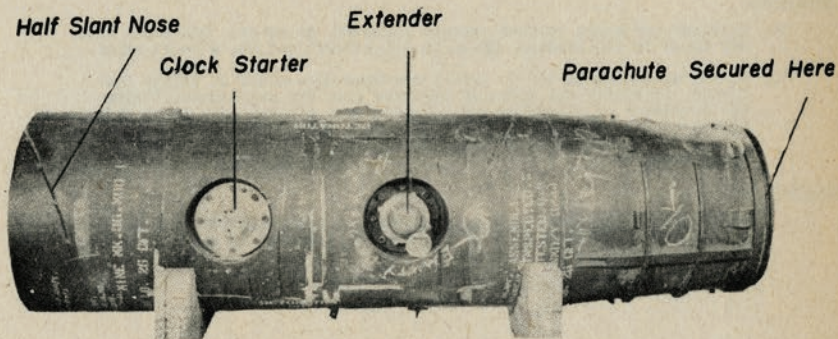


Fig. 26- Mk 36-1 Mine

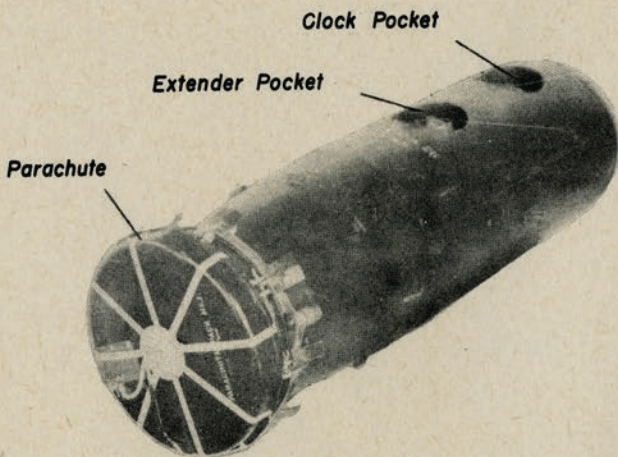


Fig. 27- AN-Mk 26-1 Mine

U. S. INFLUENCE MINES

Mark 36-2

General

1. Ground, acoustic mine.
2. Aircraft laid, with parachute.
3. Laid offensively in depths of water from 30 to 120 ft. against surface craft.

Description

1. Case

(a) Same as Mark 36-0 or 36-1.

2. External fittings

Microphone

Mi-4, in recessed cup offset from center of tail cover.

All other external fittings are the same as those on the Mark 36-0.

Operation

1. Extender and clock starter operate in 16 ft. of water. The clock runs off (CD-8 in 170 minutes, CD-14 in 3-145 days) and the mine is armed.
2. Firing mechanism (A-5-0 or A-5-1) operates when sound of proper frequency, intensity and duration impinges upon the microphone, firing the detonator or advancing the 10-place ship counter (SE-3) one step. Two CD-14's in parallel or an SD-4-1, or a single CD-14 in combination with an SD-4-1 may be fitted to render the mine inert after a set period.

Precautions

1. Never attempt RMS under any circumstances. The sensitivity of the firing mechanism is so great that the dangers involved in any RMS procedure are prohibitive.

U. S. INFLUENCE MINES

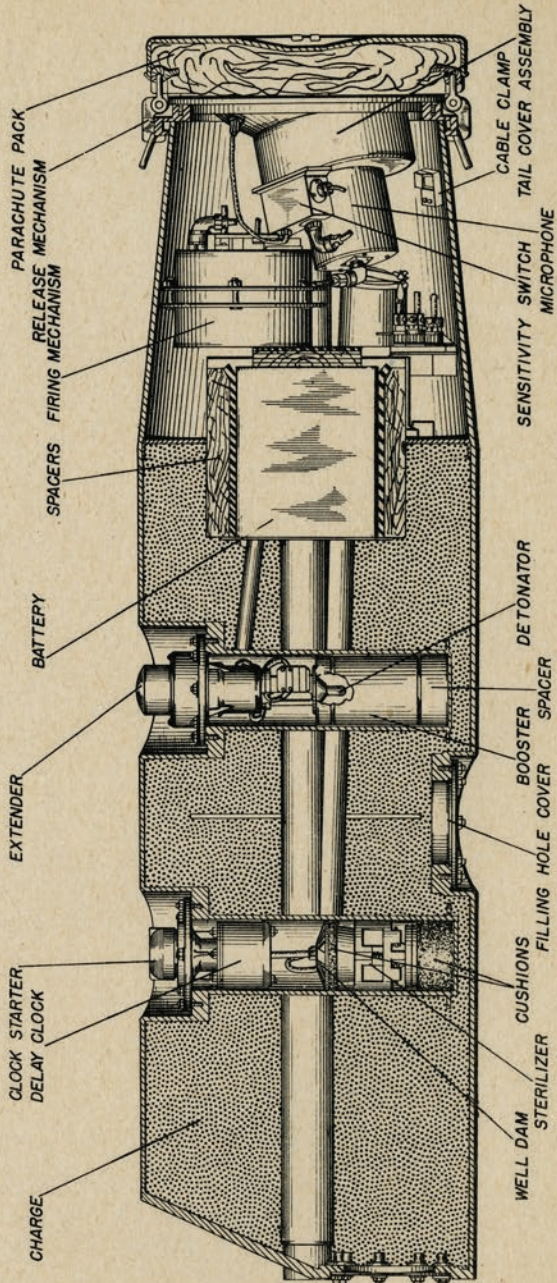


Fig. 28 - Mine Mk 36-2, Sectional View

U. S. INFLUENCE MINES

Mark 27 Mod 0

General

1. The Mark 27-0 is a torpedo-mine which combines an electric torpedo propulsion mechanism with a magnetic induction firing mechanism. It is designed to be launched from a torpedo tube, travel a distance between 1000 and 5000 yards at a depth between 10 and 60 ft, and then sink and become a ground mine. The weapon is designed to be effective as a mine in depths between 16 and 200 ft.
2. This mine is designed primarily for use against surface craft in harbors, anchorages, and other locations which are inaccessible to surface mine-laying craft.

Description

1. Case

Shape	Torpedo-shaped, with ogival nose and finned tail.
Color	Yellowish brown (shellacked surface).
Material	Steel
Length	
Overall	20'6"
Warhead	3'11"
Battery Compartment	10'6"
Afterbody	4'6"
Tail	1'7"
Diameter	21"
Charge	847 lb. HBX with 2 1/2 lb. granular grade A TNT booster.
Total weight in air	2620 lb.

2. External fittings

(a) Warhead

Impeller base	8" diam., on bottom center line. 2' 5" forward of battery compartment joint.
Flood valves	Two, on top and bottom center lines, respectively 3' 6" forward of battery compartment joint

(b) Battery Compartment

Guide studs	Three, on top center line; one 11 1/2" abaft warhead joint; two, 5' 5" and 7 1/2" forward, respectively, of afterbody joint.
Extender	Mk 14-0, in pocket on top center line, 2' 9 1/2" abaft warhead joint.
Clock starter	Mk 1-9, in pocket on top center line, 20 1/2" abaft warhead joint.
Flood valves	Two; one on top center line, 4' 8 1/2" forward of afterbody joint; one on bottom center line, 3' 8" forward of afterbody joint.
Priming switch	7 1/2" to starboard from top center line, 11" forward of afterbody joint.
Filling hole	90° to port from top center line, 2' 3" abaft warhead joint.
Access hole to battery discharge compartment	On top center line, 8" forward of afterbody joint.



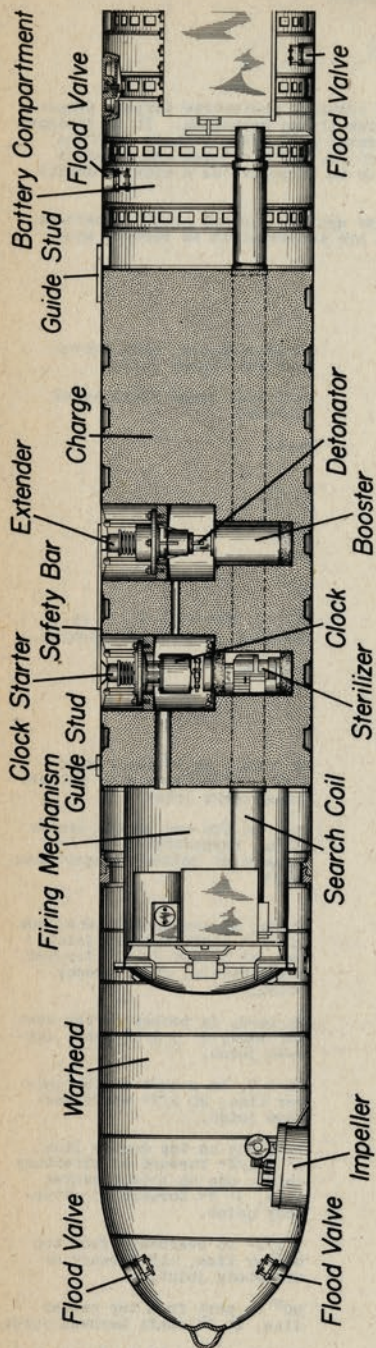


Fig. 28 - Mk 27-O Mine, Sectional View, Forward Half

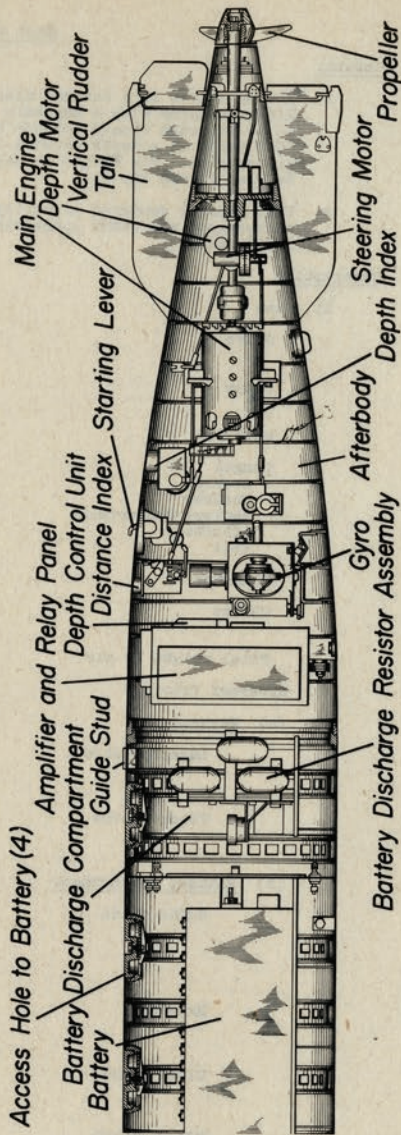


Fig. 29 - Mk 27-O Mine, Sectional View, After Half

U. S. INFLUENCE MINES

(Mark 27 Mod 0, Cont'd.)

Access holes to battery

On top center line, 3' 11", 2' 10", and 1' 9", respectively forward of afterbody joint.

(c) Afterbody

Distance index

On top center line, 14 1/2" abaft battery compartment joint.

Starting lever

3 1/2" to starboard from top center line, 21" abaft battery compartment joint.

Depth index

1" to starboard from top center line, 2' 3 1/2" abaft battery compartment joint.

Gyro angling setting spindle and dial

Two, 19" to starboard and to port, respectively, from top center line, 23" abaft battery compartment joint.

Flood valve

14 1/2" to port from top center line, 2' 3 1/2" abaft battery compartment joint.

Heater flange

On bottom center line, 3' 4 1/2" abaft battery compartment joint.

Access holes to gyro and motor

Two; one 90° to starboard from top center line, 2' 6" abaft battery compartment joint; one 19 1/2" to port from top center line, 17 1/2" abaft battery compartment joint.

(d) Tail

Fins

Upper vertical

Length, including rudder, 2' 1 1/2"

Lower vertical

Length, including rudder, 23 1/2"

Horizontal

Two; length, including rudders, 23 1/2"

Propeller (one)

Three-bladed, 6" span.

3. Internal arrangement of parts

(a) Warhead - contains the following:

- (1) An impeller mounted in the base of the warhead.
- (2) Two flood valves. It should be noted that the explosive charge of this mine is not contained in the warhead.

(b) Battery Compartment - consists of three main parts as follows:

- (1) The firing mechanism and charge compartment which contains not only the firing mechanism and charge but also the various firing mechanism accessories.
- (2) The battery chamber, separated from the firing mechanism and charge container by a bulkhead, which contains the following:
  - (i) The battery, consisting of two sections rated at 72 and 24 volts, respectively.
  - (ii) Three flood valves.
- (3) The battery discharge compartment, separated from the battery chamber by a bulkhead, which contains the following:
  - (i) The battery discharge resistor assembly which allows two sections of the battery to discharge at the end of the laying run.
  - (ii) The priming switch which is used to open or close the control circuits.

U. S. INFLUENCE MINES

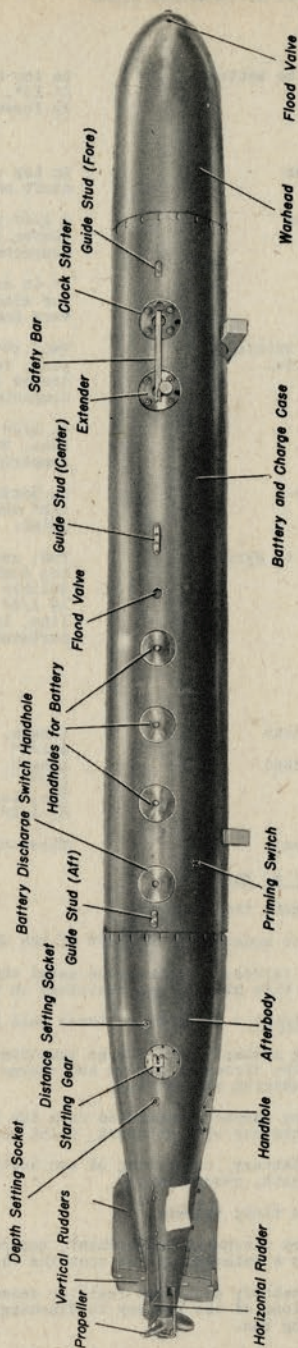


Fig. 30- Mk 27-O Mine

## U. S. INFLUENCE MINES

(Mark 27 Mod 0, Cont'd.)

(c) Afterbody - contains the following:

- (1) The depth control assembly composed of:
  - (i) The depth control unit.
  - (ii) The depth setting unit.
  - (iii) An amplifier.
  - (iv) The depth motor.
- (2) The steering assembly composed of:
  - (i) The gyro.
  - (ii) The gyro angling setting unit
  - (iii) An amplifier.
  - (iv) The steering motor.
- (3) A relay panel containing the protective and supervisory relays.
- (4) The distance assembly composed of:
  - (i) Distance setting unit.
  - (ii) Distance gear.
- (5) The starting gear.
- (6) The main engine.
- (7) A circuit testing plug.

(d) Tail - contains the following:

- (1) The rudder control linkages from the depth and steering motors.
- (2) The propeller drive shaft.

### 4. Method of Assembly

- (a) The various sections of the mine are attached by means of joint screws similar to those used in U.S. torpedo assembly.

### Operation

#### 1. Prior to launching the mine:

- (a) The batteries are heated through the heater flange.
- (b) The desired distance, gyro angling, and depth of run are set on the respective control units.
- (c) The priming switch is turned on, thereby energizing the control circuits.

#### 2. When the mine is launched, the starting lever is tripped, starting the motor. As the mine leaves the tube, the safety bar springs off, allowing the clock starter and extender to operate if the mine is in more than 16 ft. of water. The mine then travels through the water, with the various control assemblies operating as follows:

- (a) The depth control assembly keeps the mine at its set depth. The depth control unit records the actual depth which is relayed to the depth setting unit which compares it with the set depth. Any deviation from the set depth is noted and a correction is made by the amplifier which controls the depth motor. As a special precaution a ceiling switch in the depth control unit cuts off the propulsion engine if the mine rises above a depth of 1 1/2 ft. at any time during the run, and allows the engine to start again as soon as the mine sinks to a depth of 20 ft. This feature prevents the mine from broaching, running on the surface, or running up on the beach.
- (b) The steering assembly controls the mine's course. The gyro records the actual course which is relayed to the gyro angling device which compares it with the set course. Any deviation from the set course is thereby noted and a correction made by the amplifier which controls the steering motor.

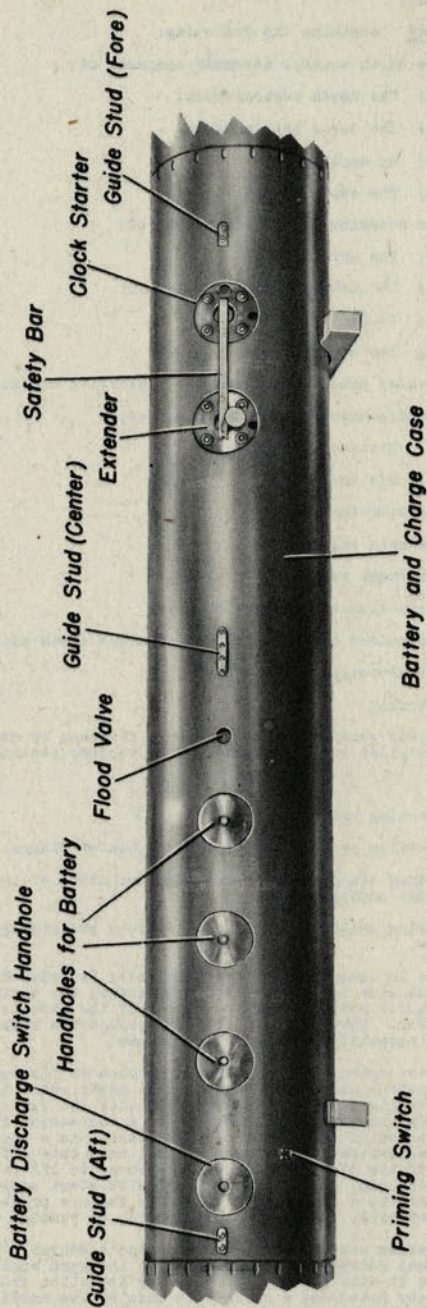


Fig. 31- Mk 27-O Mine, Battery Compartment (Including Firing Unit and Charge)

Added 25 July 1945  
(Change No. 9)

## U. S. INFLUENCE MINES

(Mark 27 Mod O, Cont'd.)

- (c) The impeller revolves and after the mine has traveled at least 350 yards it closes the impeller switch which provides a connection from one side of the 24 volt battery to the solder pot.
3. When the mine has run the desired distance as determined by the mechanical motion transmitted by the distance gear, which is run by the propulsion motor, to the distance setting unit, the distance switch in the distance setting unit closes and performs the following functions:
  - (a) It stops the propulsion engine, and removes power from the control mechanisms after the horizontal rudders have been placed in the down position.
  - (b) It opens the various flood valves, allowing the mine to sink.
  - (c) It closes a switch, thus completing the circuit to the solder pot and allowing current from the 24 volt battery to flow through a solder pot and close a relay which completes one side of the mine firing circuit.
  - (d) It closes a relay to allow the battery to discharge through the discharge resistor.
4. When the mine sinks, the extender and clock starter operate if they have not done so previously. The clock (CD-10-0) runs off in 170 minutes and the mine is armed.
5. The firing mechanism (M-9-1) operates upon receipt of two "looks" of proper magnitude and opposite polarity within a preset time limit, firing the detonator or advancing the eight-place stepping switch (SS-9) one step thus "counting" one ship. An SD-4-1 mechanism is fitted to render the mine inert after a set period.

### Precautions

1. Do not attempt RMS unless absolutely necessary.
2. Do not move or jar the mine except from a safe distance.
3. Allow no movement of magnetic material near the mine.
4. Extender may fail to retract upon release of hydrostatic pressure.

### RMS

1. Under development

# MINE DISPOSAL HANDBOOK

## PART II

### UNITED STATES UNDERWATER ORDNANCE

• • • • •

#### CHAPTER 2

#### U. S. CONTACT MINES

U. S. CONTACT MINES

Mark Laid By	How Fired	Length (in.)	Diameter (in.)	Case Depth (ft.)	Type & Wt. of Charge (lbs.)	Total Wt. (lbs.)	Extender	Notes	
5	Surface Craft	Chem. Horn	40 5/8	36	25 to 500	500 TNT	800 (appr)		
6	Surface Craft	Sea Battery		34 1/4	15 to 320	300 TNT	495	Mk. 6-2	All Mods. of Mk. 6 use K2-2, K2-3, K3 K4 and K4-1.
6-2	Surface Craft	Sea Battery		34 1/4	15 to 320	300 TNT	495	Mk. 6-2	Rising mine
6-3	Surface Craft	Sea Battery		35 13/16	15 to 320	300 TNT	540	Mk. 6-2	Lower Antenna
6-4	Surface Craft	Sea Battery		34 1/4	15 to 320	300 TNT	495	Mk. 6-2	"
7	Surface Craft	Sea Battery		34 1/4	15 to 320	300 TNT	495	Mk. 6-2	Drifter
10-1	Sub-marine	Chem. Horn	91 5/8	20 3/4	10 to 65	300 TNT	700	Mk. 6-4	
11-1	Sub. or Surface Craft	Sea Battery	40	35 3/4		500 TNT	700 approx	Mk. 6-3	Uses K3-1A
19	Aircraft	Impact Inertia	67	18 5/8		210 TPX	550	Mk. 14-5	Drifting Oscillator
23	Surface Craft	Impact	44	18 maximum	18 to 30	2 TNT	77		Sweep Obstructor

Table II--Contact Mines

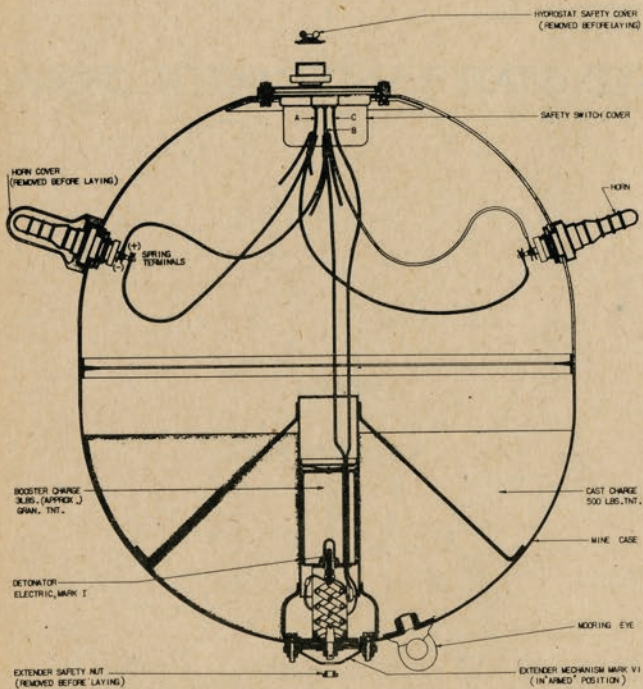


Fig. 1-- Mk. 5 Mine, Sectional View



## U. S. CONTACT MINES

### Introduction

1. Most of the mines are spherical or cylindrical in shape, and have four copper horns equally spaced around the upper hemisphere. A "K" device is fitted in the top of the mine, and an extender in the base, both depending on hydrostatic action for their operation. Copper antennae, both upper and lower, may be fitted.
2. The firing mechanisms depend upon galvanic action for operation, with the exception of those fitted in the Mk. 5 and Mk. 10-1 which use chemical horns.
3. All mines laid from surface craft take depth by means of a plummet fitted on the anchor, while the submarine-laid mines take depth by means of a loose bight-hydrostat system.
4. All mines have mild steel cases, and the explosive train is made up as listed below:
  - (a) Detonator Mercury fulminate
  - (b) Booster Granular TNT
  - (c) Main charge Cast Grade A TNT or Torpex
5. All mines, whatever the firing device fitted, depend upon hydrostatic action for arming and disarming. The safety switches and extenders tend to jam due to marine growth after they have been planted for a short time, and cannot be depended upon to disarm the mine upon release of hydrostatic pressure. Therefore, all mines found must be considered dangerous until they are proven by inspection to be otherwise. When possible, a mine that is found in the armed condition should not be rendered safe, but should be countermined or sunk in deep water.

### Mark 5

#### General

1. Moored, contact, chemical horn mine.
2. Laid by surface craft.
3. Laid defensively in depths of water from 40 to 2800 ft. against surface craft or submarines. Case depth is from 25 to 500 ft.

#### Description

1. Case

Shape	Two hemispheres with a cylindrical mid-section 4 5/8" wide
Color	Black
Material	Steel
Diameter	36"
Length	40 5/8"
Charge	500 lbs. TNT with granular TNT booster
Total weight in air	800 lbs. (approx.).
2. External fittings

Horns	Four, lead, evenly spaced around upper hemisphere
Lifting lug	One, on lower hemisphere
Hydrostatic safety switch	Mk. 1, fitted to opening on top
Extender	Fitted to opening on bottom.
3. Anchor

Mk. 6 anchor is used.

#### Operation

1. Mine takes depth by plummet. Extender operates in 24 ft. of water,

U. S. CONTACT MINES

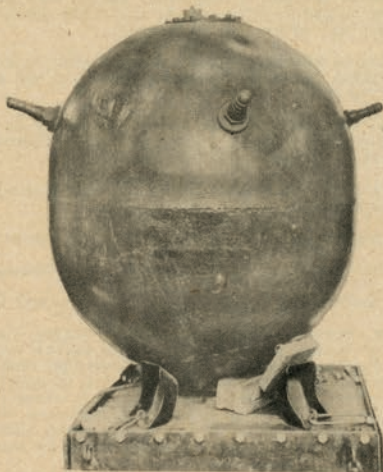


Fig. 2-- Mk. 5 Mine

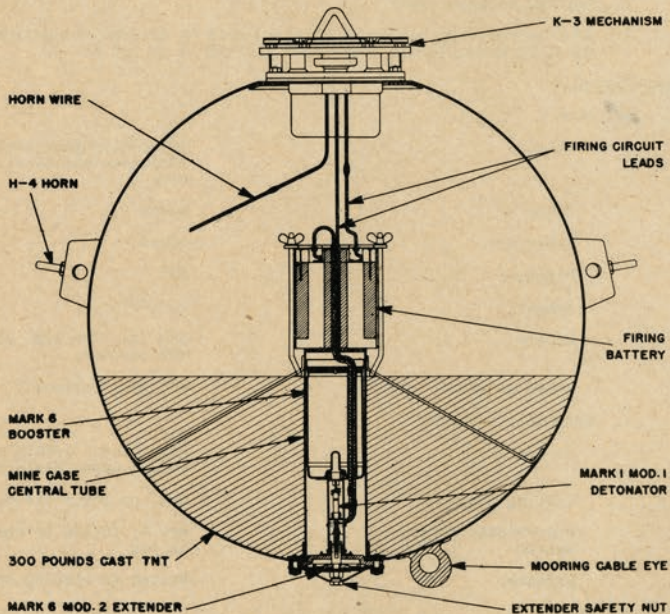


Fig. 3-- Mk. 6 Mine, Sectional View

CONFIDENTIAL

## U. S. CONTACT MINES

and, after the soluble washer dissolves, the hydrostatic safety switch will close, and the mine is armed.

2. Mine fires when the glass vial in a chemical horn is broken.
3. The hydrostatic safety switch and extender are designed to retract upon release of hydrostatic pressure.

### Precautions

1. Take care not to damage the horns in any way.
2. Hydrostatic safety switch and extender may fail to retract upon release of hydrostatic pressure.

### FMS

1. Retract and lock out the hydrostatic safety switch by screwing the soluble washer cap and nut down, or by using the dummy soluble washer from the Mk. 6 tool kit.
2. Retract and lock out the extender.
3. Remove the extender.
4. Cut and tape the detonator leads separately.
5. Dispose of detonator, booster and charge.

### Mark 6

### General

1. Moored, contact, antenna mine.
2. Laid by surface craft.
3. Laid offensively or defensively in depths of water from 40 to 2800 ft. against surface craft or submarines. Case depth is from 15 to 320 ft.
4. The Mk. 6 may be modified for planting in depths shallower than 15 ft. by removing the springs from the hydrostatic safety switch and extender.

### Description

1. Case

Shape	Spherical
Color	Black
Material	Steel
Diameter	34 1/4"
Charge	300 lbs. TNT with granular TNT booster
Total weight in air	495 lbs.
2. External fittings

K device	K2-2, 2-3, 3, or 4, fitted to the upper end of the central tube
Extender	Mk. 6-2, fitted to lower end of central tube
Horns	Four, H-4, evenly spaced around upper hemisphere
Antenna	Connects eye in K device with the antenna float
Hydrostatic safety switch	On K device
Mooring cable eye	One, on lower hemisphere
Lifting eye	One, on upper hemisphere
3. Anchor

Mk. 6 anchor is used.

U. S. CONTACT MINES

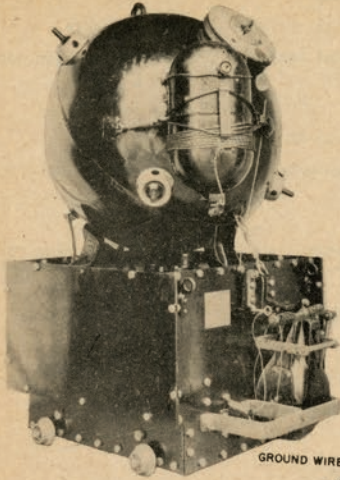


Fig. 4-- Mk. 6 Mine

Fig. 5-- Mk. 6-2 Mine,  
Sectional View

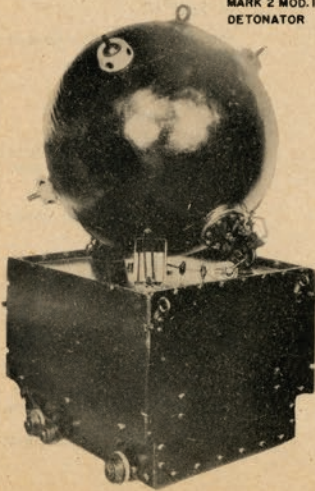
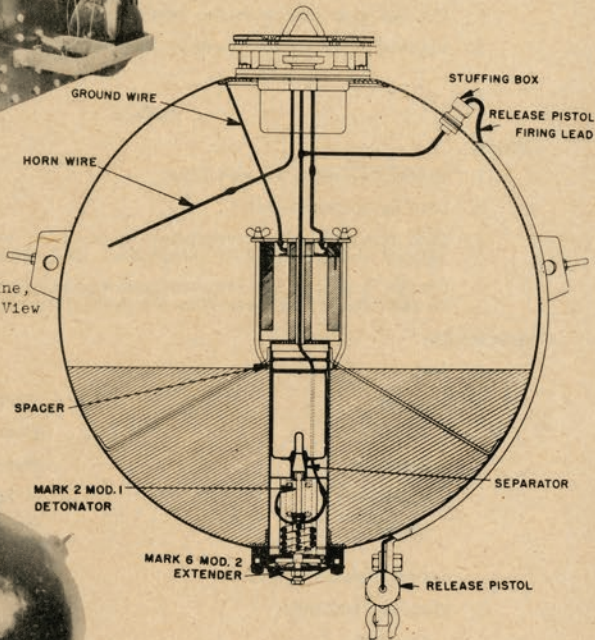


Fig. 6-- Mk. 6-2 Mine

## U. S. CONTACT MINES

4. The antenna floats used with the Mk 6 are the D-4, D-4-3 and D 4-6. The D-4, is a small float 20" long and 10" in diameter, consisting of two hemispheres joined by a cylindrical mid-section. The D-4-3 and D-4-6 differ from the D-4, in that they are fitted with three and four H-6 horns respectively which are electrically connected to the antenna.

### Operation

1. Mine takes depth by plummet. The extender operates in 24 ft. of water, and after the soluble washer dissolves, the hydrostatic safety switch will close, and the mine is armed.
2. Mine fires when a steel object contacts the antenna or an H-4 horn, or when an H-4 or H-6 horn is forced against its horn guard. This creates a sea battery, the current from which will operate a relay and close the firing circuit.
3. The hydrostatic safety switch and extender are designed to retract upon release of hydrostatic pressure.

### Precautions

1. Do not allow the horns or antenna to contact any metallic objects.
2. Hydrostatic safety switch and extender may fail to retract upon release of hydrostatic pressure.

### RMS

1. Place a copper short-circuiting clip on the K device, being certain that contact is made with both copper plates. (See note below).
2. Retract and lock out the extender. Any necessary movement of the mine must be done from a safe distance.
3. Retract and lock out the hydrostatic safety switch using the appropriate device, whether it be the retracting tool, splash cap or dummy soluble washer with nut.
4. Remove the extender.
5. Cut and tape the detonator leads separately.
6. Remove the K device.
7. Dispose of detonator, booster and charge.

Note: Any U. S. antenna mine may be fitted with an anti-sweeping crown, which so modifies the K device that a short-circuiting clip cannot be used. In this case, the K device should be short-circuited by thrusting a non-magnetic screwdriver firmly between the two plates. The screwdriver should be of the standard beryllium-copper type issued in the RMS tool kit. The K-4, which has a layer of plastic between the plates and cannot be shorted with a screwdriver, may be disarmed by contacting both plates with a bent piece of copper wire in the shape of a "V".

### Mark 6-2

### General

1. Same as the Mk. 6 except that it is a rising mine.

### Description

1. Mk 6 case is used.
2. External fittings

Release pistol	On bottom of case near extender
Stuffing box	On side of upper hemisphere
Firing lead	On outside of case, runs from stuffing box to release pistol

All other fittings are the same as on the Mk. 6

### Operation

1. Same as the Mk. 6, except that when contact is made, the release pistol is fired, opening a release hook, and freeing the mine, which rises approximately 34 ft. before the delay detonator fires.

U. S. CONTACT MINES

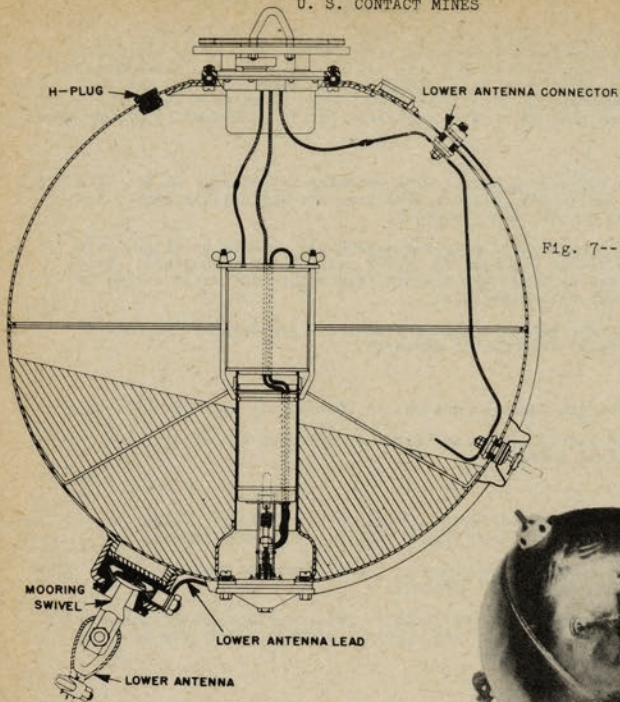


Fig. 7-- Mk. 6-3 Mine,  
Sectional View

Fig. 8-- Mk. 6-3 Mine

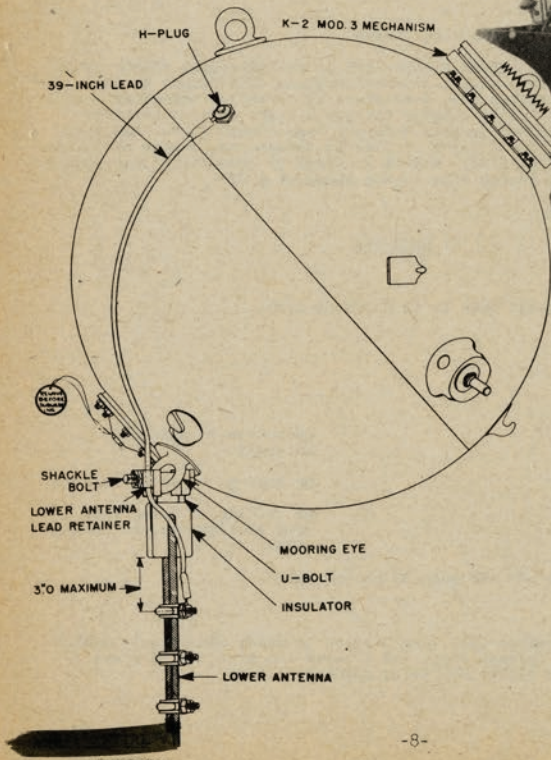
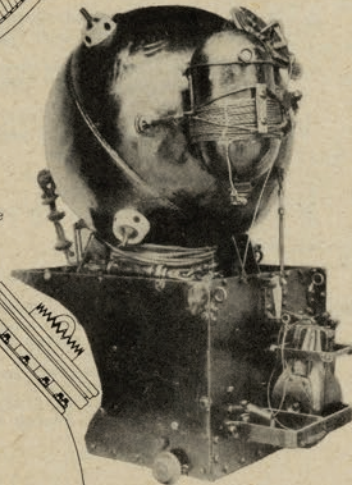


Fig. 9-- Mk. 6-4 Mine,  
Sectional View

U. S. CONTACT MINES

Precautions

1. Same as the Mk. 6, except that additional care must be exercised when handling the release pistol.

RMS

1. Same as the Mk. 6.

Mark 6-3

General

1. Moored, contact, upper and lower antenna mine.
2. Laid by surface craft.
3. Laid defensively in depths of water from 40 to 2800 ft. primarily against submarines. Case depth is from 15 to 320 ft.

Description

1. Case (Mk 9 modified)

Shape	Spherical
Color	Black
Material	Steel
Diameter	35 13/16"
Charge	300 lbs. TNT with granular TNT booster
Total weight in air	540 lbs.
2. External fittings

Mooring swivel	Near extender
Lower antenna	Streamed from mooring swivel
Stuffing box	Near K device
Lower antenna lead	Runs along case from lower antenna to the lower antenna connection, and is electrically insulated from case.
Horns	Four, H-4, two above and two below the center weld

All other fittings are the same as on the Mk. 6.

3. Anchor  
Mark 6-3 anchor is used.

Operation

1. Same as the Mk. 6 except that the firing device may also be actuated by a steel contact on the lower antenna.

Precautions and RMS

1. Same as the Mk. 6.

Mark 6-4

General

1. Same as the Mk. 6-3.

Description

1. Mk. 6 case is used.
2. External fittings

Horns	Three, H-4, on upper hemisphere
Stuffing box	In place of removed horn

U. S. CONTACT MINES

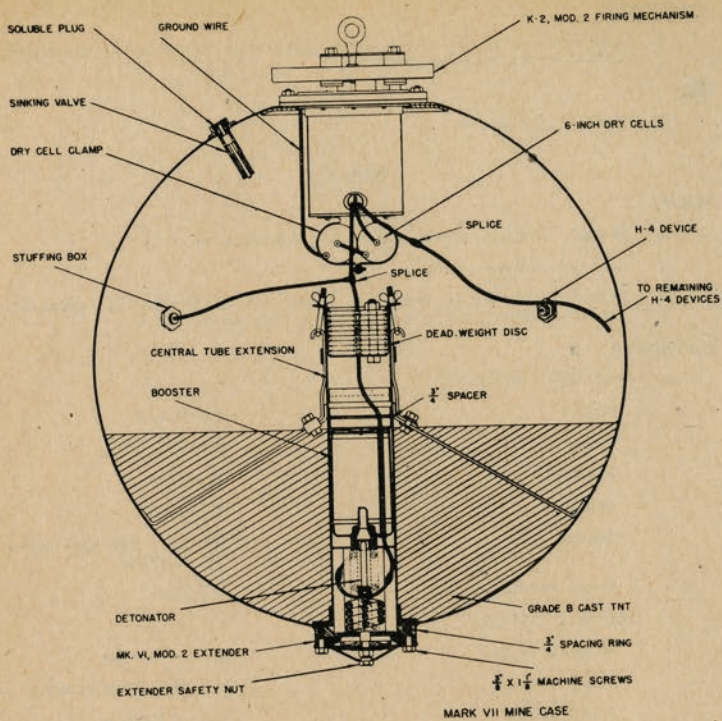


Fig. 10-- Mk. 7 Mine, Sectional View

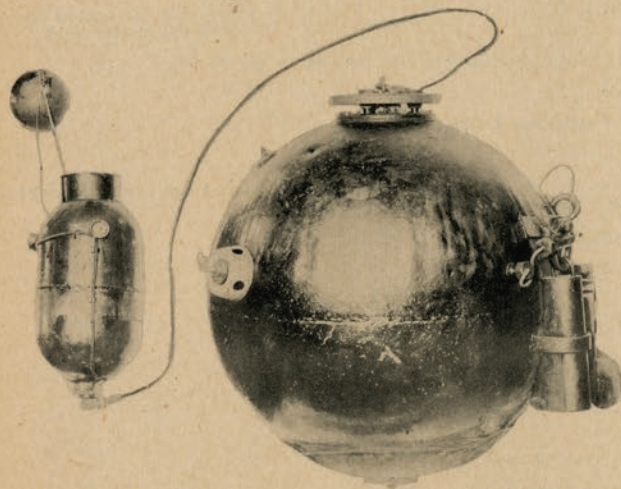


Fig. 11-- Mk. 7 Mine



U. S. CONTACT MINES

Insulator	On mooring attachment
Lower antenna lead	Runs outside case from lower antenna to stuffing box

All other fittings are the same as on the Mk. 6.

3. Anchor  
Mk. 6 anchor is used.

Operation, Precautions and RMS

1. Same as the Mk. 6.

Mark 7

General

1. Drifting, tactical mine.
2. Laid by surface craft.
3. Laid tactically or offensively against surface craft and designed to float about 37 ft. below the surface.

Description

1. Mk. 6 case is used.
2. External fittings

Horns	Three, H-4, around upper hemisphere
Stuffing box	In place of removed horn
Ballaster depth taking device	Directly below lifting eye
Flooder valve	Near K device on upper hemisphere
Release pistol	Secured to bracket

All other fittings are the same as on the Mk. 6.

3. Anchor  
A special truck or dolly is used to launch the mine and assist in initial depth taking.
4. An additional D-8 spherical float, 5" in diameter, is connected to the top of the D-4-3 float by 10 ft. of white line.

Operation

1. Mine takes depth by the hydrostatically controlled ballister device, and the depth is maintained by the positive buoyancy of the D-8 float.
2. When contact with the antenna or D-4-3 float is made, the release pistol fires, releasing an attached weight, and allowing the mine to rise about 34 ft. before the delay detonator fires.
3. If the mine has not fired one hour after laying, a soluble washer in the flooder valve dissolves, allowing water pressure to depress the valve and flood the mine.
4. The safety features are the same as in the Mk. 6.

Precautions and RMS

1. Same as for the Mk. 6.

Mark 10-1

General

1. Moored, contact, chemical horn mine.
2. Laid by submarine.

~~CONFIDENTIAL~~

U. S. CONTACT MINES

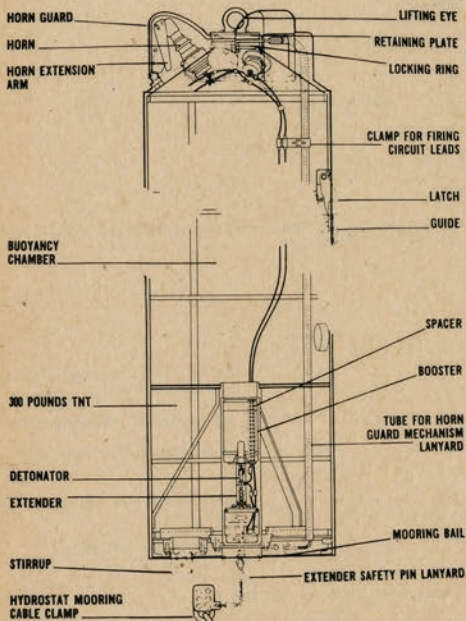


Fig. 12-- Mk. 10-1 Mine, Sectional View



Fig. 13-- Mk. 10-1 Mine

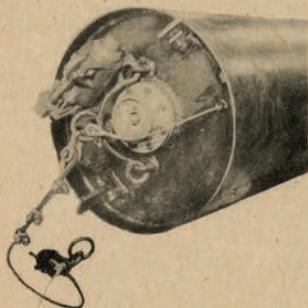


Fig. 14-- Mk. 10-1 Mine,  
Bottom View

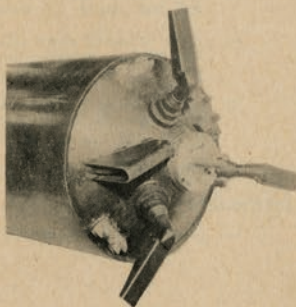


Fig. 15-- Mk. 10-1 Mine,  
Top View

U. S. CONTACT MINES

3. Laid offensively in depths of water from 50 to 500 ft. against surface craft. Case depth is from 10 to 65 ft.

Description

1. Case

Shape	Cylindrical with conical nose
Color	Black
Material	Steel
Diameter	20 3/4"
Length	91 5/8"
Charge	300 lbs. TNT with granular TNT booster
Total weight in air	About 700 lbs.
2. External fittings

Horns	Three, lead, extension type, on top
Extender	Mk. 6-4 on bottom
Depth taking hydrostat	Mk. 1, on bottom
Mooring eye	Bail type, on bottom
Lifting eye	On top
3. Anchor

Mk. 10-1 anchor is used.

Operation

1. Mine takes depth by the loose bight hydrostat system. Extender operates in 15 ft. of water, and releases clockwork. Clock runs off in a maximum of 52 min. and mine is armed.
2. Mine fires when the glass vial in a chemical horn is broken.
3. Extender is designed to retract upon release of hydrostatic pressure.

Precautions

1. Take care not to damage the horns in any way.
2. Extender may fail to retract upon release of hydrostatic pressure.

RMS

1. Retract the extender, close the jaws around the hydrostatic piston, and insert a cotter key or pin in the hole provided.
2. Remove the extender.
3. Cut and tape the detonator leads separately.
4. Dispose of detonator, booster and charge.

Mark 11-1

General

1. Moored, contact antenna mine.
2. Designed to be laid offensively from a special submarine, but may be laid from surface craft.

Description

1. Case

Shape	Two hemispheres, joined by a cylindrical mid-section 4 1/4" wide
Color	Black
Material	Steel

U. S. CONTACT MINES

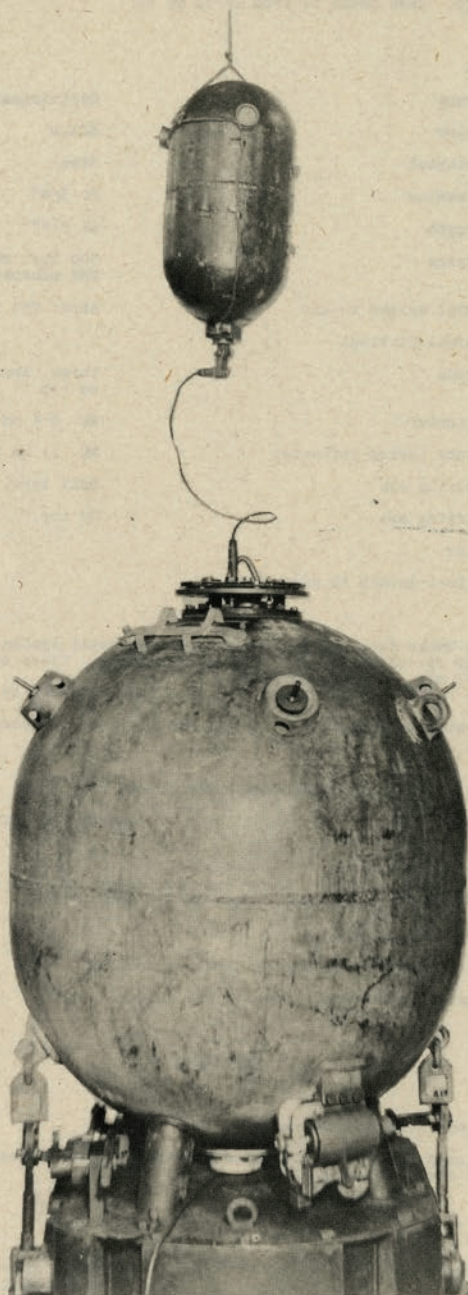


Fig. 16 - Mk 11-1 Mine

U. S. CONTACT MINES

Diameter	35 3/4"
Length	40"
Charge	500 lbs. TNT with granular TNT booster
Total weight in air	About 700 lbs.
2. External fittings	
Horns	Four, H-4, evenly spaced around upper hemisphere
K device	K-3-1, fitted to top of central tube
Extender	Mk. 6-3, fitted to bottom of central tube
Hydrostatic safety switch	On K device
Lifting eyes	Two, on lower hemisphere
Depth-taking hydrostat	Mk. 1, on lower hemisphere near extender

Operation

1. Mine takes depth by the loose bight hydrostat system. Extender operates in 24 ft. of water. Hydrostat in K device releases clockwork. Clock runs off in maximum of one hour and mine is armed.
2. Mine fires in the same manner as the Mk. 6, ~~except that there is no float or antenna firing.~~
3. The safety features are the same as in the Mk. 6.

Precautions

1. Same as the Mk. 6.

RMS

1. Place a short-circuiting clip on the K device.
2. Retract and lock out the hydrostatic safety switch.
3. Retract and lock out the extender as on the Mk. 10-1.
4. Remove the extender.
5. Cut and tape the detonator leads separately.
6. Remove the K device.
7. Dispose of detonator, booster and charge.

U. S. CONTACT MINES

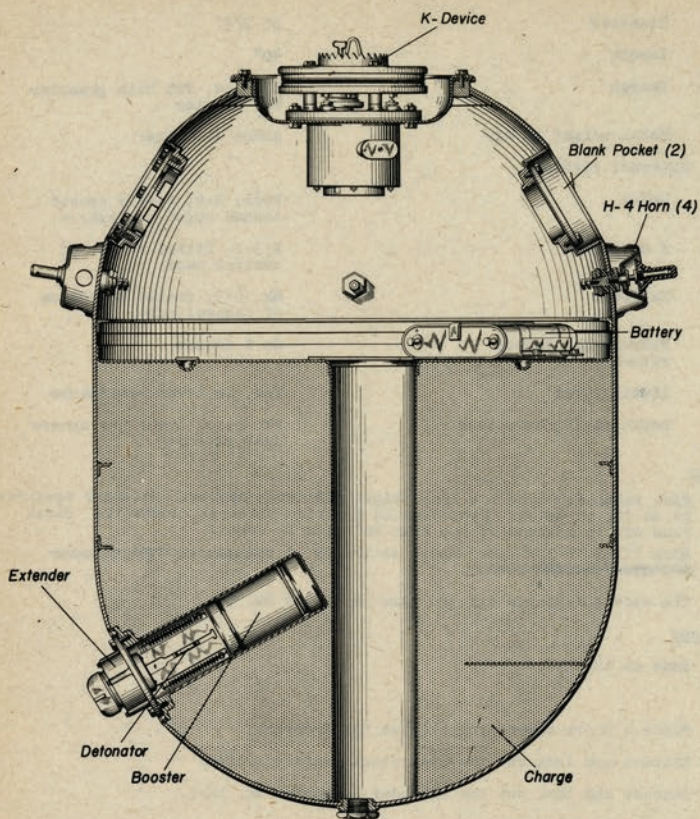


Fig. 17- Mk 16-1 Mine, Sectional View

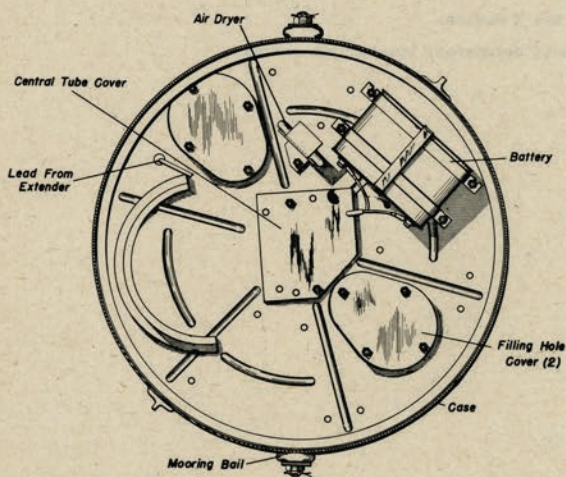


Fig. 17a- Mk 16-1 Mine, Top View - Cover Plate Removed

Added 15 April 1945  
(Change No. 3)

U. S. CONTACT MINES

Mark 16-1

General

1. Moored, contact, upper antenna mine, laid by surface craft.
2. Defensive mine, for use in maximum depth of water of 2800 ft. against surface craft or submarines. Maximum depth of case when moored is 300 ft.

Description

1. Case

Shape	Two hemispheres, joined by a 15" cylindrical mid-section
Color	Black
Material	Steel
Diameter	36"
Length	50 1/2"
Charge	600 lb. cast TNT with TNT booster
Total weight in air	1090 lb.

2. External fittings

Cover plate	16" diam., in center of upper hemisphere, flush type, secured by 24 bolts. Fitted with K device (probably K4, K4-1, possibly K3, K2-3).
Horns	Four, H-4, equally spaced around upper hemisphere, 17" from center. If a flooder is fitted, one of the horns is removed and a short length of pipe substituted.
Extender	Mk 12-3, on lower hemisphere, 17" from center.
Lifting eyes	Three, equally spaced around upper hemisphere, 25" from center.
Floater securing lugs	Two; one on upper hemisphere, 15" from center; one on cylindrical mid-section, 37" from center of upper hemisphere.
Anchor securing lugs	Three; two on lower hemisphere, 9" from center; one on lower weld, 29" from center of lower hemisphere.
Blank cover plates	Two, 7 1/2" diam., recessed, on upper hemisphere, 19" from center, secured by 8 bolts.
Blank plug	2 3/4" diam., screwed into center of lower hemisphere.
Mooring ball	Secured to two pivot posts, 180° apart on mid-section, 36" from center of upper hemisphere.

Operation

1. Same as Mk 6 except that an SD-4 device and flooder may be used to sink the mine after a set period.

Precautions

1. Note that other models of this mine are fitted with influence firing mechanisms and take appropriate precautions.
2. Keep clear of the flooder during RMS.

RMS

1. Same as Mk 6 except as follows:
  - (a) If a flooder is fitted, reach in the top of the mine case after removing the K device and cut and tape separately each of the five leads.

Added 15 April 1945  
(Change No. 3)

U. S. CONTACT MINES

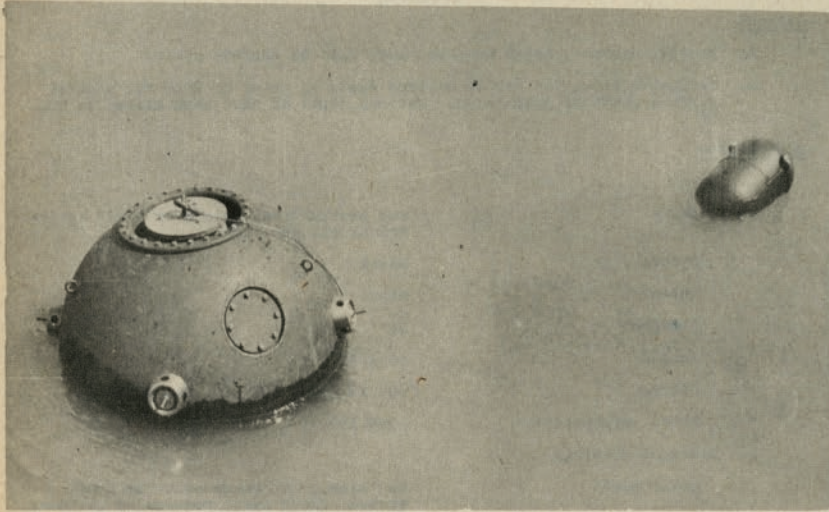


Fig. 18- Mk 16-1 Mine, Floating

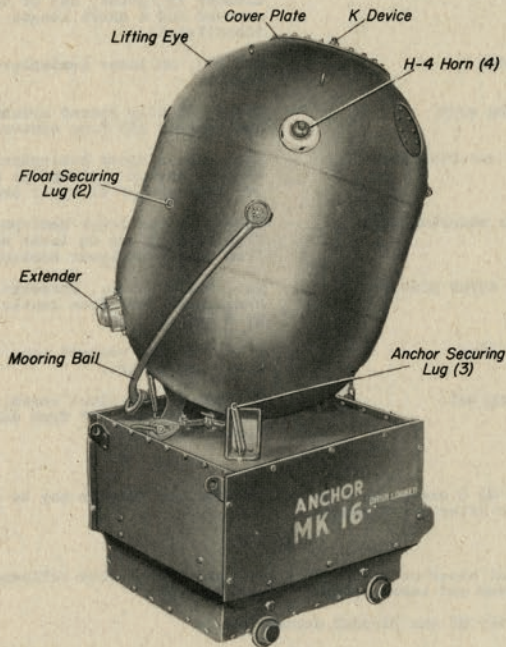


Fig. 19 - Mk 16-1 Mine



U. S. CONTACT MINES

Mark 19 (19-1, 19-2)

General

1. Drifting, contact, oscillating mine.
2. Laid by aircraft.
3. Laid offensively in rivers, harbors and anchorages. Designed to oscillate near a set depth, drift with the current, and to destroy shipping, docks, dams, bridges, etc.

Description

1. Case

Shape	Cylindrical, with conical tail section and fins
Color	Gray
Material	Steel
Diameter	
Case	18 5/8"
Fins	25 1/2"
Length	67"
Charge	210 lb. Torpex, with granular TNT booster
Total weight in air	550 lb.
2. External fittings

Propeller	Three bladed, 7" span, in tail section housing
Extender	Mk 14-5, in pocket on top center line 9" aft nose
Suspension lugs	Two sets of two, on longitudinal axis of case, 150° and 270° respectively from top center line
Hydrostatic switch	HS-2, in pocket on top center line, 14" forward of joint between case and tail section
3. The Mk 19-1 differs from the Mk 19 as follows:
  - (a) It is fitted with a Mk 14-6 extender which differs from the 14-5 only in the type of lock fitted.
  - (b) Small ballast weights are added to the tail and to the interior of the case.
  - (c) Minor wiring changes are made to vary the firing delay from 0-60 seconds.
4. The Mk 19-2 differs from the Mk 19-1 as follows:
  - (a) Its firing delay may vary from 0-7 seconds due to minor wiring changes.

Operation

1. The HS-2 which controls the depth at which the mine oscillates can be set from 10-60 ft. When the mine is launched, it sinks to a depth of 30 ft. due to momentum with the extender operating in 5-9 ft. of water. At 30 ft., HS-2 makes one of its contacts, starting the motor and ballast intake and automatically sending the mine toward its set depth. When the propeller rotates clockwise, the mine rises and ejects ballast. Counterclockwise rotation of the propeller causes the mine to sink and take on ballast. The mine oscillates between its set depth and a point six ft. below until oscillation is sufficiently slow to require 15 seconds for a single traverse between the two depths, at which time a heater coil arms the C-4 firing device.
2. The firing device operates on receipt of a lateral blow or when tilted more than 50°. Firing may be instantaneous or incorporate a 15-30 second delay. The design of the C-4 prevents a countermining shock from firing the mine. When battery potential falls below four volts, the mine destroys itself.

U. S. CONTACT MINES

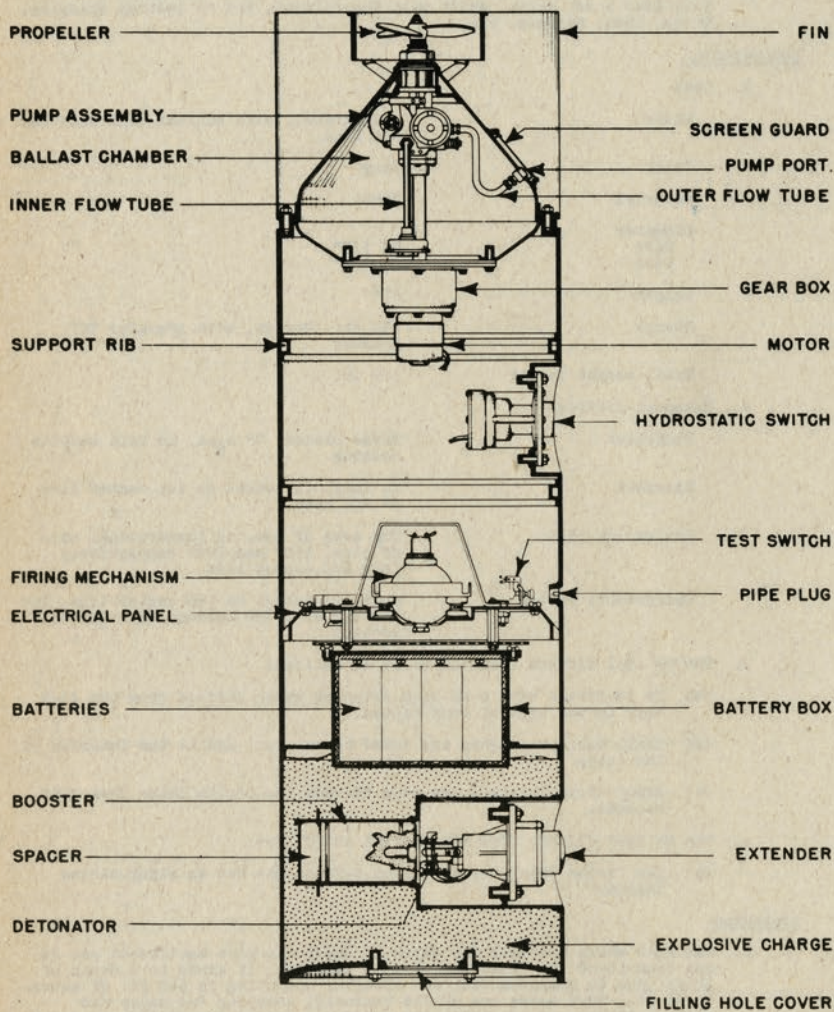


Fig. 20-Mk 19 Mine, Sectional View

U. S. CONTACT MINES

Mark 19 (19-1, 19-2) (Cont'd.)

3. No self-disarming devices are fitted.

Precautions

1. Do not attempt RMS unless absolutely necessary.
2. Do not move or jar the mine except from a safe distance.
3. Extender will not retract upon release of hydrostatic pressure.
4. Do not attempt underwater RMS. If the mine is found floating or submerged, pull it ashore from a safe distance.

RMS

1. Prepare Shaped Charge Liner, Type 1 (Part I, Chap. 5) and pack it with 1/3 lb. C or C-2 plastic explosive. Place the charge on the mine case in an athwartships position 300° from the top center line and 32" from the flange of the tail section.
2. Insert the detonator in the charge, secure the detonator leads and firing leads, and fire the charge from a safe distance.
3. Examine the mine to insure that the green wires from the battery to the detonator and to the extender switch are severed.
4. Remove the extender.
5. Dispose of detonator, booster and charge.

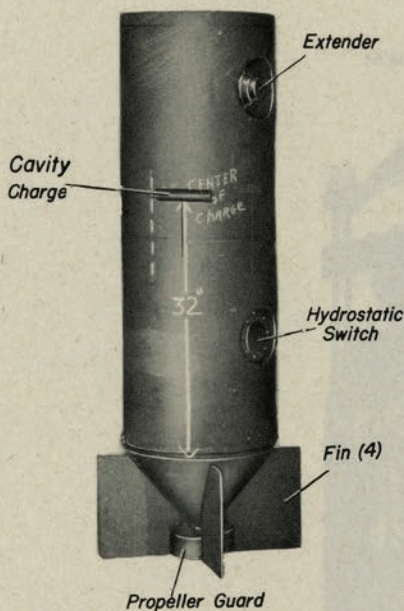


Fig 21 - Mk 19 Mine With Cavity Charge Fitted For R.M.S.



Fig 22 - Mk 19 Mine, Leads cut by Cavity Charge

U. S. CONTACT MINES

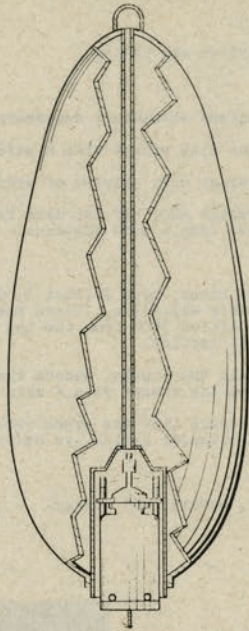


Fig. 23 - Mk 23 Mine



Fig. 24 - Mk C-1 Mechanism

U. S. CONTACT MINES

Mark 23

General

1. Moored, contact sweep obstructor.
2. Laid by surface craft.
3. Laid offensively or defensively in depths of water from 35 to 750 ft. Case depth is from 18 to 30 ft.
4. Laid in our own mine fields to destroy enemy minesweeping gear.

Description

1. Case (D-10 float)

Shape	Ovoid
Color	Black
Material	Steel
Diameter	18" maximum
Length	44"
Charge	2 lb. TNT
Total weight in air	77 lb.
2. External fittings

Lifting eye	Top of case
Firing device well	Bottom of case
C-1 firing device	In well
3. The complete unit consists of the case, the firing device, and a Mk 3-5 anchor with Mk 1 buoyancy chamber attached, and weighs about 1100 lb.

Operation

1. Mine takes depth by plummet. After the soluble washer dissolves, the firing device arms in 15 ft. of water.
2. Firing device operates when a sweep wire, riding up the mooring cable, exerts pressure on the firing ring, releasing locking balls which hold a spring-loaded percussion striker.
3. No self-disarming devices are fitted.

Precautions

1. Do not attempt RMS by disassembly or underwater. If the mine is found in the surf or submerged, pull it ashore from a safe distance.
2. When the float is armed, a firing ring protrudes about 1/2" from the housing of the firing mechanism. Never set the mine on its base, and take all possible precautions to prevent pressure from bearing on the firing ring. If the firing ring is not protruding when the mine is found, it should have fired, and is extremely dangerous.
3. Do not move or jar the mine except from a safe distance.

RMS

1. If necessary to move the mine before destroying it, wedge the firing ring in the "out" position.
2. Place 2/3 lb. to 1 lb. plastic explosive (or any equivalent charge) against the case 6 to 8" from the base.
3. Insert the detonator in the charge, secure the detonator leads and firing leads, and fire the charge from a safe distance.

U. S. CONTACT MINES

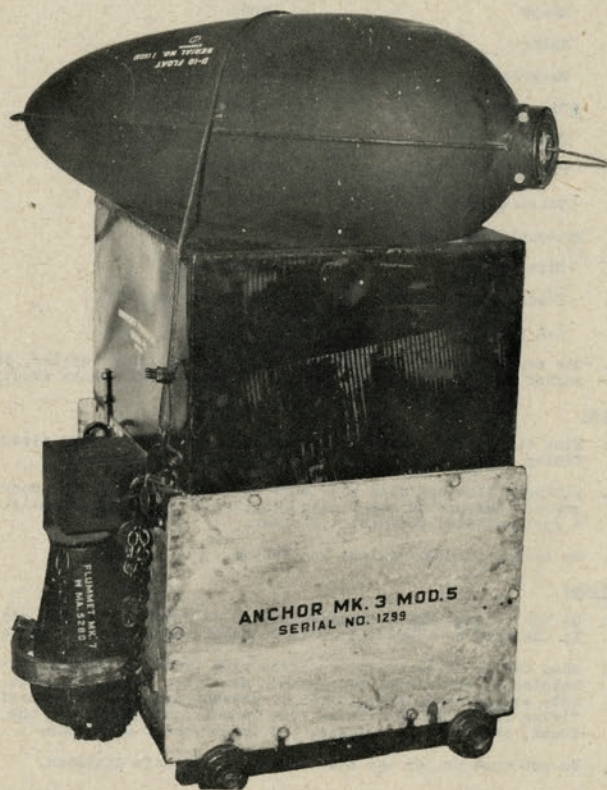


Fig. 25 - Mk 23 Mine With Anchor

# MINE DISPOSAL HANDBOOK

## PART II

### UNITED STATES UNDERWATER ORDNANCE

• • • • •

#### CHAPTER 3

#### U. S. TORPEDOES

U. S. TORPEDOES

Torpedo Mark	Launched From	Length Overall Including Warhead	Diameter	Power Source	Speed and Range Knots/Yards	Warhead Length (in.)	Remarks
8-3C 8-3D	Destroyer	20'8"	21"	Steam turbine	27/13,500	27	Obsolescent
13 and Mods	Aircraft or PT	13'5"	22 3/4"	"	See table #5	54	See table #5 for details of several Mods
14-3A	Submarine	20'6"	21"	"	31-32/9000 45-47/4500	47	
15-1 15-2 15-3	Surface Craft except PT	24'0"	"	"	27/15,000 34/10,000 46/6,000	58	
18-1 18-2	Submarine	20'6"	"	Storage battery	29/4,000	47	Electric
23 23-1	"	Same as 14-3A	"	Steam turbine	45-47/4500	41 or 47	Same as 14-3A except has single high speed

Table 1 - U.S. Torpedoes

Warhead Mark	Torpedo Fitted on	Exploder Used	Type and Wt. (lb.) of Charge	Total Wt. (lb.)	Length (in.)	Material	Remarks
8-2	8-3C 8-3D	Mk 3-2 Mk 3-4	371 TNT	510	27	Steel	Obsolescent
8-3	"	"	384 TNT	523	"	"	"
13-1	Mk 13 and all Mods	4-1, 4-3, 4-5, 4-8, 4-8A, 4-8B, 4-9	600 TNT or TPX	825	54	"	
13-2	"	8, 8-2, 8-4, 8-6	600 TNT or 554 TPX	826	"	"	Nose cap of TNT used with Torpex
13-3	"	"	554 TPX	826	"	"	"
15	14-3A, 15-1, 15-2, 23, 23-1	6-1, 6-1A, 6-1B, 6-4A, 6-4B, 6-5, 6-6, 6-7, 6-8, 10-3	494 TNT	845	41	Bronze	Used only with Mk 1 extension
15-1	14-3A, 23, 23-1	6-1, 6-1A, 6-4A, 6-5, 6-7, 10-3	588 TNT	996	47	"	Same as Mk 15 plus Mk 1 Extension
15-2	15-1, 15-2, 15-3	6-1, 6-1B, 6-4B, 6-6 6-8	789 TNT	1224	58	"	Same as Mk 15 plus Mk 2 Extension
16	14-3A, 23 23-1	Same as 15-1	594 TNT or 589 TPX	956	47	"	Nose cap of TNT used with Torpex
16-1	"	"	621 TPX	1053	"	"	Nose cap of TNT
16-4	14-3A, 23 23-1	"	613 TPX	1057	"	"	"
17	15-1, 15-2 15-3	Same as 15-2	807 TNT	1229	58	"	
17-2	"	"	800 TNT	1234	"	"	
18-1	18-1, 18-2	8-1, 8-3, 8-5, 8-7	570 TPX	711	47	Steel	Nose cap of TNT
18-2	"	"	600 TPX	736	"	"	"

Table 2 - U.S. Torpedo Warheads

Added 10 June 1945  
(Change No. 6)



U. S. TORPEDOES

Mark	Length (in.)	Diameter (in.)	Type and Wt. (lb.) of Charge	Weight (lb.)	Remarks
Mk 1	6	21	94 TNT	151	
Mk 2	17	21	295 TNT	379	

Table 3- U.S. Torpedo Warhead Extensions

Exploder	Shape of Base Plate	Base Plate Dimensions (in.)	Approx. Weight (lb.)	Fits in Following Warheads	Firing Mechanism	Remarks
Mk 3, Mods 2 and 4	Round	3 1/2 diam.	5 1/4	Mk 8 Mods 2 and 3	Inertia Ball Type	Obsolescent
Mks 4-1, 4-1A, 4-3, 4-5, 4-8, 4-8A, 4-8B, 4-9	Oval	7 x 13	32	Mk 13-1	Inertia Ring Type	Fits forward in warhead
Mks 8, 8-2, 8-4, 8-6	Round	8 diam.	26	Mks 13-2, 13-3	"	Fits aft in warhead
Mks 8-1, 8-3, 8-5, 8-7	"	"	"	Mks 18-1, 18-2	"	Mk 18 electric torpedo only. Fits aft in warhead
Mks 6-1, 6-1A, 6-1B, 6-4A, 6-4B, 6-7, 6-8	Rectangular. Round corners	14 1/2 x 12	90	See Warhead table	Combination Inertia Ring and Magnetic	Powered by Generator
Mks 6-5, 6-6	"	"	"	"	Combination Inertia Ball Switch and Magnetic	"
Mks 5-1, 5-2, 5-3, 5-4, 5-4A, 5-4B, 5-5	"	"	"	Mk 15, 16, 17 and Mods	Inertia Ring Type	Same as Mk 6-1 type less Magnetic Section
Mk 10-3	"	"	"	Mks 15, 15-1 and 16, 17 and Mods	Combination Inertia Ring and Magnetic	Battery Power

Table 4- U.S. Torpedo Exploders

## U. S. TORPEDOES

### Introduction

1. The U. S. Navy has more than 15 marks and modifications of torpedoes in service. All of these, however, represent but a few basic design types. Each torpedo is composed of the following main parts:
  - (a) Warhead and exploder.
  - (b) Air flask section or battery compartment.
  - (c) After body.
  - (d) Tail section.
2. The interest of disposal personnel is centered around the warheads and exploder mechanisms and each of these is treated in detail in this chapter. General descriptive material on the torpedo, including physical characteristics and performance ratings, is also included to give background information and also to aid in identification.
3. All torpedoes of this security classification now in service are air driven with the exception of the Mk 18 which utilizes electric drive. A 21" diameter is standard for all types except the Mk 13 aircraft torpedo which is 22 7/8" in diameter.
4. The warheads used are of the same diameter as the torpedoes, the 22 7/8" Mk 13 series being used with the Mk 13 torpedoes. Each warhead consists of a thin steel or bronze shell and contains an athwartships exploder pocket on its bottom center line, directly forward or abaft its transverse center line, and a lifting eye in the center of its nose. The charges vary in weight from 400 to 800 lb. and may be of either TNT, Torpex, or HBX.
5. The more than 35 marks and modifications of service exploders discussed herein represent three impact-inertia and two magnetic induction design types, the many small modifications not being significant from a disposal viewpoint. It will be noted that the rendering-safe procedures for many of the exploders are almost identical due to the fact that the exploders are very similar with respect to the alignment of their internal parts.
6. The component parts of the torpedo assembly are joined by means of screws which pass through holes which are set at an angle in the forward edge of the after of the two sections making up the joint and screw into threaded holes which are also set at an angle in the forward of the two sections. Torpedo tool #49 may be used to remove these screws. The various exploders, except the Mk 3, are secured in the warheads by similar screws which may also be removed by tool #49.
7. Rendering these torpedoes safe involves disposing of the particular exploder which may be fitted. Consequently, the rendering-safe procedures are given with the treatment of the individual exploders rather than with the torpedoes.

### Identifying Features

1. Any U. S. torpedo may be readily identified by an examination of its markings. The mark number, modification number and register number of each torpedo are all stamped in the following places:
  - (a) On the top center line of the air flask section or battery compartment near the forward joint.
  - (b) On the top center line of the afterbody near the forward joint.
  - (c) On the tail section, adjacent to the top fin.
2. The mark and modification numbers of each warhead are stamped on its top center line near the after end.
3. Most exploders have the mark and modification numbers stamped near the edge of the base plate.

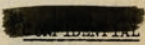
### General Precautions

1. The following precautions, in addition to those prescribed for the individual exploders, should generally be observed when dealing with U. S. air-driven torpedoes (Special precautions for the Mk 18 electric torpedo will be included under that heading):
  - (a) Block the propellers before rendering safe. Specially designed propeller locks, chain, wire or manila rope may be used for this purpose. Since the two propellers rotate in opposite directions, binding them together provides an effective lock.
  - (b) Avoid contact with the starting lever and water trip valve.

U. S. TORPEDOES

(Introduction, Cont'd.)

- (c) If possible, close the main stop valve before rendering safe in order to avoid starting the motor. To close the stop valve, rotate it clockwise using torpedo tool #13-14. The words MAIN STOP VALVE are always stamped around the valve spindle.
- (d) If the torpedo has not completed its full run, air pressures as high as 2800 lb./in<sup>2</sup> may be present. Due precautions should be taken.



## U. S. TORPEDOES

### Torpedo Mk 8 Mods 3C and 3D

#### General

1. 21" air-driven torpedo, designed to be launched from submarines or surface craft. This torpedo is obsolescent and is now issued only to older types of destroyers.
2. Fitted with Warhead Mk 8 Mod 2 or Mk 8 Mod 3.
3. The torpedo is driven by a steam turbine engine and is capable of running 13,500 yards at a speed of 27 knots.

#### Description

##### 1. Lengths

Overall	20'8"
Warhead	2'3"
Air flask section	12'3"
Afterbody	4'8"
Tail	1'6"

2. Total weight in air 3026 lb.

##### 3. External fittings

###### (a) Air flask section

Guide studs	Two; one each on the top and bottom center lines, 11'7" forward of after end.
Stop valve	On top center line, 6'5" forward of after end.
Charging valve	1 1/2" to port from top center line, 6'5" forward of after end.

###### (b) Afterbody

Depth index	On top center line, 4'10" forward of after end.
Starting lever	2" to starboard from top center line, 4'4" from after end.
Distance gear dial	3 1/2" to starboard from top center line, 4'4" forward of after end.
Gyro setting socket	20" to port from top center line, 4'2" forward of after end.

###### (c) Tail

Propellers	Four-bladed, 19" span.
Forward	Four-bladed, 17 3/4" span.
After	
Fins	Two vertical and two horizontal; length, including rudders, 13".

##### 4. Internal arrangement of parts

- (a) The general arrangement of internal parts is very similar to that of the Mk 14-3A, the main differences being as follows:

- (1) The speed change mechanism is omitted from the air flask section.
- (2) The control valve is omitted from the afterbody.
- (3) A siphon-type reducing valve is added to the valve assembly in the air flask section and performs the same functions as the control and reducing valves in the Mk 14-3A.

#### Operation

1. Similar to Mk 14-3A.

U. S. TORPEDOES

Torpedoes Mark 13-2A, 13-3, 13-5, 13-5, 13-6, 13-7, 13-8, 13-9.

General

1. 2274 air-driven torpedo, designed to be launched from aircraft: some models may now be launched from motor torpedo boats (see Table #5).
2. Fitted with Warhead Mk 13 Mods 1, 2 or 3.
3. The torpedo is driven by a steam turbine engine. Some modifications are capable of running 4000 yards at a speed of 40 knots and others, 6000 yards at 33 1/2 knots (see Table #5).

Description

1. Lengths

Overall	13'5"
Warhead	4'6"
Air flask section	4'5"
Afterbody	3'1"
Tail	1'5"

2. The weights of the various modifications are given in Table #5

3. External fittings

(a) Air flask section

Stop valve	On top center line, 4'10" forward of after end.
Charging valve	1 1/2" to port from top center line, 4'10" forward of after end.

(b) Afterbody

Depth index	2" to starboard from top center line, 3'2" forward of after end.
Starting lever	On top center line, 2'4" forward of after end.

(c) Tail

Propellers	
Forward	Four-bladed, 16" span.
After	Four-bladed, 14" span.
Fins	Two vertical and two horizontal; length, including rudders, 17". A horizontal tail blade extension may be added to PT boat launched torpedoes if a shallow run is desired. A shroud ring may be fitted around the outer extremities of the fins.

4. Internal arrangement of parts

(a) The general arrangement of internal parts is very similar to that of the Mk 14-3A, the main differences being as follows:

- (1) A water trip valve, added to the midship section of the air flask, prevents the igniter from firing before the torpedo is waterborne. The torpedo runs cold during air travel.
- (2) The speed change mechanism is omitted from the midship section of the air flask.
- (3) The control valve is omitted from the afterbody.
- (4) A siphon-type reducing valve is added to the valve assembly in the midship section of the air flask and performs the same function as the control valve and reducing valve in the Mk 14-3A.
- (5) The gyro angling setting device is omitted from the afterbody of the Mk 13-2A, 13-5, 13-6 and 13-9.

Operation

1. Similar to Mk 14-3A.

U. S. TORPEDOES

	13-2A	13-3	13-5	13-6	13-7	13-8	13-9
Speed (kts)	40	40	33 1/2	40	40	40	33 1/2
Range (yds)	4000	4000	6000	4000	4000	4000	6000
Gyro Angling	No	Yes	No	No	Yes	Yes	No
Shroud Ring	No	No	No	Yes	Yes	Yes	Yes
Used on PT Boats	Yes	Yes	Yes	No	No	No	No
Total Weight (lb)	2125	2125	1925	2125	2125	2125	2125

Table 5 - Design Differences in Mods of the Mk 13 Torpedo

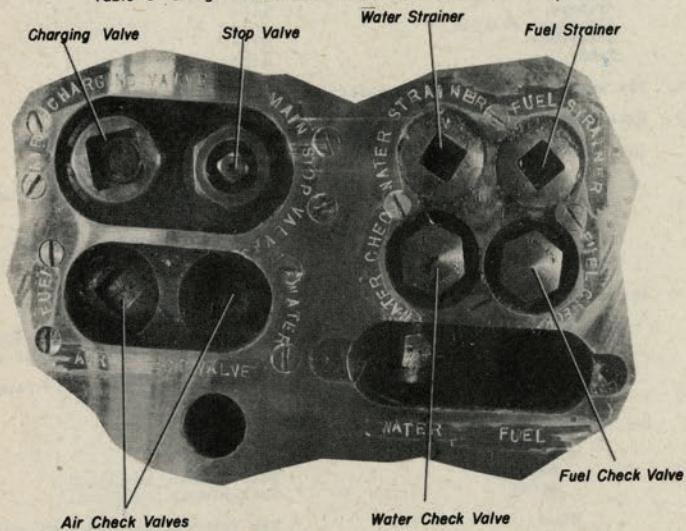


Fig. B - U.S. Torpedo Mk 13-3, After End of Airflask, Top View

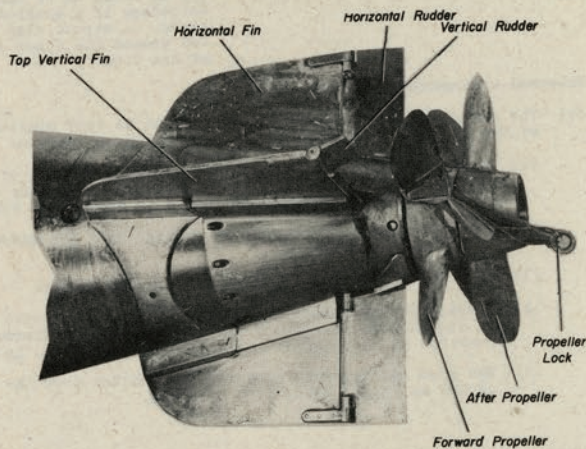


Fig. C - U.S. Torpedo Mk 13-3, Tail Section

U. S. TORPEDOES

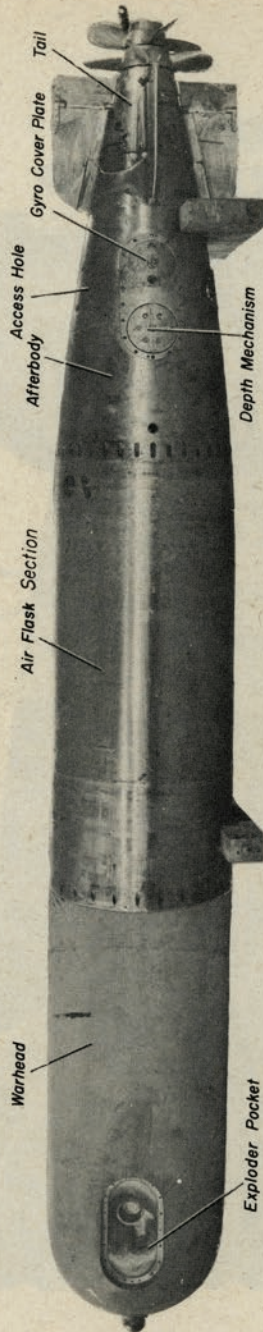


Fig. A - U.S. Torpedo Mk 13-3, Bottom View

Added 10 June 1945  
(Change No. 6)

U. S. TORPEDOES

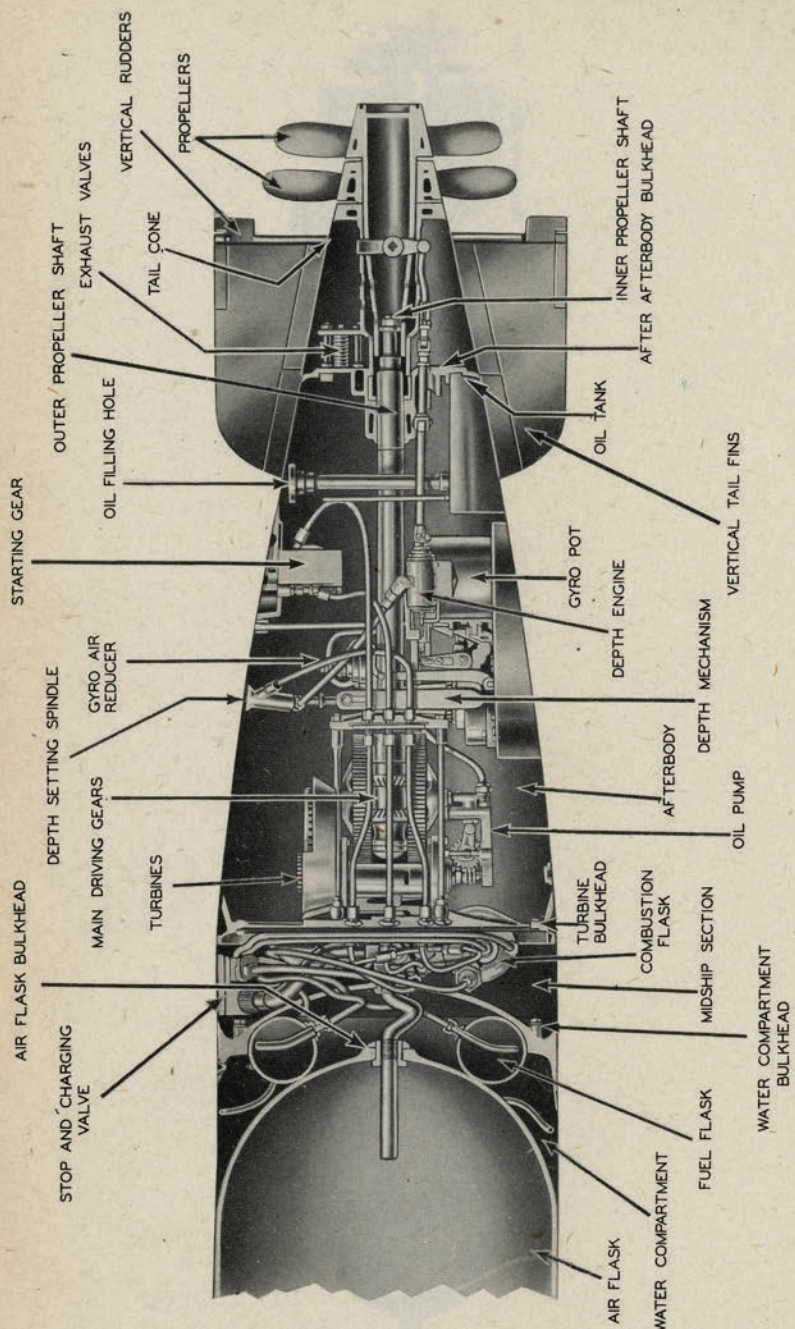


Fig. D - U.S. Torpedo Mk 13-3, After End, Sectional View



U. S. TORPEDOES

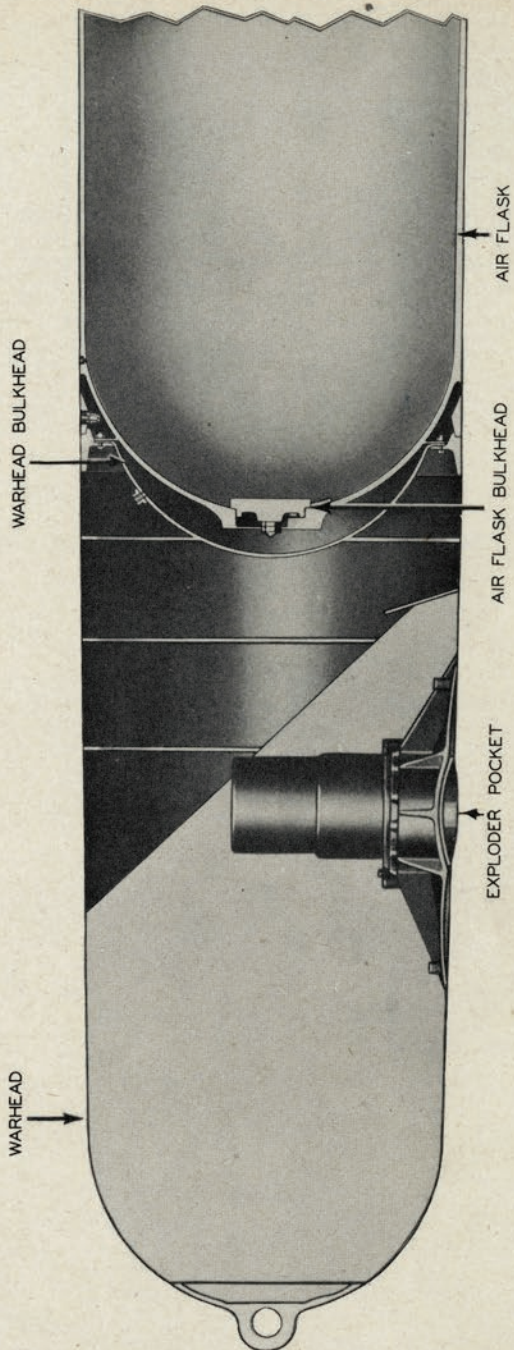


Fig. E - U.S. Torpedo Mk 13-3, Forward End, Sectional View

Added 10 June 1945  
(Change No. 6)

U. S. TORPEDOES

Torpedo Mark 14-3A (Mark 23 Mod 0 and Mark 23 Mod 1)

General

1. 21" air-driven torpedo, designed to be launched from submarines; may be launched from surface craft.
2. Fitted with warheads Mk 15-0, 15-1, 16-0, 16-1 or 16-4.
3. The torpedo is driven by a steam turbine engine and is capable of running 9000 yards at a speed between 31 and 32 knots or 4500 yards at a speed of between 45 and 47 knots.

Description

1. Lengths

Overall	20'5"
Warhead	3'11"
Air flask section	9'8"
Afterbody	5'3"
Tail	1'7"

2. Total weight in air 3200 lb.

3. External fittings

(a) Air flask section

Guide stud	On top center line, 11'6" forward of after end.
Speed setting hole	7" to starboard from top center line, 7' forward of after end.
Stop valve	On top center line, 7'2" forward of after end.
Charging valve	1 1/2" to port from top center line, 7'2" forward of after end.

(b) Afterbody

Depth index	On top center line, 4'10" forward of after end.
Starting lever	2" to starboard from top center line, 4'5" from after end.
Gyro setting sockets	Two, 22" to starboard and to port, respectively, from top center line, 4'2" forward of after end.

(c) Tail

Propellers	
Forward	Four-bladed, 19" span.
After	Four-bladed, 17" span.
Fins	Two vertical and two horizontal; length, including rudders, 13".

4. Internal arrangement of parts

(a) Air Flask Section - contains the following main parts:

- (1) The air flask proper, a hollow cylinder of uniform outside diameter, closed at each end by a dome-shaped, steel bulkhead. Both the sides and the end bulkheads are built to withstand extremely high internal pressures.
- (2) The water compartment, directly abaft the flask, is formed by the air flask forging. Its forward and after limits consist of the after bulkhead of the flask and a third dome-shaped bulkhead. The fuel flask is centrally located inside the compartment. The main air line to the air flask passes through the compartment. Access to the water compartment and fuel flask for filling purposes is gained through the top of the water compartment.
- (3) The midship section, a short, cylindrical extension of the air flask and water compartment, connects the air flask section to the afterbody. The stop and charging valves and the air, fuel, and water check valves are all mounted around the shell

U. S. TORPEDOES

(Torpedo Mark 14-3A (Mark 23 Mod 0 and Mark 23 Mod 1), Cont'd.)

of the section. The space in the center of the section accommodates the following parts, each of which is attached to the forward end of the afterbody:

- (i) A valve group, consisting of the starting, reduction and restriction valves. The starting valve opens when the starting gear is actuated, allowing air to pass through the reducing and restriction valves which reduce the air pressure until it is suitable for operating the turbine motor.
  - (ii) A combustion pot, wherein the burning fuel and air mix with water to form high-pressure gases and steam.
  - (iii) An igniter, mounted on the combustion pot, consisting of a small cap and a powder cartridge.
  - (iv) The speed-change mechanism.
- (4) Access to the various fittings in the midship section may be gained through openings in the shell. During its run, the combustion pot is cooled by sea water entering these openings.
- (b) Afterbody - contains the following main parts:
- (1) The propelling mechanism consisting of:
    - (i) Two counter-rotating horizontal turbines.
    - (ii) Turbine nozzles mounted on the turbine bulkhead.
    - (iii) High- and low-pressure air leads.
    - (iv) A turbine reduction gear system.
    - (v) The propeller drive shafts.
    - (vi) The turbine exhaust system.
  - (2) The depth control and steering mechanisms consisting of:
    - (i) The steering gyroscope.
    - (ii) The hydrostatic pendulum depth mechanism.
    - (iii) The steering and depth engines.
    - (iv) The gyro angle setting device and rudder connections.
- (c) Tail - contains the following main parts:
- (1) Connections for both the vertical and horizontal rudders.
  - (2) Propeller drive shafts and sleeves. The two counter-rotating propellers are mounted on the sleeves directly abaft the case.
5. The Mk 23-0 and the Mk 23-1 differ from the Mk 14-3A only in that the lower speed range (31-32 knots) is omitted from their design. The Mk 23-0 is a modified Mk 14-3A whereas the Mk 23-1 is the production model of the single speed torpedo.

Operation

1. Before the torpedo is launched, its stop valve is opened slowly, allowing high pressure air (2800 lb/in<sup>2</sup>) from the air flask to leak through the upper part of the starting valve and build up a pressure head behind the starting piston of the starting gear. When the torpedo is launched, the starting lever is tripped, raising the starting piston and allowing air to pass through the starting gear, thereby reducing pressure on top of the starting valve and allowing it to open. Opening the starting valve allows high pressure air to flow as follows:
  - (a) To the gyro spin where it quickly brings the gyro wheel up to its required speed, at which point the air is automatically shut off.
  - (b) To the reducing valve where its pressure is reduced to about 400 lb/in<sup>2</sup>.
2. From the reducing valve, the air flows as follows:
  - (a) To the top of the fuel flask and water compartment where it forces fuel and water into the combustion flask.

U. S. TORPEDOES

(Torpedo Mark 14-3A (Mark 23 Mod 0 and Mark 23 Mod 1), Cont'd.)

- (b) To the gyro, where it sustains the rate of gyro spin after the initial impetus of the high pressure air has been removed.
  - (c) To the depth and steering engines where it furnishes the power to operate the horizontal and vertical rudders.
  - (d) To the combustion flask where it mixes with the fuel and water.
  - (e) To the igniter on the combustion pot where it shears a thin shear plate, allowing a spring-loaded firing pin to impinge on the two igniter caps.
3. When the igniter fires, it shoots flame into the combustion pot for a few seconds, ignited the fuel and forming hot gases. The gases are cooled slightly by the water which turns into steam. The resulting mixture of hot gas and steam then passes, at high velocity, to the two turbines turning them at high speed. The turbines, in turn, rotate the impeller shafts through a simple reduction gear transmission.
  4. The depth mechanism, consisting of a pendulum, a hydrostat, the depth engine and the horizontal rudders, keeps the torpedo at the depth set on the depth index prior to launching.
  5. The steering mechanism, consisting of the gyro, a pallet mechanism, the steering engine and the vertical rudders, keeps the torpedo on the course set prior to launching.

U. S. TORPEDOES

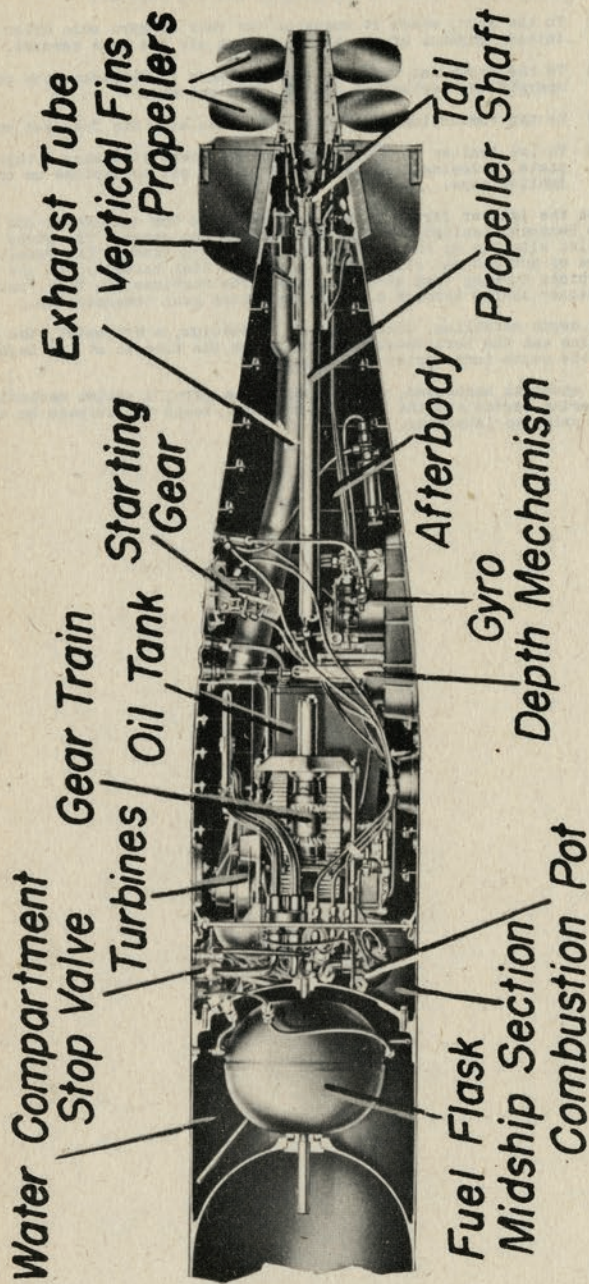


Fig. F - U.S. Torpedo Mk 15-1, After End, Sectional View

U. S. TORPEDOES

Torpedo Mark 15 Mods 1 and 2 (Mark 15 Mod 3)

General

1. 21" air-driven torpedo, designed to be launched from surface craft; may be launched from submarines.
2. Fitted with warheads Mk 15-0, 15-2, 17-0 and 17-2.
3. The torpedo is driven by a steam turbine engine and is capable of running 6000 yards at a speed of 49 knots, 10,000 yards at 34 knots, or 15,000 yards at 27 knots.

Description

1. Lengths
 

Overall	23'11"
Warhead	4'10"
Air flask section	12'3"
Afterbody	5'3"
Tail	1'7"
2. Total weight in air
 

	3850 lb.
--	----------
3. External fittings
  - (a) Air flask
 

Guide stud	On top center line, 12'3" from after end.
Stop valve	On top center line, 8'6" forward of after end.
Charging valve	1 1/2" to port of top center line, 8'6" forward of after end.
Speed setting hole	7" to starboard from top center line, 7' forward of after end.
  - (b) Afterbody
 

Depth index	On top center line, 4'10" forward of after end.
Starting lever	2" to starboard from top center line, 4'5" forward of after end.
Gyro setting sockets	Two, 22" to starboard and to port respectively from top center line, 4'2" forward of after end.
  - (c) Tail
 

Propellers	
Forward	Four-bladed, 19" span.
After	Four-bladed, 17" span.
Fins	Two vertical and two horizontal; length, including rudders, 14".
4. Internal arrangement of parts
  - (a) The general arrangement of internal parts is very similar to the Mk 14-3A.
5. The Mk 15-3 differs from the Mk 15-1 and 15-2 in that it employs only a single gyro setting socket, located on the bottom center line.

Operation

1. Similar to Mk 14-3A.

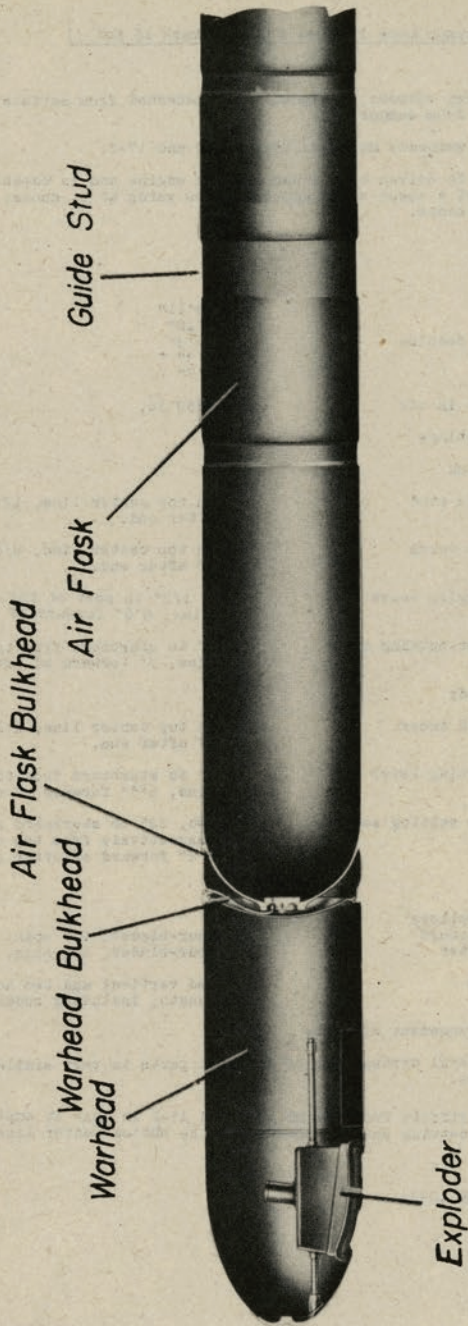


Fig. 6 - U.S. Torpedo Mk 15-1, Forward End, Sectional View

U. S. TORPEDOES

Torpedo Mark 18 Mod 1 (Mark 18 Mod 2)

General

1. 21" electrically-driven torpedo, launched from submarines.
2. Fitted with warhead Mk 18-1 or Mk 18-2.
3. The torpedo is driven by a DC-powered, series-wound motor and is capable of running 4000 yards at a speed of 29 knots.

Description

1. Lengths

Overall	20'6"
Warhead	3'11"
Battery compartment	10'6"
Afterbody	4'6"
Tail	1'7"

2. Total weight in air 3000 lb.

3. External fittings

(a) Battery compartment

Guide stud	On top center line, 11'8" forward of after end.
Access holes	Eight; seven on top center line, three forward and four abaft the guide stud; one to port from top center line, near after end of section.

(b) Afterbody

Depth index	On top center line, 4'10" forward of after end.
Starting lever	2" to starboard from top center line, 4'5" forward of after end.
Stop valve	On top center line, 3'9" forward of after end.
Charging valve	1 1/2" to port from top center line, 3'9" forward of after end.
Gyro setting sockets	Two, 22" to starboard and to port respectively from top center line, 4' forward of after end.
Access holes	Two, to starboard and to port respectively from top center line, just forward of gyro setting sockets.

(c) Tail

Propellers	
Forward	Two-bladed, 17" span.
After	Two-bladed, 16" span.
Fins	Two vertical and two horizontal; length, including rudders, 25".

4. Internal arrangement of parts

(a) Battery Compartment - contains the following main parts:

- (1) The propulsion battery, consisting of 80 lead-acid storage cells connected in series. The 80 cells are divided into three sections, each of which is further subdivided into units of six cells each (Mk 18-2 contains 72 cells in two sections). This arrangement supplies about 140 volts to the motor.
- (2) The motor operating compartment, separated from the battery mounting by a watertight bulkhead, comprises the after part of the battery compartment section and houses the battery switch, charging plug (mounted in tail in Mk 18-2), battery heater relay switch and poppet valve. Part of the motor, which is mounted in the afterbody, protrudes into the motor operating compartment.



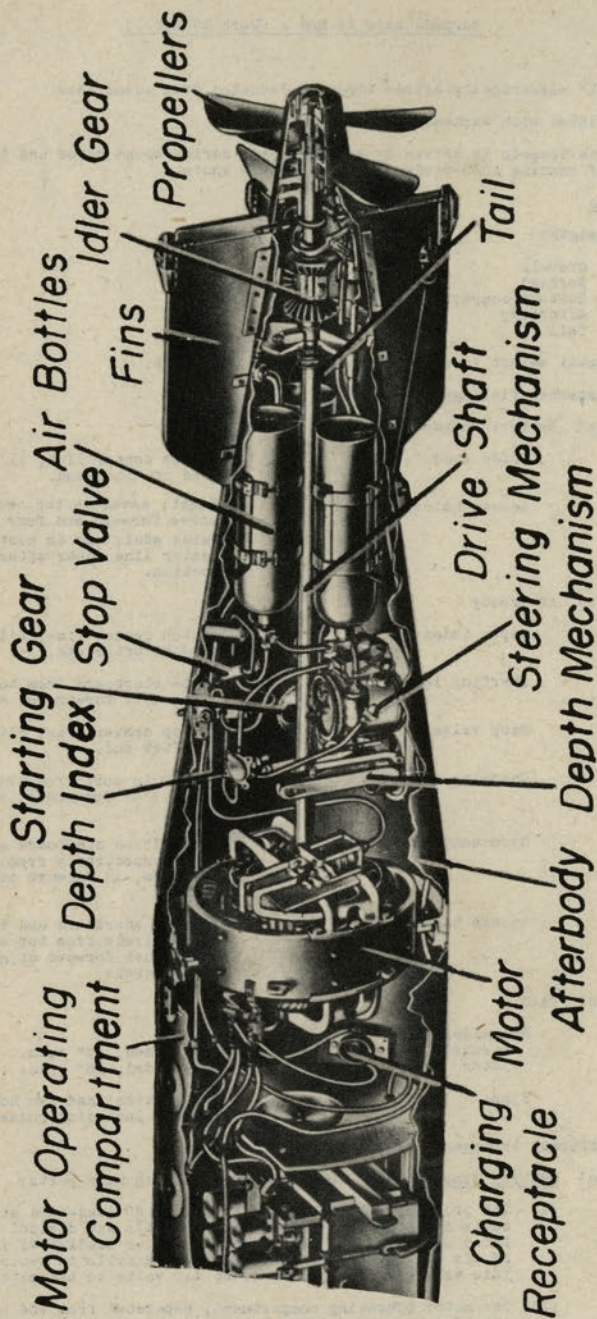


Fig. H - U.S. Torpedo Mk 18-1, After End, Sectional View

## U. S. TORPEDOES

(Torpedo Mark 18 Mod 1 (Mark 18 Mod 2), Cont'd.)

(b) Afterbody - contains the following main parts:

- (1) A six-pole, D. C. series motor at the forward end.
- (2) The propeller shafts.
- (3) The depth control and steering mechanism with their associated parts. High pressure air, stored in three small bottles near the after end, is used to start the gyro and propulsion motor. Air from these same bottles is passed through a reducing valve and then used as low-pressure air to operate the steering and depth control engines which are located in the after part of the section.

(c) Tail - contains the following:

- (1) An idler gear system which transmits rotary motion from the main drive shaft to the propeller drive shafts.

### Operation

1. Before launching the torpedo, its stop valve is opened, allowing high pressure air (2800 lb/in<sup>2</sup>) from the air bottles to flow to and build up pressure behind the starting valve in the starting gear body. When the torpedo is launched, the starting lever is tripped, thereby unseating the starting valve and allowing high pressure air to flow as follows:
  - (a) To the gyro spin where it quickly brings the gyro wheel up to the required speed, at which point the air is automatically shut off.
  - (b) To the motor switch where it operates the switch, starting the motor.
  - (c) To the reducing valve where its pressure is reduced to about 400 lb/in<sup>2</sup>. From the reducing valve, the air flows to the depth and steering engines, where it furnishes the power to operate the horizontal and vertical rudders, and to the power cylinder of the motor control unit.
2. When the motor switch operates, it makes two contacts, allowing current to flow from the battery through the motor which then turns at a speed of 1620 R. P. M. A motor control unit, consisting of a governor and a hydraulic cylinder, regulates motor speed and maintains the 1620 R. P. M. speed, regardless of battery potential, for the first 4000 yards of the torpedo's run. The motor revolves the two propellers through an idler gear assembly.
3. The depth and steering mechanisms are very similar to those in the Mk 14-3A, the main difference being that no further air is supplied to the gyro after the high pressure starting air is cut off.

### Special Precautions

1. Note that the batteries may evolve hydrogen which is particularly sensitive to static electric discharges. Should quantities of this gas be collected in the battery compartment, an extremely dangerous condition prevails which is likely to result in a serious explosion. As a preventative measure, always remove one of the access hole covers from the battery compartment before rendering the torpedo safe.
2. Reach in through the after access hole of the battery compartment and rotate the hand-operated knob of the disconnect switch clockwise to its limit stop. The switch is mounted in the motor operating compartment on the starboard side and rotation of the knob as prescribed above disconnects the battery and motor.
3. Lock the propellers (See Introduction) but bear in mind that no lock may be relied upon when dealing with electric torpedoes. If the motor is able to overcome starting torque when a strong propeller lock is fitted, the drive shaft may break. If this occurs, the motor, running free with no load, will probably fly apart.

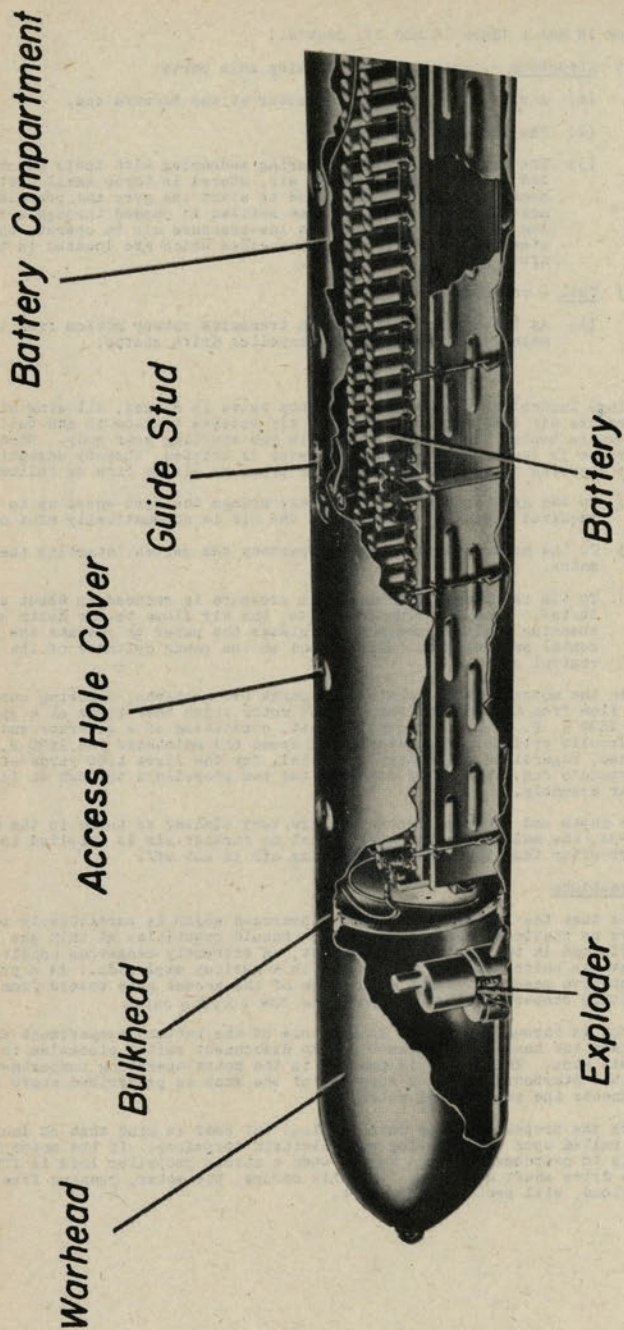


Fig. 1 - U.S. Torpedo MK 18, Forward End, Sectional View

U. S. TORPEDOES

Exploders Mk. 3-1, 3-2, 3-3, 3-4

General

1. Impact-inertia type.
2. Fits in the bottom of the warhead, forward of the transverse center line.

Description

1. The exploder is mounted on a round base plate  $3\frac{1}{2}$ " in diameter, and secured in the warhead by six screws. The exploder weighs 5  $\frac{1}{4}$  lbs.
2. The main working parts are:
  - (a) A three-bladed arming impeller set in a well alongside the exploder pocket.
  - (b) An arming gear, operated by the impeller through a gear train.
  - (c) An arming screw, threaded to the arming gear internally.
  - (d) An inertia ball-and-trigger assembly for releasing the spring-loaded firing pin.
  - (e) A detonator carrier, screwed into a detonator safety chamber mounted on top of the exploder and secured to the arming gear by four screws.

Operation

1. After the torpedo has been launched, the impeller revolves, due to the water travel, driving the gear train and rotating the arming gear. This performs three functions:
  - (a) It moves the detonator carrier into the booster by the rotary motion of the detonator safety chamber.
  - (b) It compresses the firing spring by the upward movement of the arming screws.

U. S. TORPEDOES

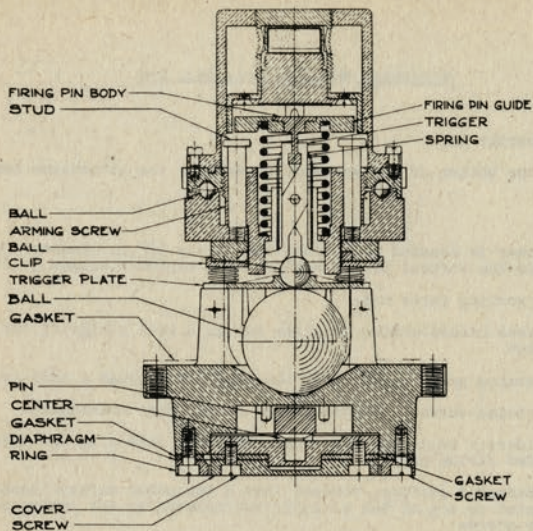


Fig. 1-- Mk. 3 Type Exploder, Unarmed

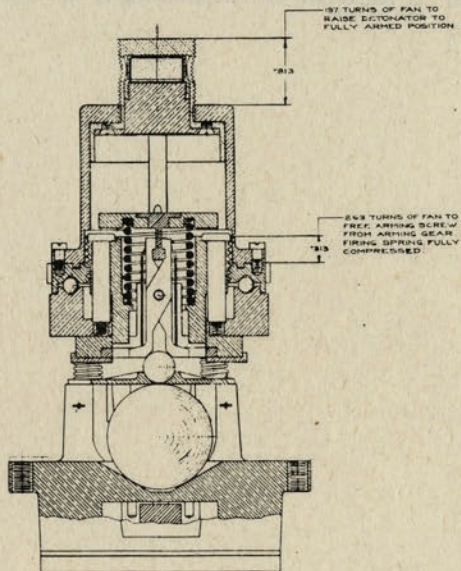


Fig. 2-- Mk. 3 Type Exploder, Armed

Added 1 July 1945  
(Change No. 8)

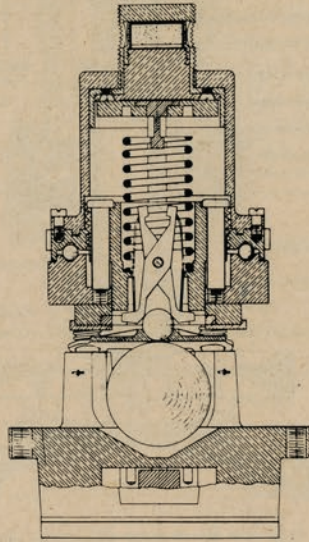


Fig. 3-- Mk. 3 Type Exploder, Fired

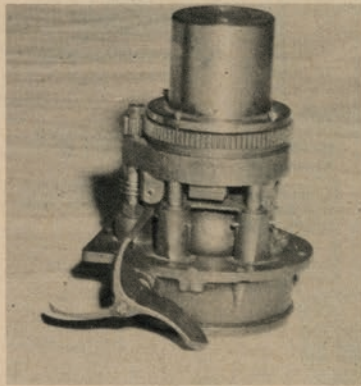


Fig. 4-- Mk. 3-2 Exploder, Unarmed

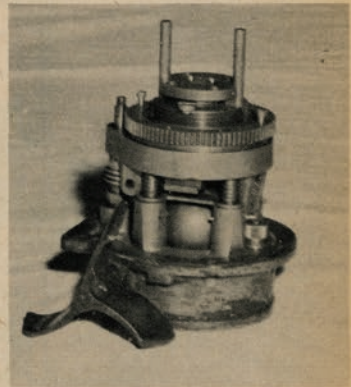


Fig. 5-- Mk. 3-2 Exploder Armed  
With Safety Chamber Removed

U. S. TORPEDOES

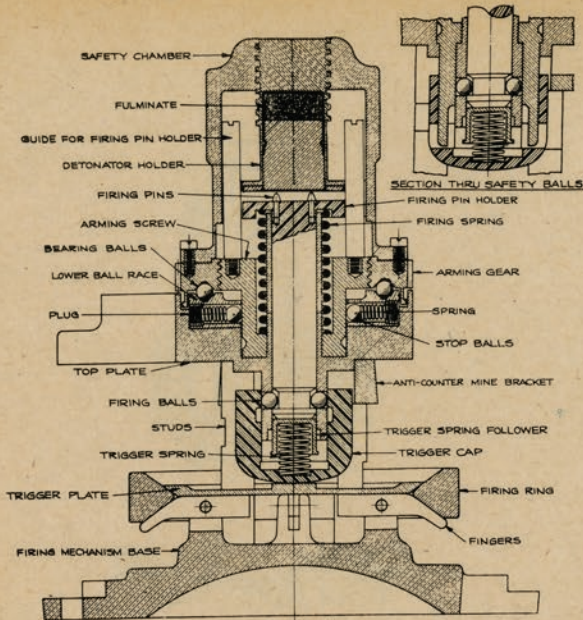


Fig. 6-- Mk. 4 Type Exploder, Unarmed

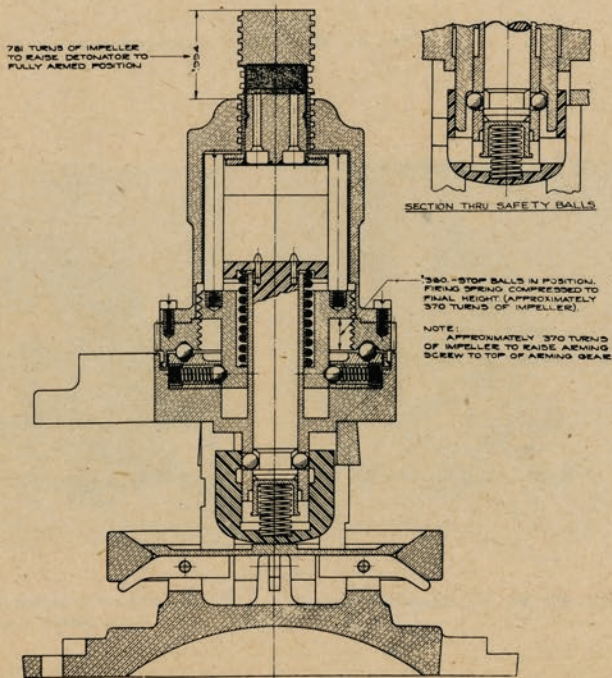


Fig. 7-- Mk. 4 Type Exploder, Armed

## U. S. TORPEDOES

- (c) It unlocks the trigger mechanism by the upward movement of the arming screw.

Arming is normally completed in approximately 140 yards of water travel.

2. The exploder operates when the torpedo receives a blow sufficient to cause a large inertia ball to roll up the slope of a dish-shaped seat in which it rests. This upward movement operates the trigger device, unlocking a scissors which holds the spring-loaded striker, allowing it to impinge on the detonator.

### Precautions

1. Do not attempt to render safe unless absolutely necessary.
2. Assume that the exploder is armed, since its condition cannot be determined by an examination of the exterior. A blow of less than five lbs. will fire the exploder.
3. Lock the torpedo propeller (or propellers) with a standard torpedo lock or a suitable length of chain. Should the motor start to run, the propeller is very dangerous.
4. Do not move or jar the torpedo except from a safe distance. In handling the exploder, do not move the inertia-firing device.

### Rendering-Safe-Procedure

1. Lock the impeller with tape or other suitable means.
2. Remove the exploder from a safe distance.
3. Remove the safety chamber from the exploder body. This unit contains the detonator carrier, and is secured to arming gear by four screws.
4. Remove the booster from the warhead.
5. Dispose of detonator, booster and charge.

### Exploders Mark 4 and 8 and Mods.

#### General

1. Inertia-impact type.
2. Fits in bottom of warhead, forward of the transverse center line. The Mk. 8-1, 8-3, 8-5 and 8-7 exploders, which are used with the Mk. 18 warheads, fit aft the transverse center line.

#### Description

1. The exploder is mounted on a heavy brass base plate. The weights of the various modifications and the dimensions of the different plates are given in Table IV. The exploders fitted with round base plates are secured to the warhead pocket by 12 countersunk screws. Those with oval base plates are secured by 18 screws.
2. The main working parts of the exploder are:
  - (a) A detonator and safety chamber assembly almost identical to that fitted in the Mk. 3 and Mods.
  - (b) A 15-bladed arming impeller housed in a channel in the base plate.
  - (c) An arming gear assembly similar to that fitted in the Mk. 3 and Mods.
  - (d) An inertia firing-ring assembly (not similar to that fitted in the Mk. 3) which releases locking balls and a spring-loaded firing pin.

#### Operation

1. The arming gear revolves, driving the gear train as in the Mk. 3, performing three functions:
  - (a) It houses the detonator carrier in the booster.
  - (b) *It causes the arming screw to move upward*  
It compresses the arming screw, compressing the firing spring.
  - (c) It allows the lug extensions on the arming screw to release the safety balls, and unlocks the firing pin and the inertia firing assembly.



U. S. TORPEDOES

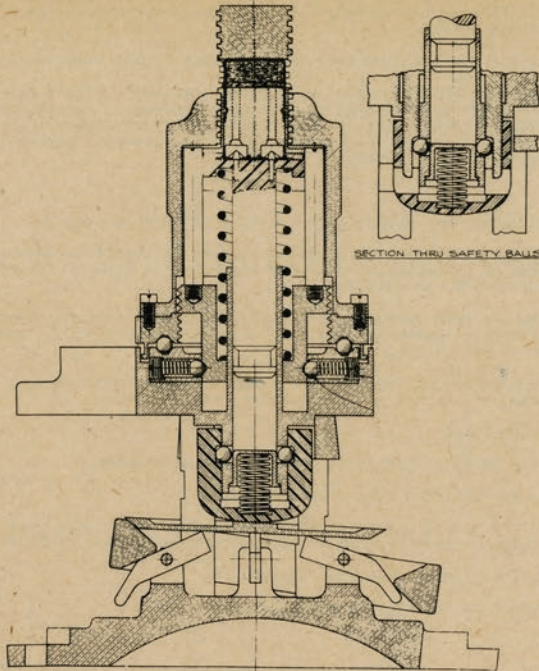


Fig. 8-- Mk. 4 Type Exploder, Fired

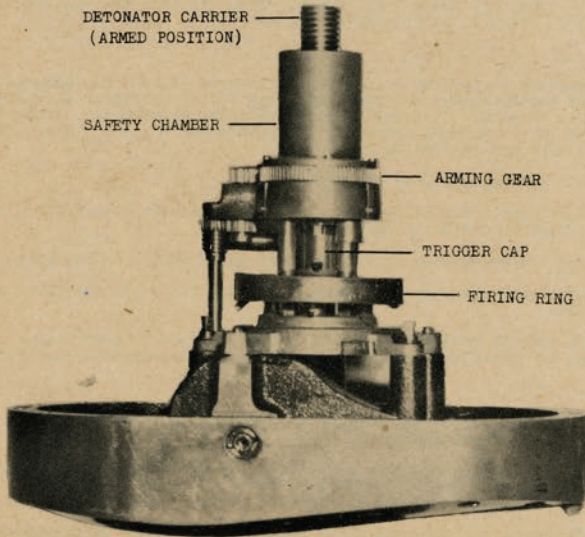


Fig. 9-- Mk. 4-1 Exploder

## U. S. TORPEDOES

Arming is normally completed in approximately 350 yards of water travel.

2. The exploder operates when the torpedo receives a blow sufficiently heavy to cause movement of the inertia firing ring. Movement in any direction will lift a trigger cap, releasing locking balls, and allowing the spring loaded striker to impinge on the detonator.

### Precautions

1. Same as for the Mk. 3.

### Rendering-Safe Procedure

1. Stuff rags or other suitable material into the channel of the base plate to lock the impeller.
2. Using a standard exploder socket wrench, remove the 12 (18 if the base plate is oval) countersunk screws which secure the exploder to the warhead.
3. Screw standard exploder-handling tools into the two extra holes tapped in the base plate on the fore-and-aft center line of the exploder. These holes will not have screws fitted in them.
4. Secure a bridle to the handling tools, and remove the exploder from a safe distance.
5. Remove the detonator safety chamber as prescribed for the Mk. 3, and dispose of it, along with the booster and the charge.

### Exploders Mark 6 and Mods. (except Mk. 6-5 and 6-6)

### General

1. Impact-inertia and magnetic influence type.
2. Fits in bottom of warhead, forward of the transverse center line.

### Description

1. The exploder is mounted on a rectangular, brass base plate,  $14\frac{1}{2}$ " by 12", and is secured in the warhead by 24 countersunk screws. The exploder weighs 90 lbs.
2. (a) The impact-inertia firing device is identical to the Mk. 4 type.  
(b) The magnetic firing device is of the induction type. The search coil is housed in a short cylindrical container 12" long and  $\frac{1}{4}$ " in diameter. The core rod is  $\frac{3}{4}$ " long, and is inserted through a plug in the nose of the warhead, passing through the warhead and search coil longitudinally. The unit is energized by a small generator driven by a 15-bladed water wheel mounted in the base plate. Other parts include a thyatron firing tube; a voltage control tube which controls generator voltage; and a solenoid. The latter converts electrical energy into mechanical energy to trigger the firing ring of the inertia-impact firing mechanism through a lever system.

### Operation

1. (a) The impact-inertia firing device is armed in the same manner as the Mk. 4.  
(b) The magnetic firing device arms by the action of a small, spring-loaded switch that operates at the end of the torpedo's safety run, allowing the generator to energize the unit. The solenoid lever system is unlocked by an additional safety lug on the arming screw when it rises upward during arming.
2. (a) The impact-inertia section fires in the same manner as the Mk. 4.  
(b) The torpedo must be in motion for the magnetic section to operate. As the torpedo passes the target at a range between 5 and 20 ft., the magnetic field of the target will induce an EMP in the search coil. This current alters the charge on the control grid of the thyatron tube, allowing the tube to pass high-voltage generator current which has previously been blocked by the control grid. This current energizes the solenoid, moving a push rod sharply upward, thereby tripping the solenoid lever system, and operating the impact-inertia firing ring mechanism.

U. S. TORPEDOES

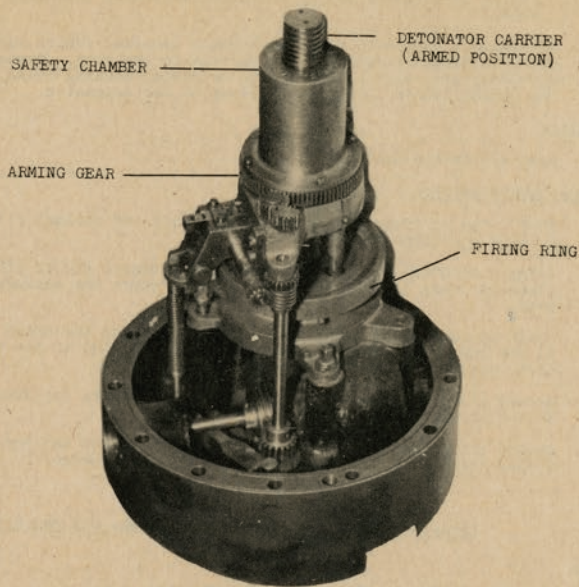


Fig. 10-- Mk. 4-2 Exploder

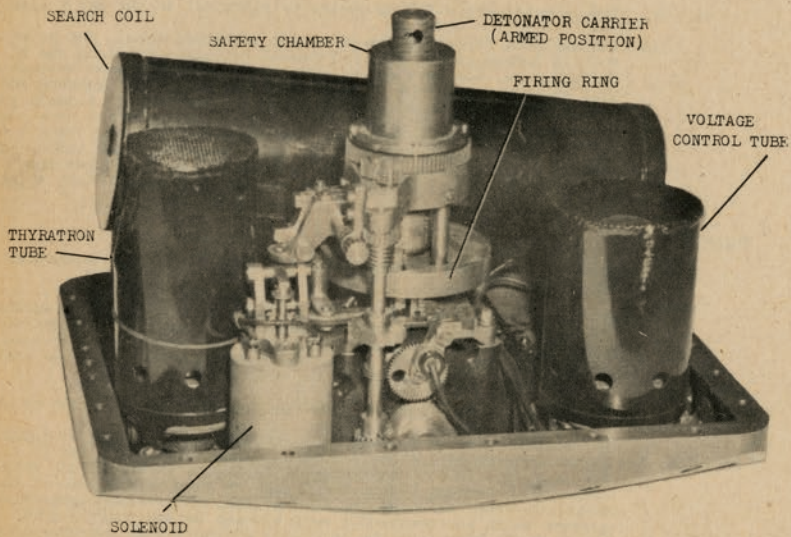


Fig. 11-- Mk. 6-1 Exploder

U. S. TORPEDOES

Precautions

1. Same as for the Mk. 3.

Rendering-Safe Procedure

1. Same as for the Mk. 4 with the following exceptions:
  - (a) The exploder is secured to the warhead by 24 countersunk screws.
  - (b) Before the exploder can be removed from the warhead, the core rod must first be removed. This may be done by removing the screwed-in plug, washer and felt pad from the small opening near the nose of the warhead, and then removing the core rod.

Exploders Mark 6-5 and 6-6

General

1. Same as the Mk. 6.

Description

1. These exploders differ from the other modifications of the Mk. 6 as noted below:
  - (a) The firing speed of the impact-inertia device has been increased considerably through use of an electric detonator. This is mounted in the same manner as the percussion detonator in the other exploders, except that it has leads connecting it to an 8-mf. condenser, mounted on the base plate. A small ~~percussion~~ inertia switch is also mounted on the exploder to close the detonator circuit on impact. This switch consists of a small leaf spring, which holds an inertia ball in a socket. Movement of the ball bends the spring to close the firing circuit. Since electric firing is employed, the percussion striker and trigger assemblies are removed.
  - (b) The presence of the electric detonator does away with the need for the solenoid and lever assembly in the magnetic firing device.
  - (c) Dummy weights have been added to the exploder framework to compensate for the loss of weight due to the various changes.

Operation

1. (a) The inertia-impact firing device is armed when, at the end of a safety run, the condenser is charged by the generator.
  - (b) The magnetic firing device arms in the same manner as the Mk. 6.
2. (a) The impact-inertia firing device fires when the inertia switch closes, allowing the condenser charge to fire the detonator. An impact of only 28 oz. will close the inertia switch.
  - (b) The magnetic device fires in the same manner as the Mk. 6, except that the thyatron tube passes current directly to the detonator instead of energizing a solenoid.

Precautions

1. Same as for the Mk. 3. Note, however, that the impact-inertia firing mechanism is much more sensitive, and should be handled accordingly.

Rendering Safe Procedure

1. Same as for the Mk. 6, except that the electric detonator leads must be cut before removing the detonator safety chamber.

Exploder Mark 5 and Mods.

General

1. Impact-inertia exploder.
2. Fits in bottom of warhead, forward of the transverse center line.

Description

1. This exploder is essentially a Mk. 6 type exploder with the magnetic firing device removed. Dummy parts are mounted on the base plate to compensate for the loss of weight caused by the modification.

U. S. TORPEDOES



Fig. 12-- Mk. 13 Warhead With Mk. 4-1 Pistol

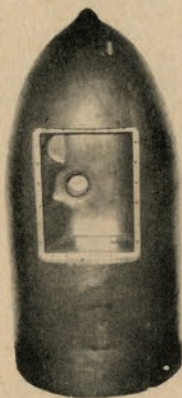


Fig. 13-- Mk. 15 Warhead With Magnetic Pistol Removed

U. S. TORPEDOES

Operation and Precautions

1. Same as for the impact-inertia firing device on the Mk 6.

Rendering Safe Procedure

1. Same as for the Mk 6, except that no core rod is fitted.

Exploder Mark 10 Mod 3

General

1. Combination magnetic-induction, impact-inertia type exploder.
2. Fits in pocket of all warheads which receive Mk 6 and Mods exploder. However, it is intended for use at present in submarine torpedoes Mk 14 and 23 and Mods which are fitted with warheads Mk 15, 16 and Mods.

Description

1. The Mk 10-3 employs the same type base as the Mk 6-1 and the mechanical arming and impact firing assemblies are the same except for minor modifications. The magnetic firing device, however, differs radically from the Mk 6-1 type.
2. The magnetic firing device consists of the following:
  - (a) A coil and core rod, identical to the type employed in the Mk 6 type exploder.
  - (b) Two dry battery sections enclosed in a watertight brass housing and mounted in the base of the exploder on the forward edge. Section "B" supplies 100 volts, Section "A" 6 volts, to the electronic unit.
  - (c) An electronic unit, consisting of the electronic circuit components, the arming switch and the terminal plate, is contained in a second watertight brass housing opposite the battery at the after edge of the base plate. The terminal plate is beneath a rectangular cover on top of the housing.
  - (d) An arming switch, mounted in the electronic unit, consisting of 6 cam-operated sections on a cam shaft. The switches are mounted in such a manner that the three normally open and three normally closed switches operate after  $3/4$  turn of the cam shaft which is rotated by the arming switch gear train and the impeller.
  - (e) An inactivating switch, mounted on one side of the electronic unit housing. A slotted shaft, which operates the switch, protrudes down from the switch mounting. Clockwise rotation of the shaft closes a pair of contacts, shorting out the filament of the thyratron and preventing it from heating, thus rendering the magnetic firing device inert. Access to the slotted shaft of the inactivating switch may be gained through the small plug on the exploder base. The plug consists of a screw,  $1/2$ " in diameter, located in the center of the exploder base plate,  $4 3/4$ " forward of the after edge.
  - (f) An electric cap gun, mounted between the induction coil housing and the mechanical firing device on two vertical support studs of the mechanical firing device. Leads from the electronic unit pass into the cap gun and are wired to a small electric cap. A small brass pellet is sealed in the gun directly above the impact firing ring in such a position as to impinge on the ring when the gun fires.
  - (g) Eight external leads, led through a rubber packing gland to the terminal plate in the electronic unit housing, four from the battery and two each from the coil and cap gun.
3. Method of Mounting
  - (a) The exploder is slipped into the warhead and is secured by 24 screws.

Operation

1. (a) Impact section.

Same as Mk 4 and 8 type exploders. Arming is complete after a 350 yard run or 780 turns of the impeller.

U. S. TORPEDOES

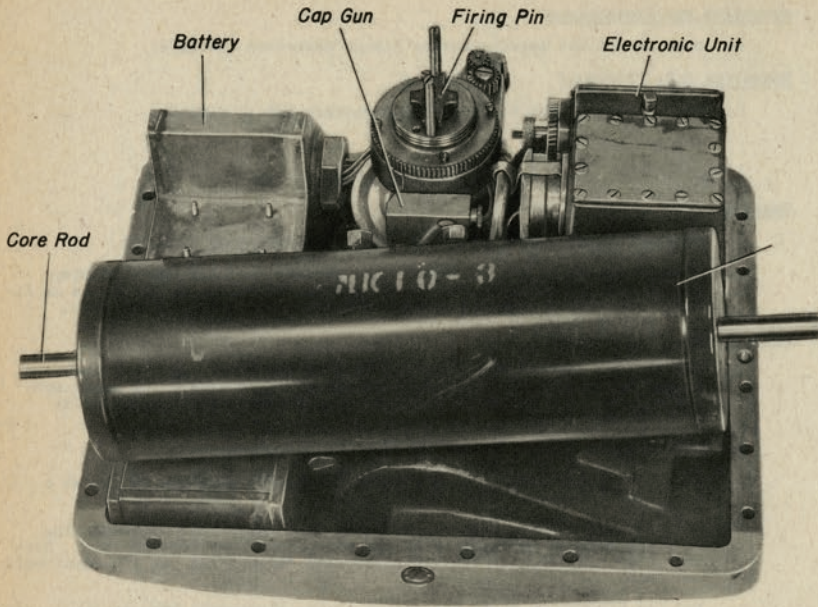


Fig. 14 - Mk 10-3 Exploder

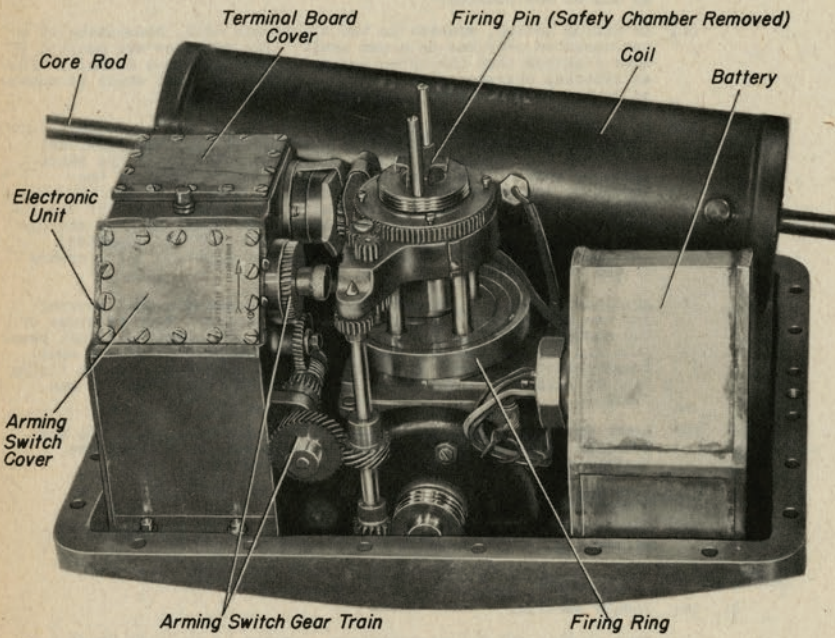


Fig. 15 - Mk 10-3 Exploder

U. S. TORPEDOES

(b) Magnetic section.

The vertical drive shaft geared to the impeller rotates the arming switch gear train. The partial spur gear of the gear train rotates the cam shaft. The cam shaft rotates about 3/4 of a turn and operates the six switches in sequence. When the sixth switch is operated after approximately 525 yards of water travel and 1175 impeller turns, the magnetic section is fully alive and armed. At this point the 45° outcut section of the partial spur gear disengages the gear train and the cam shaft ceases to revolve.

2. (a) Impact section.

Same as Mk 4 and 8 type exploders.

(b) Magnetic section.

When the torpedo passes within the magnetic field of a target, the resultant change in the surrounding magnetic field causes the core rod and coil to generate voltage which is rectified by a diode network and applied to the grid of the triode amplifier. The output of this triode is coupled to the firing thyatron through a diode arrangement which permits the thyatron to fire only when the amplifier output has reached a peak and started to decrease. At this point, usually just before the warhead reaches the keel of the ship, the thyatron fires and discharges the firing condenser through the electric cap. Detonation of the cap ejects the brass pellet which impinges on top of the firing ring, actuating the mechanical exploder.

Precautions

1. Normal torpedo and magnetic precautions.
2. Wait a minimum period of eight hours, preferably longer, before commencing RMS. This will permit the operating voltage from the battery to drop below the minimum required to keep the magnetic section alive. Tests indicate that the battery will drain below the minimum in four hours.
3. If necessary to move a torpedo with a live magnetic exploder, it should be moved slowly along, or rolled on, its longitudinal axis to minimize signals from earth's field.
4. Avoid contact with firing ring of mechanical assembly.

RMS

1. Remove the small screw plug from the exploder base. Considerable force may be necessary to break the seal.
2. Insert a screwdriver in the plug hole, placing the blade in the slotted shaft of the inactivating switch. Rotate the shaft clockwise as far as it will go (about five full turns).

Note: If this operation is carried out on a live exploder, the magnetic sensitivity immediately increases 50% but drops off to zero in 30 seconds and the exploder is dead magnetically. There is no danger of firing if no magnetic material is moved in the vicinity. The switch may have been turned off prior to launching the torpedo.

3. Remove the exploder securing screws (tool #49).
4. Remove the core rod as in RMS Mk 6-1.
5. From a safe distance, retract the exploder using two lifting tools (tool MF-2).
6. Cut and tape the two leads to the cap gun.
7. Remove the safety chamber which houses the detonator. It is secured to the arming gear by four screws.
8. Unscrew the screwed plug in the cap gun.
9. Gently withdraw the plug, leads, packing gland and cap from the gun.
10. Dispose of all explosive elements.



U. S. TORPEDOES

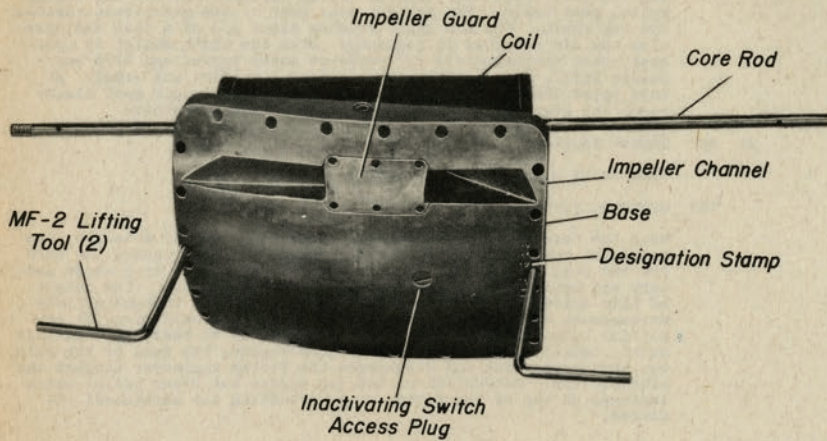


Fig. 16 - Mk 10-3 Exploder, Bottom View

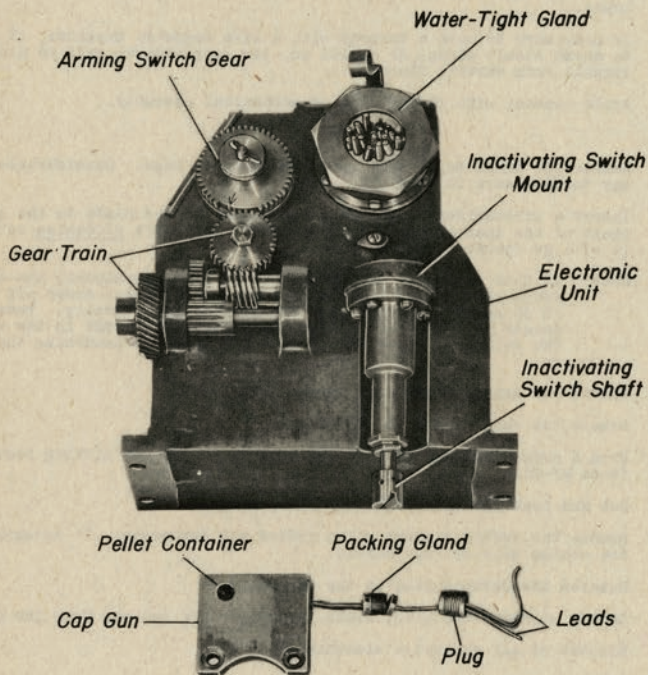


Fig. 17 - Mk 10-3 Exploder, Unit and Cap Gun

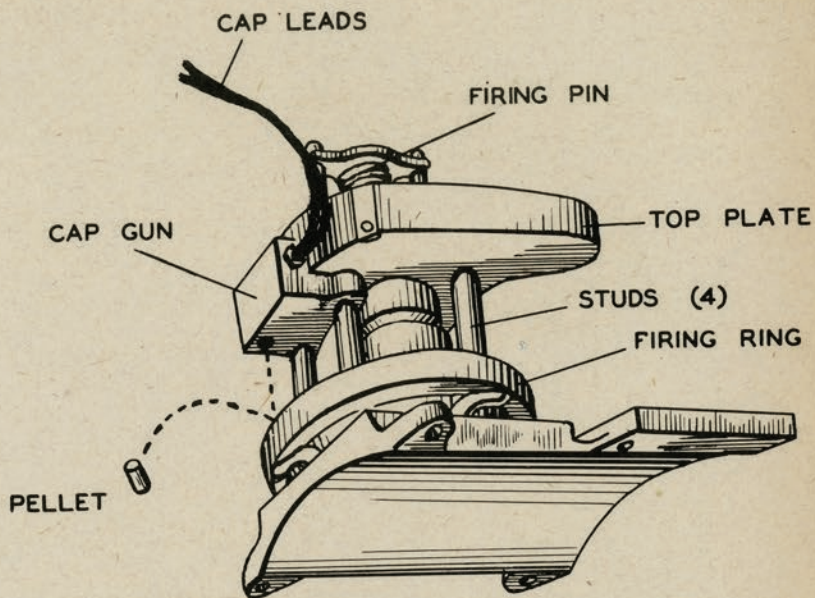


Fig. 18 - Mk 10-3 Exploder, Partial Section

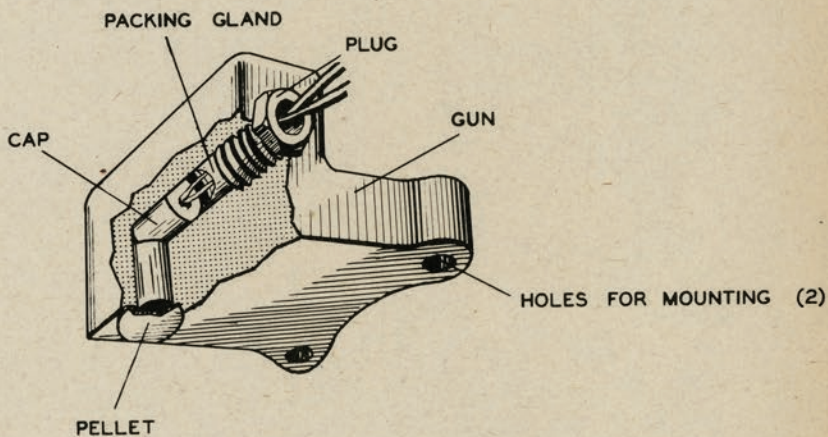


Fig. 19 - Mk 10-3 Exploder Cap Gun, Cutaway View

U. S. TORPEDOES



U. S. TORPEDOES

Exploders Mark 9 Mod 0 and Mark 9 Mod 1

General

1. Combination magnetic-induction, impact-inertia type exploder.
2. Fits in pocket of Mk 13-4, Mk 16-5, and Mk 18-3 warheads.

Description

1. The Exploder Mk 9-0 employs the same type base as the Exploder Mk 8-6 and the mechanical arming and impact firing assemblies are the same except that the impeller linkage is modified so that impeller rotation also arms the magnetic section. This is accomplished by adding to the drive shaft a spur gear which operates a pinion gear and finger which in turn control a starwheel in the magnetic firing device.
2. The magnetic firing device consists of the following:
  - (a) A gradiometer unit which is contained in a tube and consists essentially of two identical coils of wire, connected in series opposition. The coils are mounted several inches apart on a single highly permeable core rod. A cable extends from the coils to the electrical unit.
  - (b) The electrical unit which is contained in a watertight case and consists of the following:
    - (1) An electronic unit which includes a two-stage amplifier, a phase inverter, two thyratron tubes, and a firing condenser.
    - (2) Two battery units.
    - (3) A cartridge assembly consisting of an electric delay cap, a brass piston, a small shear plug, and a shear plate.
    - (4) An arming assembly composed of a starwheel and shaft, a rotary switch, and a plunger.
    - (5) Jack plugs which receive caules from the gradiometer and anticountermining units.
    - (6) A test switch.
  - (c) One of the following two devices:
    - (1) An anticountermining unit (used when the exploder is fitted to the Warheads Mk 16-5 and Mk 18-3). This unit is contained in a watertight case and consists essentially of an inertia-operated pellet which controls a short in the exploder firing circuit. In the device, a steel ball rests between a thin, flat steel anvil and a plastic thrust button. The button is mounted on the center of the leaf of a cantilever leaf spring switch which is connected across the firing condenser by the cable connecting the electrical and anticountermining units. An inactivating screw, located under a screw plug on the base of the unit, may be used to short out the firing condenser permanently.
    - (2) A combination ceiling and anticountermining unit (used when the exploder is fitted to the Warhead Mk 13-4). This unit is contained in a watertight case and consists essentially of a hydrostatic diaphragm and bellows assembly which controls a short in the exploder firing circuit. The hydrostatic diaphragm controls the bellows to which is fitted a spring and an actuating pin. The pin controls a plastic thrust button which is mounted in the center of a leaf spring. The leaf spring is fitted with a contact on each side and is mounted on a hinged arm which also contains two contacts, each of which is so positioned as to make the corresponding contact on the leaf spring if the spring moves in the proper direction. If either of the two sets of contacts is made, the firing condenser is shorted, the connection being made through the cable which connects the electrical and anticountermining units. The leaf spring is not closed to either contact if the torpedo is running at its proper depth. An inactivating screw, located in a dummy hole at the after end at the base of the unit, may be used to short out the firing condenser permanently.
3. Method of Mounting
  - (a) The various components comprising the complete exploder are mounted as follows:
    - (1) The impact exploder is slipped into the exploder pocket of the warhead and is secured by 12 screws.

U. S. TORPEDOES

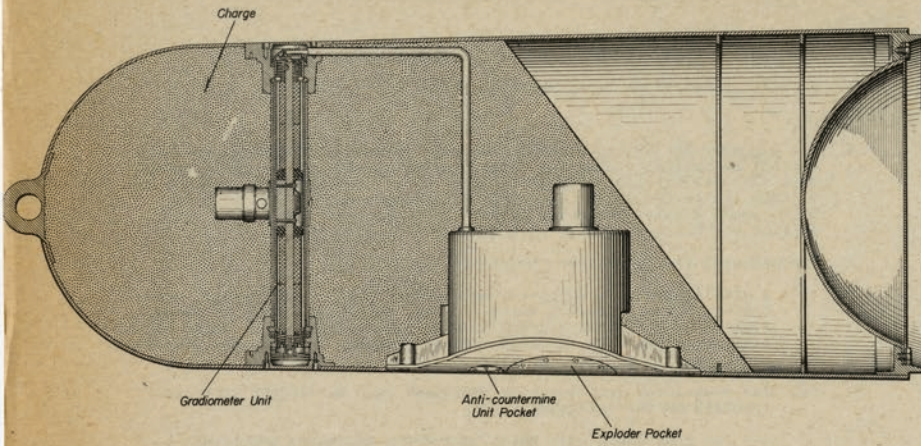


Fig. 20 - Mk 9 Exploder in Mk 13-4 Warhead, Sectional View

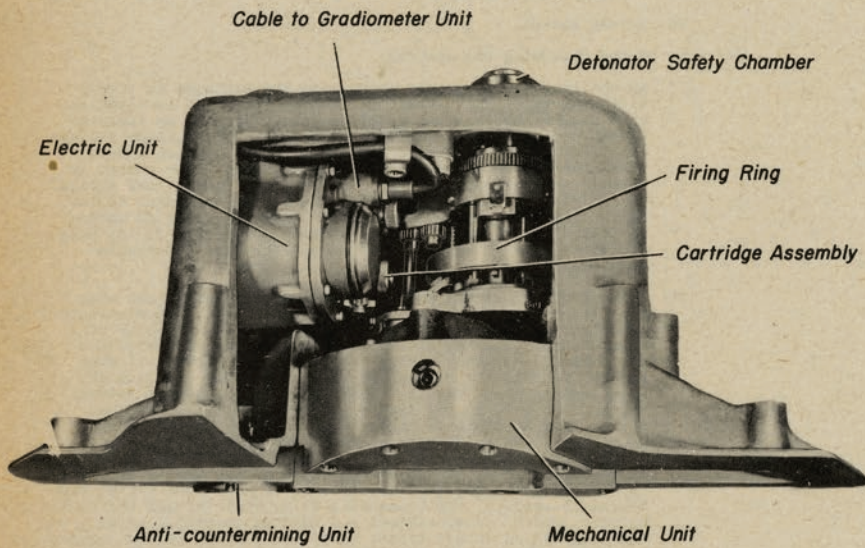


Fig. 21 - Mk 9 Exploder in Warhead Pocket, Cutaway View

## U. S. TORPEDOES

(Exploders Mark 9 Mod 0 and Mark 9 Mod 1, Cont'd.)

- (2) The gradiometer unit is permanently mounted in a vertical tube in the forward part of the warhead.
- (3) The electrical unit is mounted on a bracket on the forward edge of the exploder pocket inboard of the impact exploder.
- (4) The anticountermining unit or combination anticountermining and ceiling unit is mounted in a small pocket in the warhead shell just forward of the exploder pocket.

### Operation

#### 1. Arming

##### (a) Impact section

- (1) Same as Mk 4 and Mk 8 type exploders except that arming is normally completed after approximately 185 yards of water travel.

##### (b) Magnetic section

- (1) When the torpedo is launched, the vertical drive shaft geared to the impeller rotates the spur gear pinion and finger. The finger engages the starwheel on the electrical unit, turning it one notch for each finger revolution. The starwheel transmits its motion to the rotary switch, closing the switch and placing the amplifier in the battery circuit after about 80 yards of water travel. Further rotation of the starwheel pushes the plunger into the cartridge shear plug and shears a small wire after about 250 yards of water travel, thereby removing a short from the detonator circuit.

#### 2. Firing

##### (a) Impact section

- (1) Same as Mk 4 and Mk 8 type exploders.

##### (b) Magnetic section

- (1) When the torpedo passes within a non-uniform vertical magnetic field such as that of a ship, voltages of different magnitudes are induced in each of the two gradiometer coils, producing a small net "signal" voltage. This is fed to the amplifier where it opposes a bias voltage on the grid of one of the thyratrons, the tube selected depending on the polarity of the signal. If the signal is sufficiently large, the thyratron fires and discharges the firing condenser, putting current through the electric delay cap in the cartridge assembly. After a 1/2 second delay, the cap fires and drives the piston through the shear plate against the firing ring of the impact exploder, firing the exploder.

#### 3. Anticountermining

##### (a) With anticountermining unit only.

- (1) This unit prevents the magnetic firing device from operating when the warhead is momentarily distorted by nearby large explosions. A large shock bounces the steel ball from the anvil against the thrust button on the cantilever spring switch, thereby closing the switch and discharging the firing condenser through the short circuit provided by the switch closure.

##### (b) With combination anticountermining and ceiling device.

- (1) This unit prevents the magnetic firing device from operating when the warhead is momentarily distorted either by nearby large explosions or by the torpedo broaching. It also serves to inert the magnetic firing mechanism at the end of the torpedo's set run. The three functions are performed as follows:
  - (i) Any large shock is transmitted via the diaphragm to the bellows, forcing the actuating pin against the thrust button, making one set of contacts momentarily, and shorting out the firing condenser.
  - (ii) If the torpedo rises to a depth of water less than five ft., release of pressure on the diaphragm allows the bellows to retract and make one set of contacts, shorting out the firing condenser until the torpedo again descends to a depth greater than five ft.

U. S. TORPEDOES

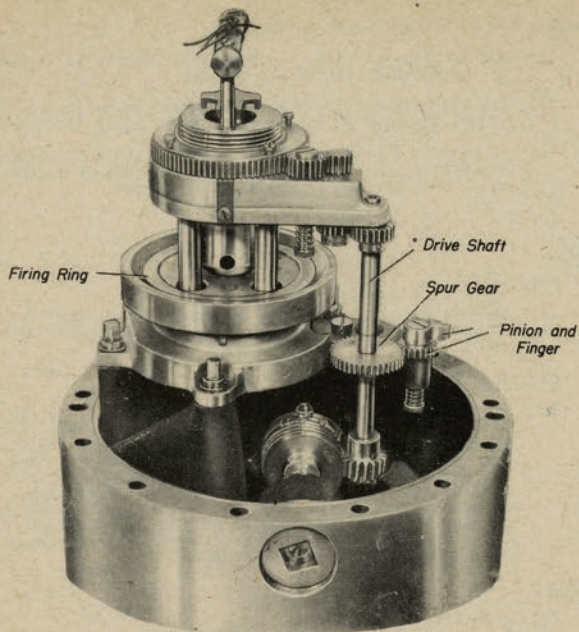


Fig. 22 - Mk 9 Exploder, Mechanical Unit

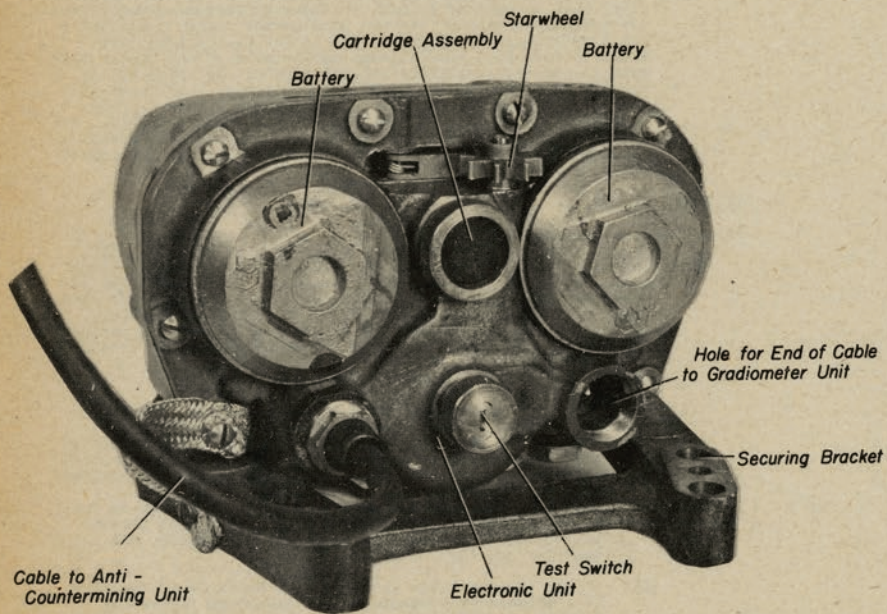


Fig. 23 - Mk 9 Exploder, Electrical Unit

CONFIDENTIAL

U. S. TORPEDOES

(Exploders Mark 9 Mod 0 and Mark 9 Mod 1, Cont'd.)

- (iii) When the torpedo sinks at the end of its run, hydrostatic pressure on the bellows forces the actuating pin against the thrust button and, at a depth of 75 feet, makes one set of contacts and shorts out the firing condenser permanently.

Precautions

1. Normal torpedo and magnetic precautions.
2. Wait a minimum of eight hours, preferably longer, before commencing to render safe. This will permit the operating battery voltage to drop below the minimum required to keep the magnetic section alive. The battery should discharge below the minimum operating voltage in about five hours.
3. Identify the warhead if possible with a view toward determining the type of anticountermining unit fitted.
4. Avoid all contact with the impact exploder firing ring.

Rendering Safe Procedure

1. For exploder fitted with anticountermining unit only.
  - (a) Remove the screw plug from the base of the anticountermining unit.
  - (b) Insert a screwdriver in the plug hole and turn the inactivating switch screw clockwise until the slot of the screw is aligned with the inscription **OFF INF** on the face of the unit. The magnetic firing device is now inoperative.
  - (c) Carry out steps 1-5 of the rendering safe procedure for the Exploders Mk 4 and 8 and Mods.
  - (d) Unscrew the gland nuts which secure the ends of the anticountermining and gradiometer cables in the electric unit and withdraw the ends.
  - (e) Remove the electric unit from the exploder pocket.
  - (f) Remove the cap and shear plate from over the cartridge unit. Remove the brass piston.
  - (g) Screw a standard 6/32" machine screw into the tapped hole in the cartridge. Remove and destroy the cartridge.
  - (h) Dispose of detonator, booster and charge.
2. For exploder fitted with combination anticountermining and ceiling device.
  - (a) If the torpedo is beached or in less than three ft. of water, the magnetic section should be inoperative; proceed with steps (c) through (h) above.
  - (b) If the torpedo is in three or more feet of water, remove the inactivating screw from the dummy hole at the after end of the base of the combination unit.
  - (c) Place this screw in the center hole in the base of the combination unit and screw down as far as possible. The magnetic unit is now inoperative; proceed with steps (c) through (h) above.

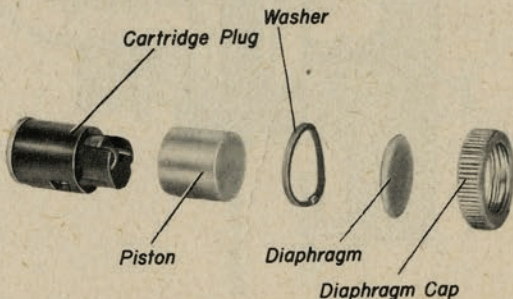


Fig. 24 - Mk 9 Exploder, Cartridge Assembly

Added 1 September 1945  
(Change No. 11)



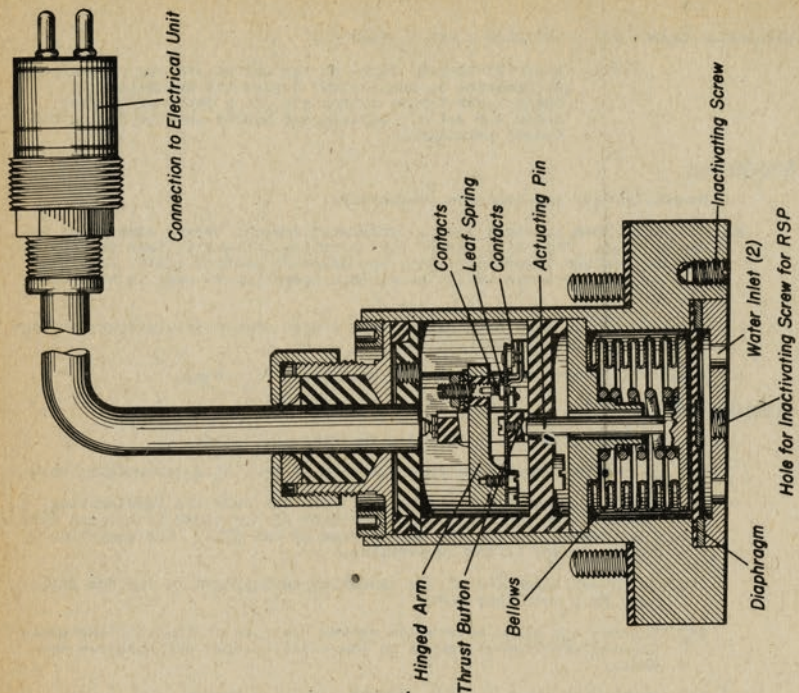


Fig. 25- Mk 9 Exploder, Combination Ceiling and Anticountermining Unit, Sectional View

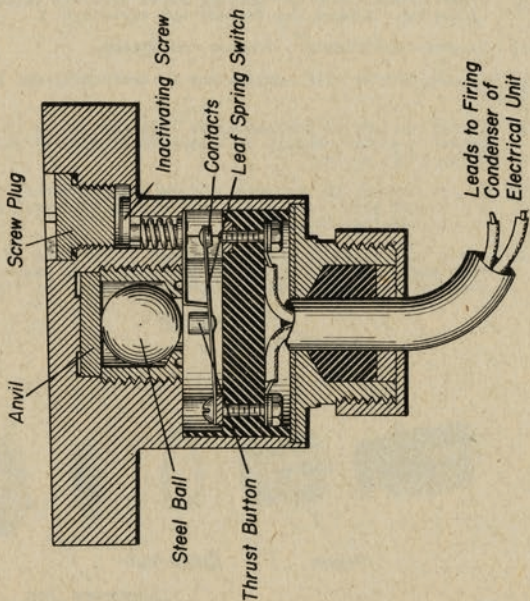


Fig. 26- Mk 9 Exploder, Anticountermining Unit, Sectional View

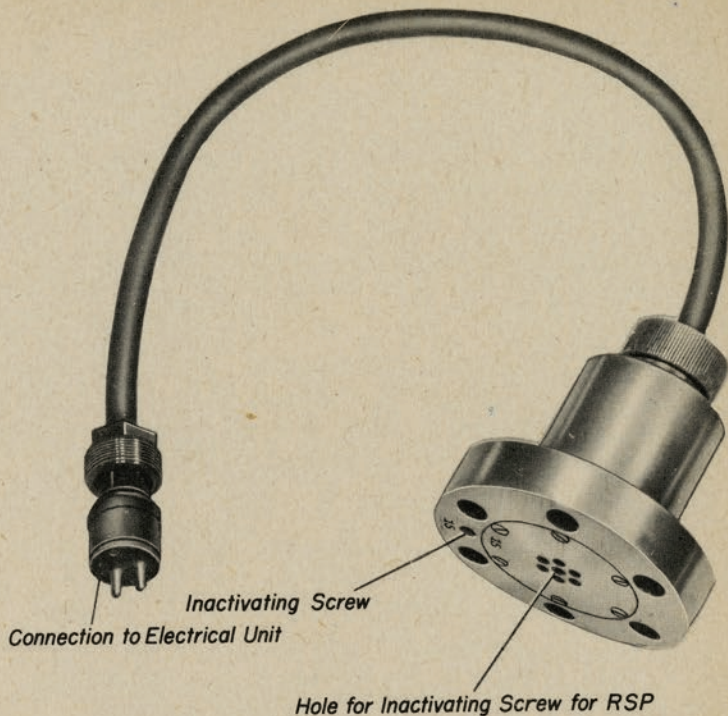


Fig. 27 - Mk 9 Exploder, Combination Ceiling and Anticountermining Unit

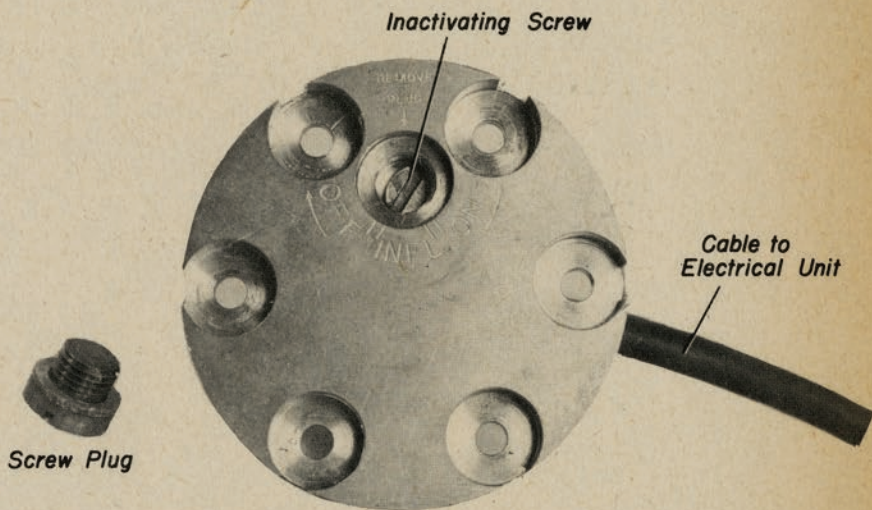


Fig. 28 - Mk 9 Exploder, Anticountermining Unit

# MINE DISPOSAL HANDBOOK

## PART II

### UNITED STATES UNDERWATER ORDNANCE

\* \* \* \* \*

#### CHAPTER 4

#### U. S. DEPTH CHARGES



U.S. DEPTH CHARGES

Mark And Mod.	Total Weight (lbs.)	Chg. Wt. (lbs.) (TWR)	Shape	Length (inches)	Diameter (inches)	Pistol	Booster Extender	Depth Settings (ft.)	Arming Depth (ft.)	How Fired	Remarks
6	420	300	Cylindrical	27.6	17.6	Mk. 6	Mk. 6, 6-1	30, 50, 75, 100, 150, 200, 250, 300 Same as above plus 350, 400, 450, 500, 550, 600	11-22 Average 15	Hydrostatic	
6-1	"	"	Cylindrical	"	"	Mk. 6-1	"		"	"	
6-2	"	"	Cylindrical	"	"	Mk. 6-2	Mk. 6-2	30, 50, 75, 100, 150, 200, 250, 300, and 350 Same as Mk. 6	"	"	
7	765	600	Cylindrical	"	24.9	Mk. 6	"		"	"	
7-1	"	"	Cylindrical	"	"	Mk. 6-1	"		"	"	
7-2	"	"	Cylindrical	"	"	Mk. 6-2	Mk. 6-2		"	"	
8	520	270	Cylindrical	"	17.6	Mk. 7-1	None	50, 75, 100, 150, 200, 250, 300, 350, 400, 450, 500 According to pistol used; see above	42-55 Average 50	Hydrostatic or magnetic	150 lbs. lead in pistol end. M-7 or M-7-2 mechanism is used.
9	320	200	Tear-drop	27.6	17.6	Mk. 6, 6-1, 6-2	Mk. 6, 6-1, 6-2		11-22 Average 15	Hydrostatic	8 fins set at 20° from longitudinal axis; 6° shroud on tail; fore and aft welded case; ring on nose. Same as above except case is circumferentially welded. Pistols are exchanged with Mk. 7-1 pistol
9-1	"	"	Tear-drop	"	"	"	"		"	"	
9-2	340	190	Tear-drop	"	"	"	"		"	"	8 fins set at 30° from longitudinal axis; 2 rings on tail instead of 6° shroud; all rings oval instead of round; materials from Mk. 9-2 is in only difference from Mk. 9-2 is in minor case change.
9-3	"	"	Tear-drop	"	"	"	"		"	"	
10	29	25	Cylindrical	9.69	8.5	Mk. 8, 9, 10	None	10-100 depending on pistol used	Armed when dropped	Delay fuze, or hydrostatic	Mk. 9 and 10 pistols obsolete; only few issued.

Table V -- Depth Charges

U. S. DEPTH CHARGES

Introduction

1. The difficulties to be overcome in the recovery of depth charges are two-fold:
  - (a) Locating the depth charge
  - (b) Recovery or disposal of the depth charge

Locating techniques and equipment are fully treated in Part I, Chap. 2. This chapter is concerned with the identification and rendering safe procedure to be followed after locating.
2. Before proceeding with locating or recovery, the following information should be obtained to the highest degree of accuracy possible:
  - (a) Exact time charge was dropped
  - (b) Course, speed, and location of ship
  - (c) Weather conditions
  - (d) Condition and rate of flow of tides and currents
  - (e) Mark and Mod. of charge dropped
  - (f) Pistol setting
  - (g) Whether safety fork and cap were attached
  - (h) How charge was dropped, i.e. from K-gun, Y-gun or rack
  - (i) How and when the location was marked
3. If possible, allow at least one passage of high tide before diving on charge.

Depth Charges Mark 6, 6-1, 6-2, 7, 7-1, 7-2

General

1. Hydrostatic depth charges.
2. Anti-submarine weapons.
3. Launched from surface craft.

Description

1. Case (Mark 6)

Shape	Cylindrical, enclosed at each end by welded steel heads.
Color	Gray
Material	Steel
Diameter	17"6
Length	27"6
Charge	300 lbs. TNT with Mk. 6, 6-1, or 6-2 gran. TNT booster
Total weight in air	420 lbs.

2: External Fittings (Mark 6)

Central tube	4"2 diameter, extends longitudinally through case
Filling holes	One in each end
Pistol	Mk. 6, in end of central tube
Booster extender	Mk. 6, or 6-1, in opposite end of central tube from booster
Air vents	One in each end, adjacent to filling hole (may be omitted)

U. S. DEPTH CHARGES

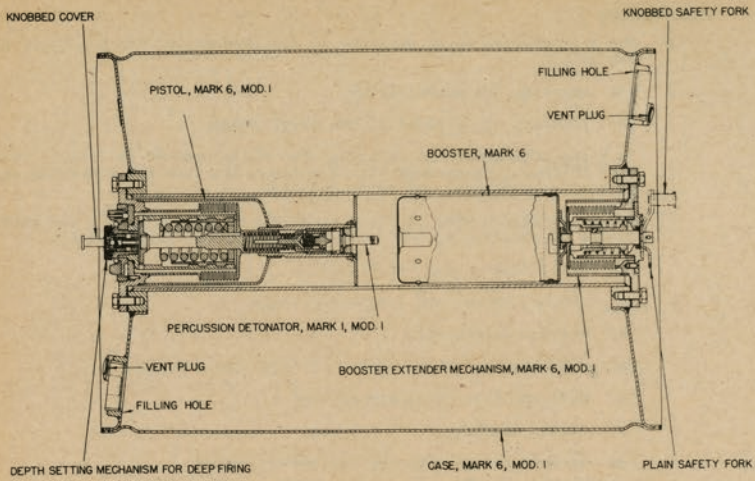


Fig. 1-- Mk. 6-1 Depth Charge, Sectional View

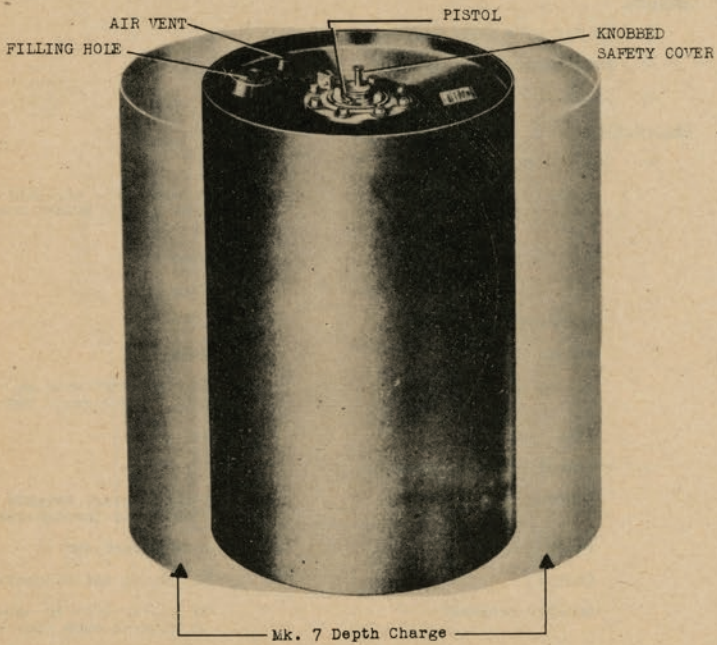


Fig. 2-- Mk. 6 Depth Charge

~~CONFIDENTIAL~~

## U. S. DEPTH CHARGES

- (a) The Mk. 6 pistol is a hydrostatically operated firing device 12" long and weighing 17.5 lbs. The parts include: a bellows, depth spring and setting device for determining the depth at which the pistol will fire; a plunger assembly for firing the detonator; an inlet valve which allows water to enter and operate the bellows; and a flange for securing the pistol to the case. Settings on the pistol dial are 30, 50, 75, 100, 150, 200, 300, (ft.) and SAFE. Variable depth control is accomplished by turning the depth setting dial to the desired firing depth. This in turn alters the position of the depth setting spring with respect to the hydrostatic piston, varying the amount of compression necessary to force the piston in far enough to free the firing plunger. The greater the pressure needed to compress the firing spring, the greater will be the firing depth.
3. The Mk. 6-1 and 6-2 depth charges are identical to the Mk. 6 except that they are fitted with Mk. 6-1 and 6-2 pistols respectively, and the Mk. 6-2 booster extender is always used with the Mk. 6-2 depth charge.
- (a) The Mk. 6-1 pistol is very similar to the Mk. 6, the only difference being that it has been modified for deep firing by replacing the inlet valve assembly with a deep firing mechanism. The Mk. 6-1 has two concentric depth setting dials, the smaller one being calibrated for depths over 300 ft. Settings on the dials are 30, 50, 75, 100, 150, 200, 250, 300, 350, 400, 500, 600 (ft.) and SAFE.
- (b) The Mk. 6-2 pistol is identical to the Mk. 6-1 except that it is modified for deep firing in depths from 300 ft. to 1000 ft. in 50 ft. steps. The bellows have been modified so that they will burst at crushing depths and render the charge safe.
4. The Mk. 7, 7-1 and 7-2 depth charges differ from the Mk. 6, 6-1 and 6-2 respectively in that their diameter is 2 1/2", the charge is 600 lbs. and the total weight is 765 lbs.
5. Boosters and Booster Extenders
- (a) The boosters Mk. 6, 6-1 and 6-2 are interchangeable in all the depth charges listed above. The booster consists of a cylindrical container filled with granular TNT and fitted with an envelope on the inboard end for receiving a detonator. The Mk. 6 and 6-1 have charges of slightly more than 3 1/2 lbs., and 6-2, which is replacing the earlier models, has a charge of slightly more than 3 lbs.
- (b) The booster extenders Mk. 6, 6-1 and 6-2 are interchangeable in all the depth charges listed above. These devices house the detonator in the booster after the charge reaches a pre-determined depth, and retract it after release of hydrostatic pressure. The chief working parts include a spindle, hydrostatic piston, bellows, spring and locking balls, all housed in a cylindrical case which is fitted with a flange for securing the assembly to the depth charge case. The Mk. 6 and 6-1 booster extenders differ in minor constructional details only, while the Mk. 6-2 is fitted with a reinforced bellows and bellows stop, the latter being added to relieve pressure on the booster at lower depths and prevent its being crushed.

### Operation

1. The knobbed safety fork and safety cap are wiped from the booster extender and pistol respectively upon launching. Upon removal of the fork, water enters the bellows, forcing the hydrostatic piston inward against the pressure of the extender spring as the charge sinks. The locking balls will release the spindle at the depth somewhere between 11 and 22 ft., allowing water pressure on the bellows to drive the booster to its armed position over the detonator. The Mk. 6, 6-1 and 6-2 booster extenders operate almost identically.
2. As the charge continues to sink, water entering the pistol bellows forces the hydrostatic piston inward, compressing the depth spring and firing spring. The piston forces a ball-release plunger in until, at the pre-set depth, the locking balls fall into a recess, allowing the firing plunger to move forward and fire the detonator.
3. When set on SAFE, the hydrostatic piston is mechanically prevented from moving in far enough to allow the pistol to fire unless subjected to crushing pressure. The inlet valve acts as an anti-countermining device, closing momentarily when subjected to a sudden and great increase in pressure, thereby blocking entry of water into the bellows.
4. The depth charges which use the Mk. 6-1 and 6-2 pistols operate in the same manner as the Mk. 6 except when the pistol is set for deep firing. In this case, the small dial is set for the depth desired, and the large dial is set at 100. The setting on the small dial adjusts tension on the deep firing valve spring so that no water can enter the pistol until the firing depth is reached. At that moment, the valve opens, water rushes in, and the pistol fires instantaneously. For shallow depths,

U. S. DEPTH CHARGES

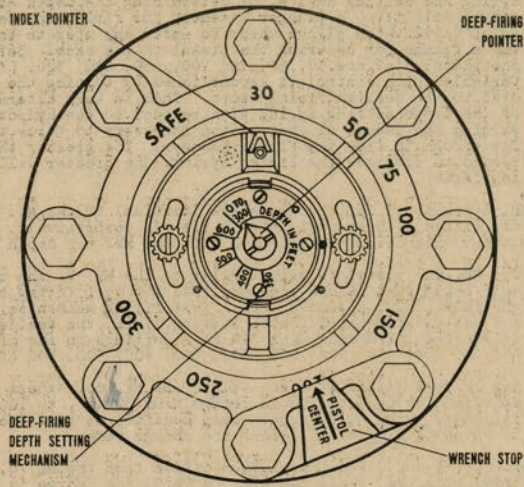


Fig. 3-- Deep-Firing Depth Setting Mechanism of Mk. 6-1 Pistol

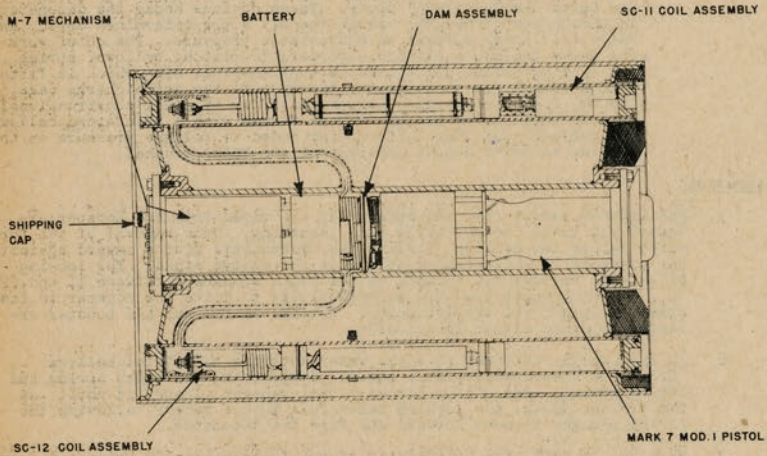


Fig. 4-- Mk. 8 Depth Charge, Sectional View



## U. S. DEPTH CHARGES

(300 ft. or less) the large depth setting dial is set for the desired depth, and the small dial is set at the mark "0 to 300". This keeps the deep firing valve open, allowing water to enter the pistol, and it operates in the same manner as the Mk. 6. It should be noted that the Mk. 6-1 and 6-2 have no anti-countermining feature, since the inlet valve has been removed.

5. The booster extender is designed to retract upon release of hydrostatic pressure.

### Precautions

1. Do not attempt to render safe unless absolutely necessary.
2. Do not move or jar the charge unnecessarily.
3. If feasible, allow at least one passage of high tide before diving on the charge.
4. If the charge is found underwater, countermine it if the situation permits. In any case, where rendering safe is to be attempted, the charge must first be raised to the surface.
5. Booster extender may fail to retract upon release of hydrostatic pressure.

### Rendering-Safe Procedure

1. Place a safety fork on the ~~pistol~~ *booster extender.* ~~if possible.~~
2. Remove the booster extender.
3. Remove the booster can from the extender.
4. Remove the pistol.
5. Remove the detonator by unscrewing the detonator holder from the end of the pistol. The holder has two holes which may be fitted by a small spanner. If the detonator cannot be removed readily, do not force it, but dispose of the pistol and detonator together.
6. Dispose of the booster and charge.

## Depth Charge Mark 8

### General

1. Hydrostatic-magnetic depth charge.
2. Anti-submarine weapon.
3. Launched from surface craft.

### Description

1. Case

Shape	Cylindrical
Color	Gray
Material	Aluminum
Diameter	17.6"
Length	27.6"
Charge	270 lbs. TNT with granular TNT booster
Total weight in air	520 lbs. (includes 150 lbs. lead case in end containing pistol)
2. External Fittings

Central tube	4" diameter, extends longitudinally through case
Filling holes	Two, on unweighted end of case

U. S. DEPTH CHARGES

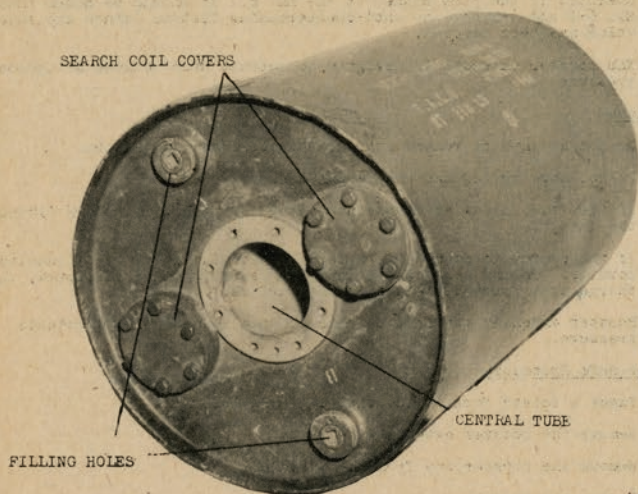


Fig. 5-- Mk. 8 Depth Charge, Pistol Removed

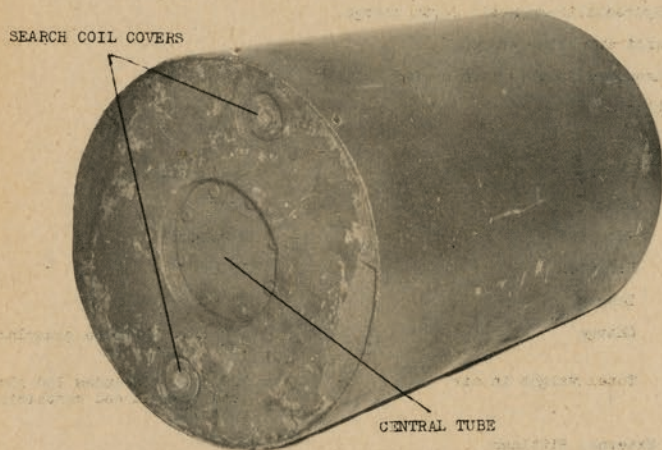


Fig. 6-- Mk. 8 Depth Charge, Weighted End

## U.S. DEPTH CHARGES

Search coils	Two, on either side of the central tube, extending longitudinally through case.
Pistol	Mk. 7-1 or Mk. 7-3 in weighted end of central tube.
Firing device	M-7 or M-7-2, in opposite end of central tube from pistol.

3. (a) The Mk. 7-1 pistol is a complete primary explosive unit containing a percussion detonator, electric detonator, tetryl leads through which the detonators fire the sub-booster and booster charges, and all the integral parts of a pistol. Settings on the pistol dial are "S" (safe, "M" (magnetic) 50, 75, 100, 150, 200, 300, 400, and 500. (Feet for hydrostatic firing.) These components are all housed in a cylindrical brass container 16 1/4" long.
- (b) The Mk. 7-3 pistol is now being issued for use in creeping attacks on submarines. It arms at a minimum depth of 200 feet and can be fired by magnetic influence only. The depth-setting dial has been covered with green paint, leaving only the marks "S" (safe) and "M" (magnetic) visible. The anti-countermine ring, inside the setting dial ring, is painted red. The Mk. 7-3 pistol is identical with the Mk. 7-1 except that the percussion detonator assembly has been removed and a washer has been placed over the depth-setting spring to provide added tension for arming the pistol. No Mk. 7-2 pistol has ever been issued.
4. The M-7 firing device is an amplifier assembly contained in a brass cylinder to which a battery is bracketed. The whole unit is 12 1/4" long. The M-7-2 device contains minor electrical changes. Both types are in general use. The changes were made to prevent premature firings due to spurious signals. No M-7-1 device has been issued.

### Operation

#### 1. Using Mk. 7-1 Pistol

- (a) Removal of a safety fork from the pistol upon launching permits the piston to advance under the action of water pressure building up within the piston bellows. The advancing piston compresses the shifting spring and after the former has moved inward 1/4 inch the balls securing the movable detonator plunger to the fixed sub-booster carrier are allowed to move into a recess in the piston extension allowing the detonator plunger to move forward under the force of the shifting spring. Such movement of the detonator plunger aligns the tetryl leads from the detonators to the sub-booster and in addition closes the electrical detonator spring contact completing the pistol part of the electrical firing circuit. Arming is normally completed at the depth between 40 and 54 feet, premature arming by inertia being prevented by a rocker-arm type inertia lock on the pistol.

The M-7 or M-7-2 devices are armed during the same period as the pistol. The safety cover is pulled from the hydrostatic port number "1" during launching. Water enters, and depresses a small hydrostatic diaphragm and plunger. The plunger operates switches which arm the magnetic unit, and it also releases the escapement of a small, spring-wound clock which operates a chopper switch. The unit is now magnetically active, and remains active for a period of three minutes, or until the clock runs down. Arming is normally completed at a depth between 42 and 55 ft.

- (b) The charge will fire magnetically on any pistol setting except "S", but it will not fire hydrostatically if set on "M", except at depth of 1100 ft. or greater.

When set for hydrostatic firing, further motion inward on the part of the hydrostatic piston causes a shoulder to move against the depth setting spring. The exact point at which this occurs is determined by the adjustment of the depth setting dial. As the piston moves in, the firing pin slides up a firing wedge compressing a leaf spring. When it is clear of the high point, the leaf spring snaps the firing pin down on the percussion detonator. When the depth setting dial is set on "M", mechanical interference prevents the percussion striker from impinging on the detonator.

U. S. DEPTH CHARGES

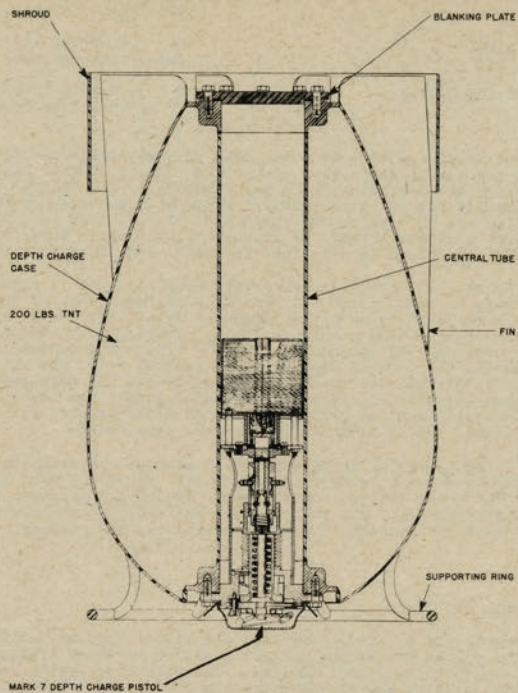


Fig. 7-- Mk. 9 Depth Charge, Sectional View

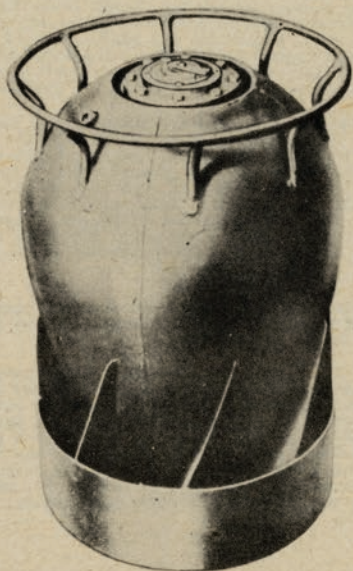


Fig. 8-- Mk. 9 Depth Charge

## U.S. DEPTH CHARGES

The search coils operating the magnetic device are connected so that motion in a uniform field, such as the earth's field, will cause little or no current to be sent to the amplifier. However, if the charge passes through a gradient field, such as that of a submarine, a much larger signal will be sent to the amplifier, and the firing circuit will close, putting current from the battery through the electric detonator.

- (c) When set on "S", the Mk. 7-1 pistol will not arm except at depth of 1300 ft. or deeper, and consequently the electric detonator will be out of the circuit, and the explosive trains of both the percussion and electric detonators will be out of alignment. An anti-countermining device similar to that on the Mk. 6 pistol is used on the Mk. 7-1 to prevent firing due to a sudden increase in water pressure.
2. Operation using Mk. 7-3 pistol is similar to that using Mk. 7-1 with the following exceptions:
    - (a) Arming is not completed until charge reaches a depth of 200 feet.
    - (b) The Mk. 7-3 pistol does not alter magnetic firing of charge, but removal of the percussion detonator assembly eliminates hydrostatic firing.
    - (c) When set on "S", the Mk. 7-3 pistol will not arm the depth charge except at depth of 1300 ft. or deeper.

### Precautions

1. Do not attempt to render safe unless absolutely necessary.
2. Do not move or jar the charge except from a safe distance.
3. Allow no movement of magnetic material near the charge. Although the magnetic life of the charge is normally limited to three minutes, the arming clock may run an additional five or six seconds if the charge is jarred.
4. Having once armed, the Mk. 7-1 pistol will never disarm. Arming results in all explosive elements being permanently married or aligned, and, for this reason, an armed pistol should never be disassembled.

(Continued on Page 11)

## U.S. DEPTH CHARGES

5. The small hydrostat in the M-7 should retract if the charge is raised above a depth of 50 ft., blocking the clock, and breaking the operating circuit of the magnetic section. However, as with other hydrostatically operated safety devices, it may fail to operate as designed.
6. If the charge is found underwater, countermine it if the situation permits. In any case where rendering safe is to be attempted, the charge must first be raised to the surface.

### Rendering Safe Procedure

Procedure for both Mk. 7-1 and Mk. 7-3 pistols is identical, ~~except that when the letter is involved, the first two steps are omitted.~~

1. Place a safety fork on the pistol if possible.
2. Remove the pistol, and unplug the cable connection on the inboard end when clear of the charge case.
3. At this point, the condition of the pistol may be determined. A small port on the sleeve of the sub-booster will reveal the letter "C" if the pistol is cocked and safe, and the letter "A" if the pistol is armed.
4. If the pistol is unarmed, it may be disassembled as follows:
  - (a) Remove the leaf-shaped firing pin and the wedge-shaped guide.
  - (b) Carefully unscrew the percussion cap.
  - (c) Remove the two firing leads from their terminals.
  - (d) Unscrew the three hexagonal nuts holding the booster and booster end flange.
  - (e) Remove the booster, booster-end spacer and sub-booster.
  - (f) Carefully unscrew the three rod bolts holding the booster and flange, spacer tube and top flange. On separation of the firing and hydrostat assemblies, the shifting spring will cause the detonator plunger to fly out.
  - (g) All explosive elements are now separated, and no further disassembly should be attempted.
5. Dispose of detonators, booster and charge.

### Depth Charges Mark 9, 9-1, 9-2, 9-3

#### General

1. Hydrostatic depth charge.
2. Anti-submarine weapon.
3. Launched from surface craft.

#### Description

1. Case (Mark 9)

Shape	Teardrop, with tail and fins
Charge	200 lbs. TNT with granular TNT booster.
Total weight in air	320 lbs.
All other data and dimensions are the same as in the Mk. 6 D.C. case.	
2. External Fittings

Filling Hole	In side of case
Central tube	Same as in Mk. 6
Support ring	Mounted on nose
Pistol and booster extender	Mk. 6 or 6-1, in opposite ends of the central tube
Fins	Eight, mounted on tail, set at angle of 20 degrees with longitudinal axis.
Shroud band	6" wide, encloses fins
Case weld	Runs fore and aft

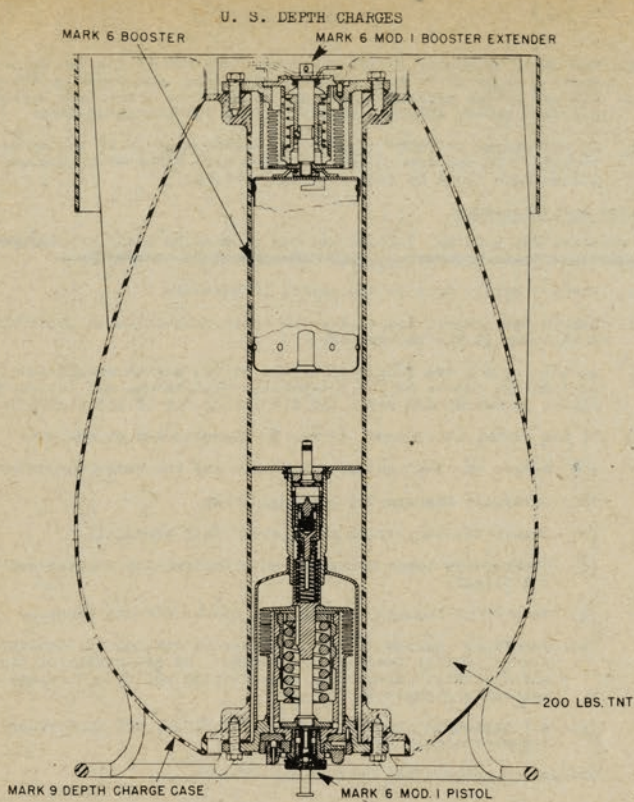


Fig. 9-- Mk. 9 Depth Charge with Mk. 6-1 Pistol and Booster Extender, Sectional View

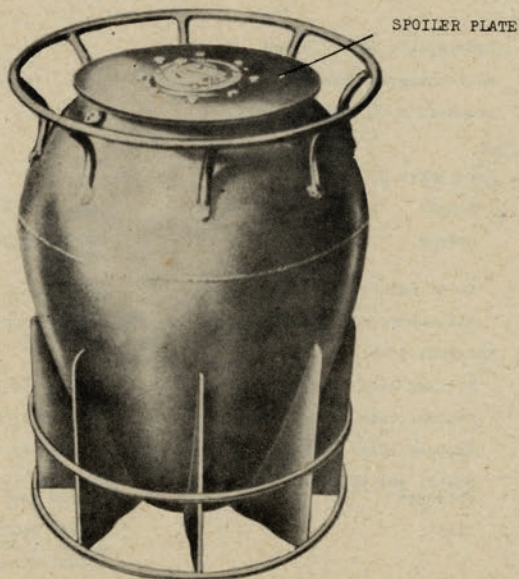


Fig. 10-- Mk. 9-2 Depth Charge with Spoiler Plate

U. S. DEPTH CHARGES

3. The Mk. 9-1 depth charge differs from the Mk. 9 as noted below:
  - (a) The case weld is circumferential.
  - (b) The Mk. 7-1 pistol may be used, and the opposite end of the central tube is then blanked off.
4. The Mk. 9-2 depth charge differs from the Mk. 9-1 as noted below:
  - (a) The eight fins are set at an angle of three degrees.
  - (b) Two tail rings are used instead of the shroud band.
  - (c) Nose and tail rings are oval in cross section instead of circular.
  - (d) 40 lbs. of lead is cast in the nose.
  - (e) Charge is 190 lbs. TNT; total weight is 340 lbs.
5. The Mk. 9-3 depth charge differs from the Mk. 9-2 as noted below:
  - (a) A minor manufacturing change has been made on the weld on the nose flange.

Operation

1. The operation of the Mk. 9 and Mods. is the same as that of the previously described charges which use the Mk. 6, 6-1 and 7-1 pistols.

Precautions and Rendering-Safe Procedure

1. Use the appropriate precautions and technique for the pistol that is fitted.

Depth Charge Mark 10

General

1. Hydrostatic or fuze delay depth charge.
2. Designed to be used in restricted waters or aboard small, slow craft where larger charges are not suitable, to destroy human torpedoes and small submarines, and to harass large submarines.
3. Launched by hand.

Description

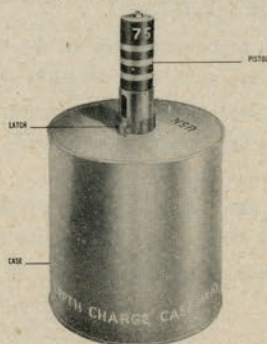
1. Case

Shape	Cylindrical, looks like a two-gallon paint can
Color	Gray or black
Material	Steel
Diameter	8½"
Length	9 11/16"
Charge	25 lbs. TNT with pressed granular TNT booster
Total weight in air	29 lbs.
2. External Fittings

Pistol well	5" deep, in end of case. Has slots, spring latch, and bayonet joint on flange for securing the pistol
Pistol	Mk. 8, 9, or 10 in pistol well
3. The Mk. 8 pistol is of the hand-grenade type, and may have one of two settings, 50 to 100 ft., depending on the length of time fuze installed in the assembly. The pistol is 10" long, protrudes 5" from the case, and has a hand-grenade type of release handle and cotter pin on top. Its pre-set depth is painted on the outside by the numeral "50" or "100" as appropriate, and two or four black stripes.
4. The Mk. 9 pistol operates hydrostatically at one of four possible depths, which are pre-set during assembly; 25, 50, 75 or 100 ft. It is 11" long, protrudes 6" from the case, and has as its basic elements two small

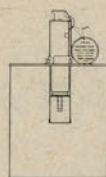


U. S. DEPTH CHARGES

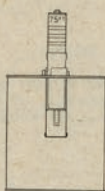


THE MARK 10 DEPTH CHARGE WITH MARK 9 PISTOL

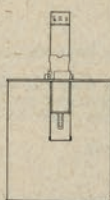
Fig. 11-- Mk. 10 Depth Charge



Mark 8 Pistol assembled in Mark 10 Depth Charge



Mark 9 pistol assembled in Mark 10 depth charge



MARK 10 PISTOL ASSEMBLED IN MARK 10 DEPTH CHARGE



MARK 8 PISTOL



MARK 9 PISTOL



MARK 10 PISTOL

Fig. 12-- Mk. 10 Depth Charges with Mk. 8, 9, & 10 Pistols

## U. S. DEPTH CHARGES

switches with hydrostatic diaphragms, which are connected in series with a battery and detonator. Spring tension on the diaphragms, which controls the firing depth, is pre-set during assembly. The pre-set depth of the pistol is painted on the outside body with the appropriate numeral and white stripes. For example, a 75-ft. setting would be indicated by the numeral "75" and three white stripes indicating depth setting #3.

5. The Mk. 10 pistol is similar in operation to the Mk. 9, the main difference being that it can be adjusted to fire at depths from 30 to 100 ft. in 10 ft. steps by a hand dial on the face of the pistol. It is about the same size as the Mk. 9, but may be distinguished by the depth setting dial and the absence of the stripes and figures which indicate the depth setting on the Mk. 9.

### Operation

1. The charge is armed as soon as the pistol is locked in the well.
2. (a) Mk. 8 operation  
The cotter pin is removed from the handle just prior to dropping. Upon dropping, the handle flies home from the cocked position, igniting a firing train consisting of primer, black powder delay, "quick match", fuze and detonator.
- (b) Mk. 9 and 10 operation  
These pistols operate after water pressure becomes sufficient to depress the diaphragms, closing the hydrostatic switches and completing the circuit from the battery to the detonator.
3. There is no anti-countermining feature fitted, and the only safety features are two mechanically opposed switches in the Mk. 9 and 10 which prevent the firing circuit from closing in case of accidental dropping.

### Precautions

1. Do not attempt to render safe unless absolutely necessary.
2. A charge found with the Mk. 8 pistol fitted to it should be classed as a dud hand-grenade, and should not be moved except from a safe distance and should not be handled except in case of an emergency. The Mk. 9 and 10 pistols may be handled if due care is exercised.

### Rendering-Safe Procedure

1. Rendering this depth charge safe consists of disposing of the particular pistol that is fitted. The approved procedure for handling each pistol is given below:
2. Mark 8
  - (a) Remove the pistol from the well by releasing the locking catch and rotating the pistol to break the bayonet joint.
  - (b) Remove the two screws from the side of the pistol.
  - (c) Unscrew the inner parts of the pistol from the top. This should be done only if the safety pin has not been removed from the top of the pistol. If the safety pin is gone, and the handle is upright, the charge has fired as a dud, and must not be disassembled.
  - (d) Remove the inner parts of the pistol.
  - (e) Cut the detonator away from the safety fuze, 1/8" of which is exposed.
  - (f) Destroy the detonator and delay elements.
  - (g) Remove the booster from the well, and dispose of it and the main charge.
3. Mark 9
  - (a) Remove the pistol from the well by releasing the locking catch and rotating the pistol to break the bayonet joint.
  - (b) Remove the locking screw, and pry off the cap on the top of the pistol.
  - (c) Shake out the battery from the top end.
  - (d) Remove the two screws from the side of the pistol body.

U. S. DEPTH CHARGES

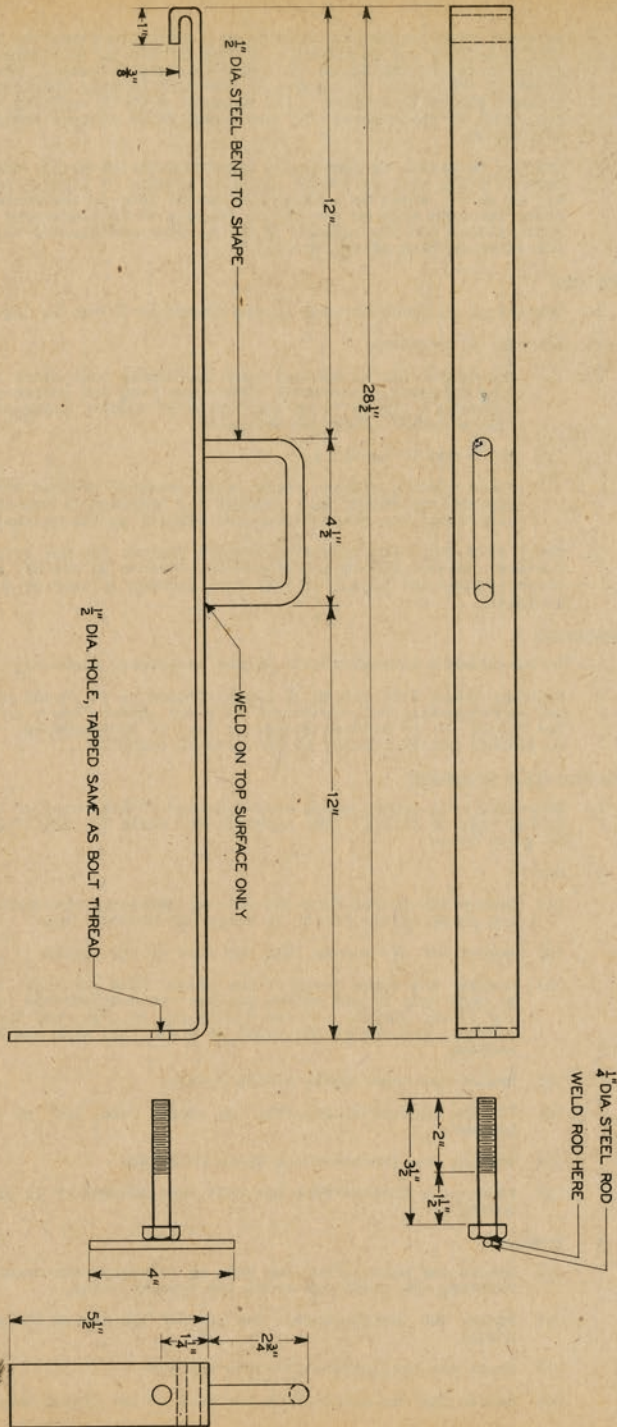


Fig. 13-- Depth Charge Recovery Sling

U. S. DEPTH CHARGES

- (e) Remove the four screws from the inner end of the pistol which secure the detonator mounting plate. Pry out the mounting plate.
- (f) Using a screwdriver or appropriate tool, push the inner parts of the pistol out the end of the pistol case.
- (g) Cut and tape the detonator leads.
- (h) Remove the booster from the well, and dispose of detonator, booster and main charge.

4. Mark 10

- (a) Through (e) same as Mk. 9.
- (f) With a probing tool less than 1/4" in diameter, (to fit in the hole at the bottom of the battery case) push the inner parts of the pistol out the end of the pistol case.
- (g) And (h) Same as Mk. 9.

Figure #13 may be used to construct a simple sling which will facilitate raising Mk. 6 and 7 type depth charges. The sling is secured to the charge by a diver, and may be made fast by taking up on the T-bolt clamp. The charge may then be raised by means of a hoisting line secured to the handle.

U. S. DEPTH CHARGES

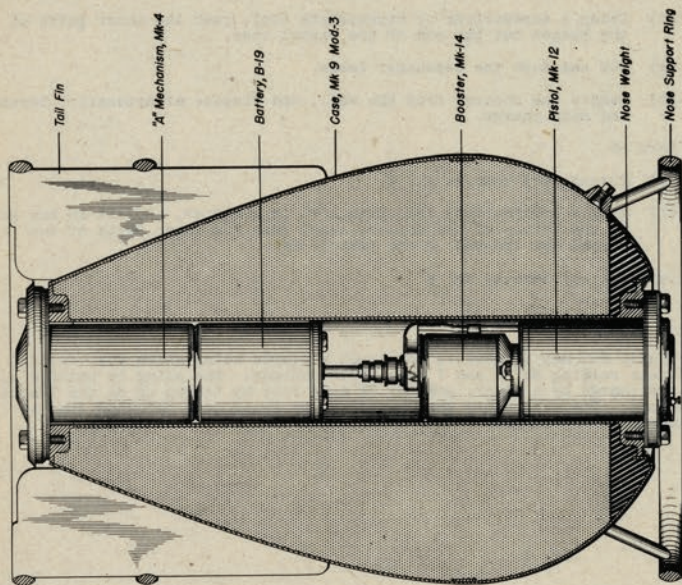


Fig. 14 - Mk 14-O Depth Charge, Sectional View

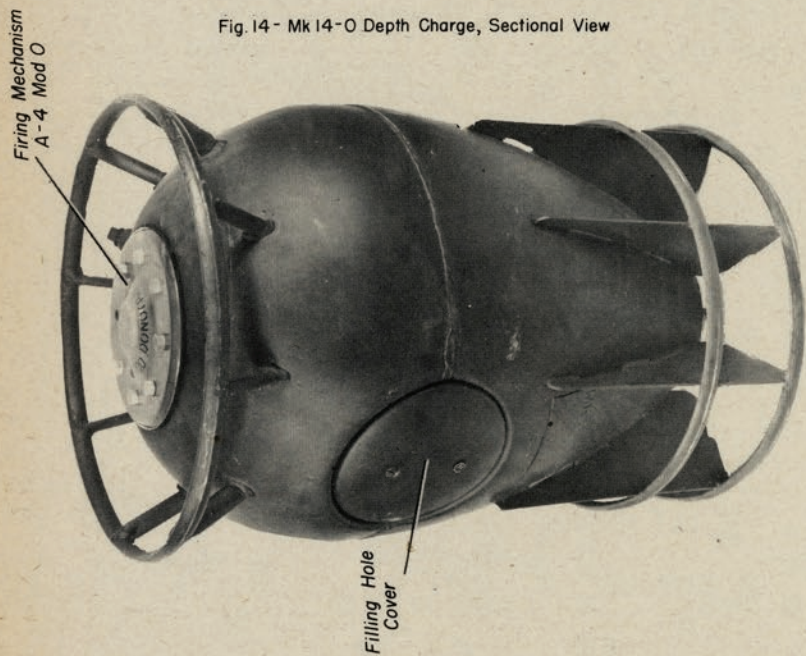


Fig. 15 - Mk 14-O Depth Charge

U. S. DEPTH CHARGES

Mark 14-0

General

1. Acoustic depth charge.
2. Anti-submarine weapon.
3. Launched from surface craft.

Description

1. Case Mk 9 Mod 3 or Mod 4 (which has strengthened nose ring supports)
2. External fittings

Same as in Mk 9-3 depth charge except for:

  - (a) Depth Charge Pistol Mk 12 Mod 0 (with Detonator Mk 35 Mod 1).
  - (b) Depth Charge Booster Mk 14 Mod 0.
  - (c) Depth Charge Battery B-19 Mod 0.
  - (d) Depth Charge Firing Mechanism A-4 Mod 0.
3. Depth Charge Pistol Mk 12 Mod 0
  - (a) The Pistol Mk 12 Mod 0 is a hydrostatically-operated arming device embodying a 0.5 second delay electric detonator, an extender mechanism which moves the detonator from the safe to the armed position, and two hydrostatic switches, all housed in a brass casing.
  - (b) On the face of the pistol is mounted a safety lock having two settings: SAFE and SERVICE. When the lock is set on SAFE the extender mechanism is locked in the retracted position; when the setting is SERVICE the pistol is free to arm hydrostatically provided that the safety fork is removed. Ultimately, the safety lock is to be replaced by a deep arming lock with an extra setting for deep arming between the SAFE and SERVICE settings. The deep arming setting delays detonator arming until a depth between 200 and 350 ft. has been reached and is for use during creeping attacks.
  - (c) The safety lock consists of a movable disc with a clover-shaped hole in the center through which the extender rod protrudes. In the SAFE position the disc engages four lugs on the extender rod; in the SERVICE position the extender rod is free to move through the hole. The safety lock is secured in either position by a spring-loaded latch which fits into either of two notches in the edge of the disc. The latch must be depressed to permit rotation of the safety lock. The deep arming setting is provided when soft copper ears on the safety lock engage the four lugs on the extender rod. The ears bend and release the extender rod at a depth between 200 and 350 ft.
  - (d) The extender mechanism embodies a double bellows assembly, a detonator holder, a pair of extension springs, and a mechanical linkage between the bellows and the detonator holder. The springs normally retain the detonator holder in the safe position, in which the detonator is pointed away from the booster and the electrical circuit to the detonator is broken. When the extender rod running through the center of the bellows assembly is free to move, and when hydrostatic pressure acts upon the external bellows, the internal bellows expands and causes the mechanical linkage to swing the detonator through 180° to the armed position, in which it is pointed toward the booster and its electrical circuit is made by contacts on the sides of the detonator holder. The detonator is designed to retract upon release of hydrostatic pressure, but this action may not be depended upon.
  - (e) The external and internal bellows are mounted on either side of a mounting plate, with the extender rod running lengthwise through them and being secured to the free ends of both bellows. The external bellows, filled with fluid, is normally expanded; the internal bellows is normally contracted. The bellows are connected by a small orifice to permit the flow of the fluid from one bellows to the other. The action of hydrostatic pressure upon the external bellows causes it to contract and to force the fluid through the orifice and into the internal bellows, expanding the latter. The damping effect of the fluid, which must be forced steadily through the orifice, prevents the arming of the pistol by a sudden shock such as a countermine explosion or a drop on a hard surface.
  - (f) The two hydrostatic switches constitute the remaining essential features of the pistol. These are mounted in the same plate as is the bellows assembly, and are low pressure switches which arm the

U. S. DEPTH CHARGES

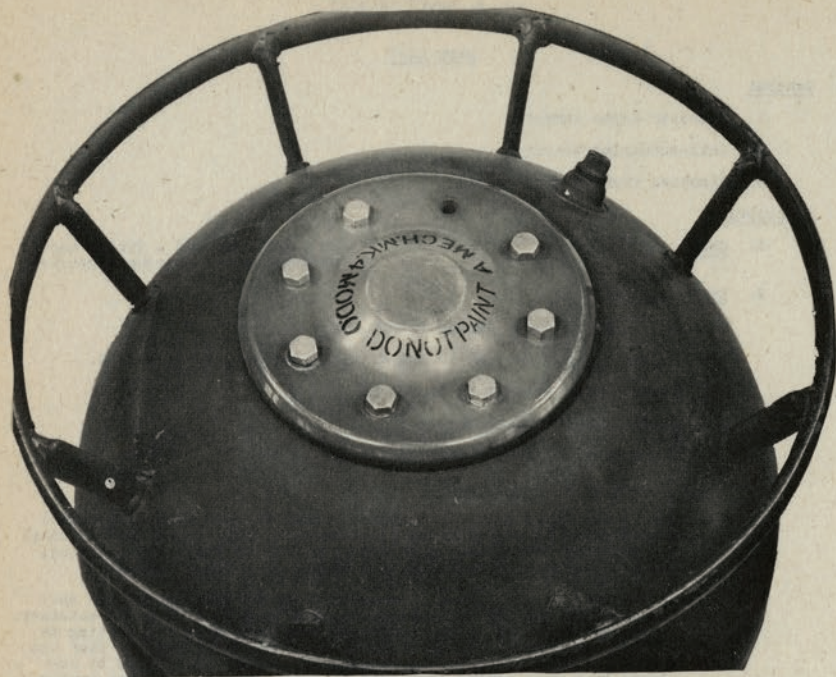


Fig. 16- Mk 14-O Depth Charge, Top View

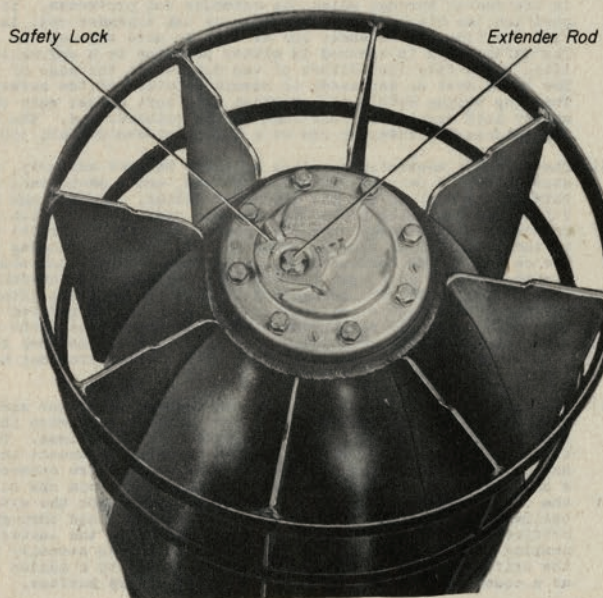


Fig. 17- Mk 14-O Depth Charge, Bottom View

## U. S. DEPTH CHARGES

(Mark 14-0, Cont'd.)

Mechanism A-4 Mod O, one closing at approximately 10 feet, the other at approximately 35 feet. Because of their relatively low operating pressures these switches are fitted with fluid-filled damping chambers which prevent their being closed by countermining or other shocks. They are designed to open upon release of hydrostatic pressure.

### 4. Depth Charge Booster Mk 14 Mod O

- (a) The Booster Mk 14 Mod O consists of a cylindrical brass canister containing four tetryl pellets (1/4 lb.) and approximately 1 3/8 lb. of granulated Grade A TNT. It is secured to the inner end of the pistol by means of a bayonet mount. One side of the canister is flattened slightly to provide for the passage of the electrical leads between the pistol and the Mechanism A-4 Mod O.

### 5. Depth Charge Battery B-19 Mod O

- (a) The Battery B-19 Mod O, which supplies operating voltages to the Mechanism A-4 Mod O, is contained in a steel canister approximately 5 inches long and 4 inches in diameter. It is mounted in the central tube of the depth charge case, between the booster and the Mechanism A-4 Mod O.

### 6. Depth Charge Firing Mechanism A-4 Mod O

- (a) The Mechanism A-4 Mod O, mounted in the opposite end of the central tube from the pistol, is a flanged canister approximately 7 1/2 inches long and 4 inches in diameter containing an electronic device which radiates a continuous signal ahead and to the sides of a sinking depth charge.

## Operation

1. As the depth charge is launched from the rack the safety fork is wiped, freeing the extender rod and enabling hydrostatic pressure to operate the bellows assembly. In the case of projector launching, the safety fork is removed by hand.
2. The charge sinks at approximately 23 ft/sec. At a depth of 10 feet the first hydrostatic switch operates, allowing the tube filaments to warm up. At a depth of 35 feet, the second hydrostatic switch operates, energizing the Mechanism A-4 Mod O. At 35 feet, also, the detonator completes its swing and is in position against the booster. The depth charge begins to radiate its signal upon closure of the second hydrostatic switch. It will not fire by influence, however, until a condenser is charged, the charging process requiring one second. Thus, the charge does not fire by influence until a depth of about 60 feet is reached.
3. When the transmitted signal strikes a reflecting surface such as the hull of a submarine, part of the signal is reflected back to the Mechanism A-4 Mod O. The mechanism is designed to be actuated and to fire the detonator as the depth charge reaches the nearest point of approach, provided that it comes within about 35 feet of the target.
4. If it does not pass near enough to the target to actuate the Mechanism A-4 Mod O, the charge will generally fire upon approaching the bottom, but may come to rest upon the bottom in a fully armed state. In the latter case, the charge usually will fire as the batteries run down, but may not do so. The mechanism is fitted with an anti-countermining device designed to prevent the charge from firing due to shock caused by underwater explosions.
5. A detailed description of this depth charge is contained in ORD 669.

## Precautions

1. Do not attempt Disposal or Recovery except in cases of dire emergency or in cases where water depth is less than 25 feet.
2. Note that if the safety fork has been removed and the charge is in more than 35 (plus or minus 10) feet of water, it must be considered alive and extremely dangerous. Although the depth charge will not ordinarily fire in less than 60 feet of water when dropped operationally (Par. 2 of Operation above), it may fire in much shallower depths if it is lying on the bottom. Note also that if the depth charge comes to rest on the bottom without firing, it will ordinarily fire as the battery runs down.
3. When a charge of this type is lying on the bottom, the following precautions and considerations should be borne in mind with regard to diving on it:



U. S. DEPTH CHARGES

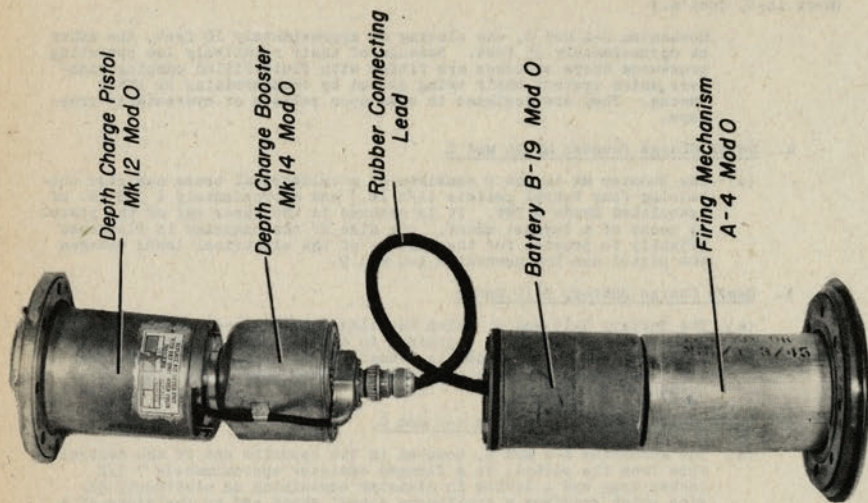


Fig. 18 - Mk 14-O Depth Charge Firing Assembly

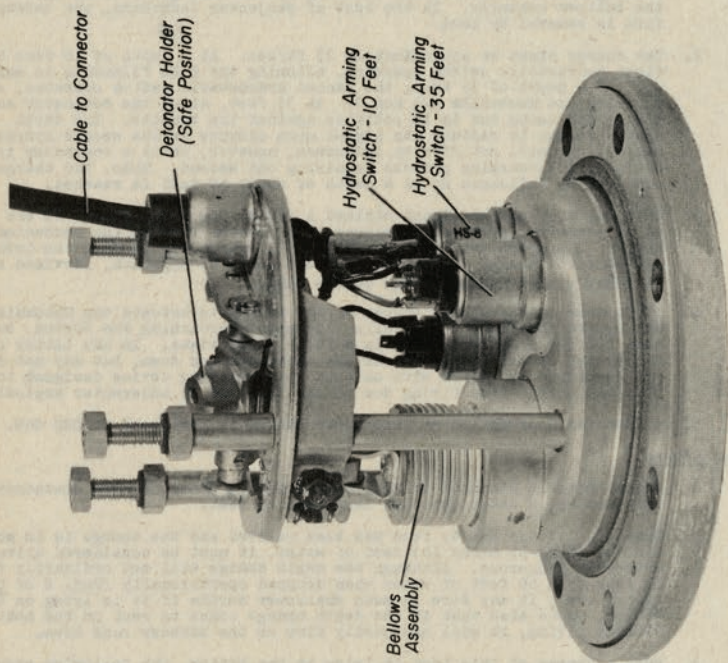


Fig. 19 - Mk 12-O Pistol, Cover Removed

U. S. DEPTH CHARGES

(Mark 14-0, Cont'd.)

- (a) If the charge lies in less than 25 feet of water, diving operations may be attempted. Due precautions must be observed, however, even though the charge may reasonably be assumed to be safe.
- (b) If the charge lies in more than 25 feet of water, no attempt should be made to dive on it except in the direst emergency and then only under ideal conditions which should include excellent visibility and negligible currents. Even under emergency conditions no diving should be undertaken until a period of 24 hours has passed. As noted above, when a charge of this type comes to rest on the bottom, it ordinarily detonates as the battery runs down. (See chart below.) The battery usually runs down within the 24 hour period, resulting either in detonation of the charge or in inerting of the firing mechanism. Attention is invited, however, to the fact that certain rare firing mechanism defects may result in the charge's being alive and dangerous even after an elapsed period of 96 hours. It must, therefore, be reemphasized that only the direst emergency conditions justify diving on a charge of this type in more than 25 feet of water.
- (c) Whenever possible, countermining should be attempted in preference to RSP.

Rendering Safe Procedure

1. Attach a line or sling to the charge and raise it to the surface by means of remote lifting gear.
2. Pry out and lock the extender rod.
3. Remove the pistol.
4. Disconnect the battery lead from the end of the booster can.
5. Remove the firing mechanism.
6. Dispose of all explosive elements.

<u>Test No.</u>	<u>Unit No.</u>	<u>Operation Started</u>	<u>Detonator Fired</u>	<u>Total Time</u>
1	2084	1330	2257	9 hrs. 27 min.
2	2066	1330	2145	8 hrs. 15 min.
3	2075	1330	2210	8 hrs. 40 min.
4	2365	1330	2237	9 hrs. 7 min.
5	2102	1330	2300	9 hrs. 30 min.
6	2080	1330	2250	9 hrs. 20 min.
7	2084	1330	1630	3 hrs.
8	2066	1330	2115	7 hrs. 45 min.
9	2075	1330	2230	9 hrs.
10	2365	1330	2120	7 hrs. 50 min.
11	2102	1330	1930	6 hrs.
12	2080	1330	2130	8 hrs.
13	2012	1615	0100	8 hrs. 45 min.
14	2061	1615	0015	8 hrs.
15	2302	1615	0015	8 hrs.
16	2365	1615	0120	9 hrs. 5 min.
17	2102	1615	2215	6 hrs.
18	2080	1615	0030	8 hrs. 15 min.
19	2012	0945	1945	10 hrs.
20	2061	0945	1900	9 hrs. 15 min.
21	2302	0945	1845	9 hrs.
22	2365	0945	1915	9 hrs. 30 min.
23	2102	0945	1855	9 hrs. 10 min.

Record of tests carried out at OIL, Indian Head, Md. to determine length of time re-

# MINE DISPOSAL HANDBOOK

## PART II

### UNITED STATES UNDERWATER ORDNANCE

\* \* \* \* \*

#### CHAPTER 5

#### U. S. DEPTH BOMBS

U. S. DEPTH BOMBS

Bomb	Total Wt. (lb.)	Type & Wt. of Charge (lb.)	Shape of Nose	Length of Case (in.)	Dia. of Case (in.)	Fuzes Which May Be Fitted	Status
Mk 54	350	TPX 245	Flat	54.6	13.5	AN-Mk 103 (nose) or AN-Mk 219 (nose) AN-Mk 230 (tail) or Mk 231 Mod 0 (tail) (summer 1945)	Service
Mk 53	325	TNT 228	"	54.6	13.5	"	Never issued.
Mk 29	657	TNT 464	Round	74.1	17.7	AN-Mk 103 or AN-Mk 219 (nose) AN-Mk 224 or Mk 234 (transverse) Mk 229 (tail)	Obsolete now. May be found.
Mk 37	659	TNT 464	"	68.1	17.7	"	"
Mk 38	634	TNT 425	Flat	61.1	17.7	"	"
Mk 49	681	TPX 472	"	61.1	17.7	"	Obsolete and no more being issued.
AN-Mk 17-2	325	TNT 224	Round	55.5	15	AN-Mk 219 or AN-Mk 103 (nose) AN-Mk 224 or Mk 234 (transverse)	"
AN-Mk 44	350	TPX 249	"	55.5	15	"	"
AN-Mk 41	330	TNT 227	Flat	53.1	15	"	"
AN-Mk 47	335	TPX 252	"	53.1	15	"	"

Table VI--Depth Bombs

Fuze	Location in Bomb	Fitted in Following Bombs	Means of Arming	Means of Firing	Depth Setting	Arming Distance (ft.)	Remarks
AN-Mk 219	Nose	AN-Mk 17, 41, 44, 47; Mk 53, 54, 37, 38, 49, 29	Air Vane	Impact (land or water)	None	1000 (approx.)	Instantaneous firing.
AN-Mk 103A1	"	"	"	Impact	"	500 to 1600 ft.	Instant. or delay firing. (0.1 sec.) Larger vanes must be used for flat nosed bombs.
M 139 A1	"	"	"	"	"	"	.01 sec. delay and instantaneous.
M 140 A1	"	"	"	"	"	"	.025 sec. delay and instantaneous.
Mk 224	Transverse pocket athwartships	Mk 29, 37, 38, 49, 17-1 AN-Mk 17-2 AN-Mk 44, 41, 47	Water Pressure	Water Pressure	25-50-75 100-125 ft. Pre-set in assembly.	15 to 20 ft. of water travel	Double-ended fuze. Used only in training. Obsolete.
Mk 234	"	"	"	"	25-50-75 100-125 ft. Set by hand.	15 to 20 ft. of water travel	Doubled-ended fuze.
Mk 229	Tail	Mk 37, 38 49, 29	Air Vane	"	"	400 ft.	Obsolete. Used in 650 lb. depth bomb.
AN-Mk 230	"	Mk 53, 54	"	"	"	"	To be replaced by Mk 231 Mod 0 fuze. Similar to Mk 229 Mods 1 & 2. Obsolete.
Mk 231 Mod 0	"	Mk 53, 54	"	"	Only 25 ft.	300 to 400	Fuze safe for take offs and landings anywhere. In general service about October 1945.

Table VII--Depth Bomb Fuzes

## U. S. DEPTH BOMBS

### Introduction

1. Depth bombs are anti-submarine weapons, designed to be dropped from aircraft and fuzed to fire hydrostatically at pre-set depths. The U. S. models are all cylindrical in shape, vary in length from 53" to 74" and in diameter from 13 7/8" to 17 7/8". They are either flat or round-nosed and may contain fuze pockets in both the nose and tail. Certain models also include an athwartships pocket. It should be noted that, in certain instances, the 500 and 1000 lb. Army-Navy Standard General Purpose bomb cases may be fitted with hydrostatic tail fuzes and used as depth bombs.
2. As noted above, all depth bomb cases are designed to incorporate multiple fuzing, provision being made for use of a nose, impact type of fuze in addition to the tail and athwartships hydrostatic fuzes. It should be noted, however, that use of impact fuzes with depth bomb cases is not desirable, the cases being so light in construction that they often shatter before the fuze operates properly. It is unlikely that depth bombs will be found fuzed with both impact and hydrostatic fuzes.
3. It is probable that mine disposal personnel will be called upon to deal with depth bombs only when diving operations are necessary or when bomb disposal personnel is not available. In any event, because bomb disposal training comprises an extensive background in mechanical fuzes, bomb disposal personnel should be called in whenever practicable.

### General Precautions

1. The following precautions should be observed when handling all depth bombs, however fuzed:
  - (a) Obtain all possible information covering the type of bomb, and the type and condition of the fuze or fuzes fitted before attempting any disposal operations.
  - (b) Destroy the bomb by countermining whenever feasible. Do not attempt to render safe unless absolutely necessary.
  - (c) Do not move or jar the bomb unnecessarily.
  - (d) Never move or rotate the arming vanes.
  - (e) When diving operations are necessary, raise the bomb before proceeding to render it safe.
  - (f) If a fuze is jammed in its pocket, make every effort to dispose of the bomb by means other than withdrawal or disassembly of the fuze. If it is not feasible to countermine the bomb where it lies, it may be more desirable to transport it to a demolition area for countermining than to attempt to render it safe.
  - (g) When dealing with a bomb which has multiple fuzing, dispose of the nose, tail and transverse fuzes in that order.
  - (h) Mine Disposal personnel should not attempt disassembly of fuzes fitted except as indicated hereinafter.

### Rendering-Safe Procedure

1. The procedure of rendering these bombs safe consists of disposing of the particular fuze or fuzes that may be fitted into them. A brief description and operation of each fuze, together with the approved procedure for rendering it safe, is included below.

#### Nose Fuze Mark 219

### Description

1. Instantaneous, impact fuze, mechanically armed.
2. The fuze is 5 1/2" long, and protrudes about 3" from the pocket. The span of the four-bladed arming vane is 4 3/4".
3. The armed or unarmed condition of the fuze is indicated as follows:
  - (a) When unarmed, the striker flange is adjacent to the outer sleeve of the fuze. An arming wire may or may not be present.
  - (b) When armed, or partly armed, a 1/2" space will be present between the flange and the outer sleeve.
  - (c) A fuze that has "dud" fired is identical in appearance to an unarmed fuze. The presence or absence of an arming wire would be the only indicator of the condition of the fuze.

U. S. DEPTH BOMBS

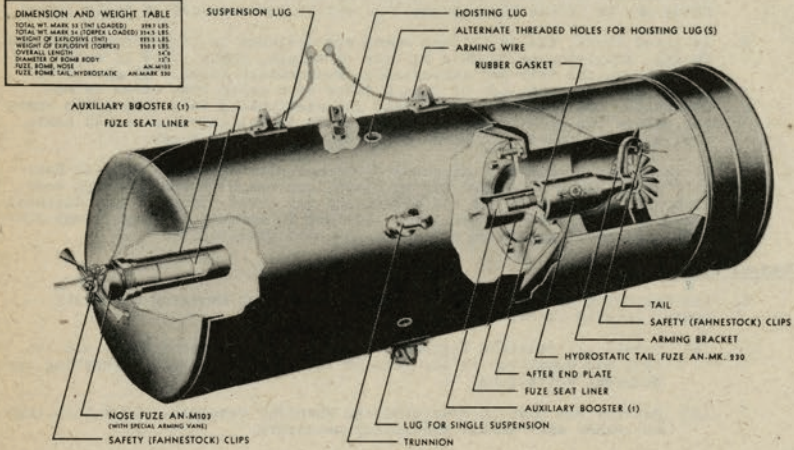


Fig. 1-- Mk. 53 and Mk. 54 Aircraft Depth Bomb

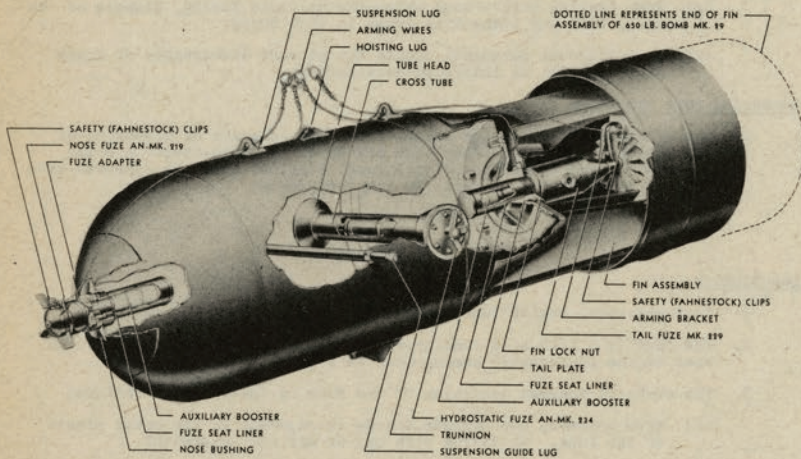


Fig. 2-- Mk. 29 and Mk. 37 Aircraft Depth Bomb

## U. S. DEPTH BOMBS

### Operation

1. When the bomb is dropped, an arming wire is withdrawn from the air vane. Air travel then rotates the working parts of the fuze through a gear train until the firing pin and explosive train are aligned. Impact with land or water drives the firing pin down onto the detonator. For detailed operation, see accompanying drawing.

### Rendering Safe Procedure

1. Tape the vanes to the fuze head to prevent rotation.
2. Remove the lock screw from the outer sleeve.
3. Grasp the vane and vane carrier, and gently lift the inner parts of the fuze out of the fuze body.
4. Unscrew the fuze body from the bomb.
5. Remove the auxiliary boosters from the fuze pocket and dispose of all explosive elements.

### Nose Fuze AN-M 103

### Description

1. Instantaneous or short delay impact fuze, mechanically armed. Delay settings are not used in depth bombs.
2. The fuze is 7" long and protrudes 2 1/4" from the pocket. Two sizes of two-bladed arming vanes may be fitted, with the smaller being used with round nosed bombs, and the larger with flat nosed bombs. The span of either sized vane is 6 1/4".
3. The armed or unarmed condition of the fuze is indicated as follows:
  - (a) When unarmed, a small space or crack is present between the vane cup and the fuze body, through which the arming discs are visible.
  - (b) When armed, the delay arming vane and vane cup will be missing from the fuze or they will have unscrewed far enough to release the arming discs, the space mentioned in (a) above being about 1/4" wide.
  - (c) If the fuze has fired as a dud, the upper shoulder of the striker will have moved down in the space formerly occupied by the arming discs.

### Operation

1. When the bomb is dropped, an arming wire is withdrawn from the air vane. Air travel then rotates the working parts of the fuze through a gear train until the firing pin and explosive train are aligned. Impact with land or water drives the firing pin down onto the detonator.

### Rendering Safe Procedure

1. If the fuze is unarmed, tape the vane and vane cap to the fuze body, unscrew the fuze from the pocket, and dispose of the fuze and auxiliary booster.
2. If the fuze is armed, wedge the space between the firing pin flange and fuze body with friction tape or other suitable means, and proceed as in Par. #1 above.
3. No safe procedure can be recommended for a dud-fired fuze.

### Transverse Fuze An-Mk 224

### Description

1. Hydrostatically armed and fired.
2. The fuze is 17" long, 3 1/2" in diameter, and fits nearly flush with either end of the transverse pocket. The depth setting, which is preset in assembly, is marked on the pistol body.

U. S. DEPTH BOMBS

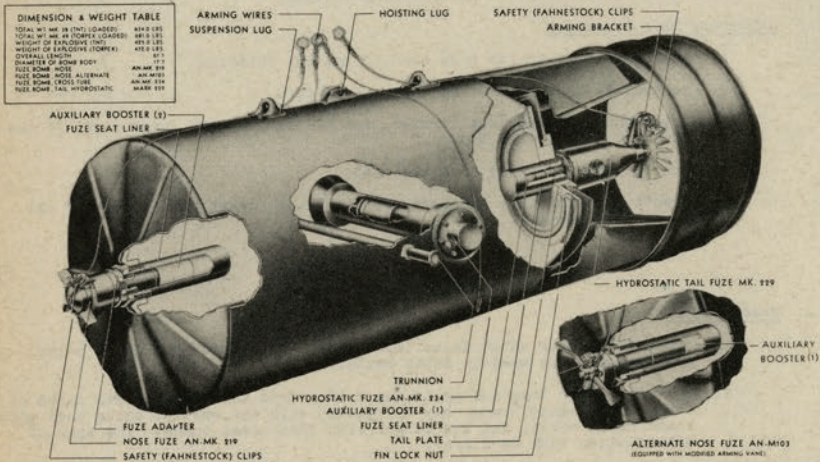


Fig. 3-- Mk. 38 and Mk. 49 Aircraft Depth Bomb

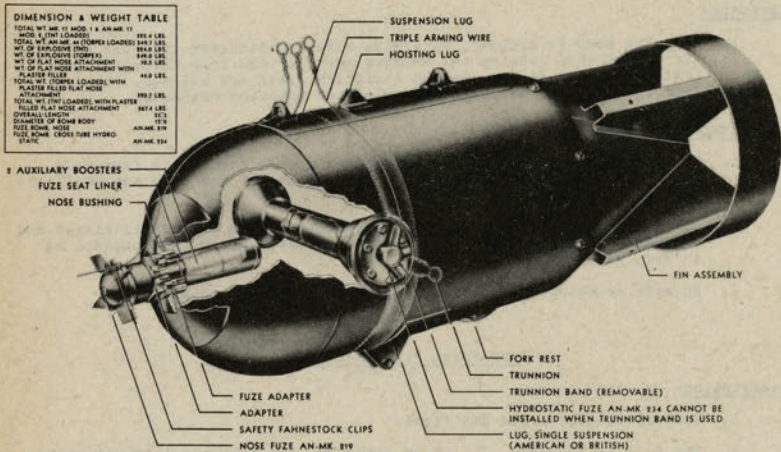


Fig. 4- Mk. 17-1, AN-Mk. 17-2 and AN-Mk. 44 Aircraft Depth Bomb

**CONFIDENTIAL**

Added 1 July 1945  
(Change No. 8)



## U. S. DEPTH BOMBS

3. If the jump-out pin is in either end of the fuze when found, the fuze is safe. There is no other way of determining the condition of the fuze by visual examination.

### Operation

1. The fuze is essentially a small scale model of a hydrostatic depth charge arming and firing mechanism, and it operates in a similar manner. When the booster extender houses the booster at a depth between 15 and 20 ft., it also operates the primer and detonator slider aligner, aligning the explosive train. The fuze then fires in the same manner as the Mk. 6 depth charge pistol. Possible depth settings are 25, 50, 75, 100 and 125 ft.

### Rendering-Safe Procedure

1. Remove the six screws from each end of the fuze pocket, and withdraw the pistol and booster extender. These two parts are not distinguishable, one from the other, from an examination of the outside of the case.
2. Separate the booster can from the extender. This can contains a small tetryl sub-booster as well as the main TNT booster.
3. Unscrew the conical primer and detonator slide aligner from the inner end of the pistol. This assembly contains a small primer cap and detonator.
4. Dispose of all explosive elements.

### Transverse Fuze AN-Mk. 234

1. This fuze is essentially a Mk. 224 modified to include a hand-operated depth-setting dial on the pistol face, permitting depth setting without disassembly.
2. It is rendered safe in the same manner as the Mk. 224 and it is recommended that the extender in this case distinguishable from the pistol, be removed first during disassembly.

### Tail Fuze Mark 229

#### Description

1. Hydrostatic fuze, mechanically armed.
2. The fuze is 16 1/3" long, its maximum diameter is 3 1/2", and it protrudes about 12" from the pocket. The span of the 16-bladed arming vane is 5 1/4".
3. If the arming wire is in the fuze when found, the fuze may be considered safe. There is no other way of determining the condition of the fuze by visual examination.

#### Operation

1. Armed by the air vane which unlocks the hydrostatic piston. The fuze then fires in a manner similar to the Mk. 6 depth charge pistol. Depth settings of 25, 50, 75, 100 and 125 ft. are made by a hand dial on the fuze body.

#### Rendering-Safe Procedure

1. Tape the vane to the fuze body to prevent rotation.
2. Unscrew the fuze from the pocket, and withdraw it.
3. Insert a safety pin or wire in the hole provided under the large shoulder of the fuze body, 3 1/4" from the inner end of the fuze. If the pin does not readily go all the way through, do not attempt to force it. The fuze must then be considered to have fired as a dud, and is highly dangerous.
4. Dispose of the fuze. Do not attempt disassembly.

### Tail Fuze AN-Mk. 230

1. This fuze is similar to the Mk. 229, except that it is only 15" long, the portion of the fuze that fits into the pocket being 1 1/3" shorter than the corresponding part of the Mk. 229. The two fuzes

U. S. DEPTH BOMBS

DIMENSION & WEIGHT TABLE	
TOTAL WT. AN-Mk. 41 (EMPTY)	318 LBS.
TOTAL WT. AN-Mk. 47 (EMPTY)	318 LBS.
WEIGHT OF EXPLOSIVE (TNT)	215 LBS.
WEIGHT OF EXPLOSIVE (TOPEX)	215 LBS.
DIAMETER OF BOMB BODY	11 1/2"
BOMB FUZE (NOSE)	AN-M103
BOMB FUZE (HYDROSTATIC)	AN-MK334

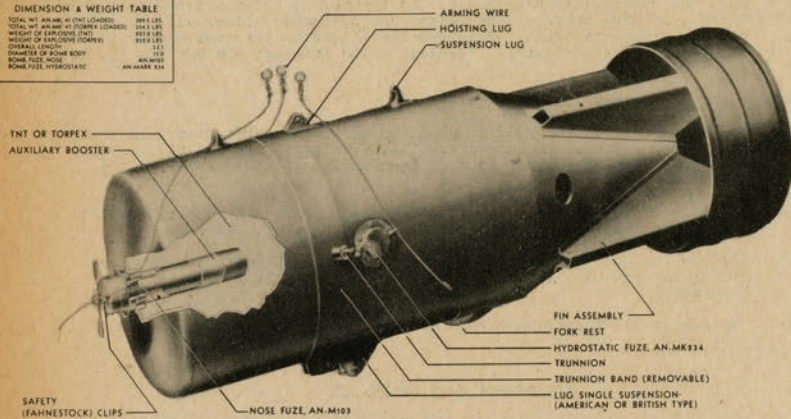


Fig. 5-- AN-Mk. 41 and AN-Mk. 47 Aircraft Depth Bomb

## U. S. DEPTH BOMBS

are therefore not interchangeable.

2. It is rendered safe in the same manner as the Mk 229.

### Tail Fuze Mk 231 Mod 0

#### Description

1. Hydrostatic fuze, mechanically armed, designed to fire at a depth of 25 ft.
2. The fuze is approximately 1275 long, 3738 in maximum diameter, and protrudes about 977 from the pocket. The span of the two-bladed arm-vane is 5 5/8".
3. There is no means of determining the armed or unarmed condition of the fuze from an exterior examination. However, it should be fairly safe to handle if out of water and absolutely safe if it has never been submerged to a depth of 20 ft.

#### Operation

1. When the bomb is dropped, an arming wire is withdrawn from the vane and fuze flange. Air travel rotates the vane and vane shaft, unscrewing the arming stem from the arming stem guide. After about 40-45 vane revolutions, the arming stem moves free of the arming balls which fall into the stem nut, freeing the hydrostatic piston and arming the fuze.
2. Upon impact with the water, an inertia counterbalance prevents the fuze from firing due to either initial impact or ricochet. As the bomb sinks, water enters around the baffle ring and through two ports on the upper fuze body. Water pressure then extends the bellows, forcing the hydrostatic piston downward and compressing the firing spring. After the hydrostatic piston has moved downward about 9/32", the six lock balls which lock the firing plunger to the plunger housing fly out into an annular recess in the hydrostatic piston, allowing the spring-loaded plunger to initiate the explosive train.

#### Rendering Safe Procedure

1. Tape the arming vane to the fuze body.
2. Unscrew the fuze from the pocket.
3. Dispose of the fuze. Do not attempt disassembly.

U. S. DEPTH BOMBS

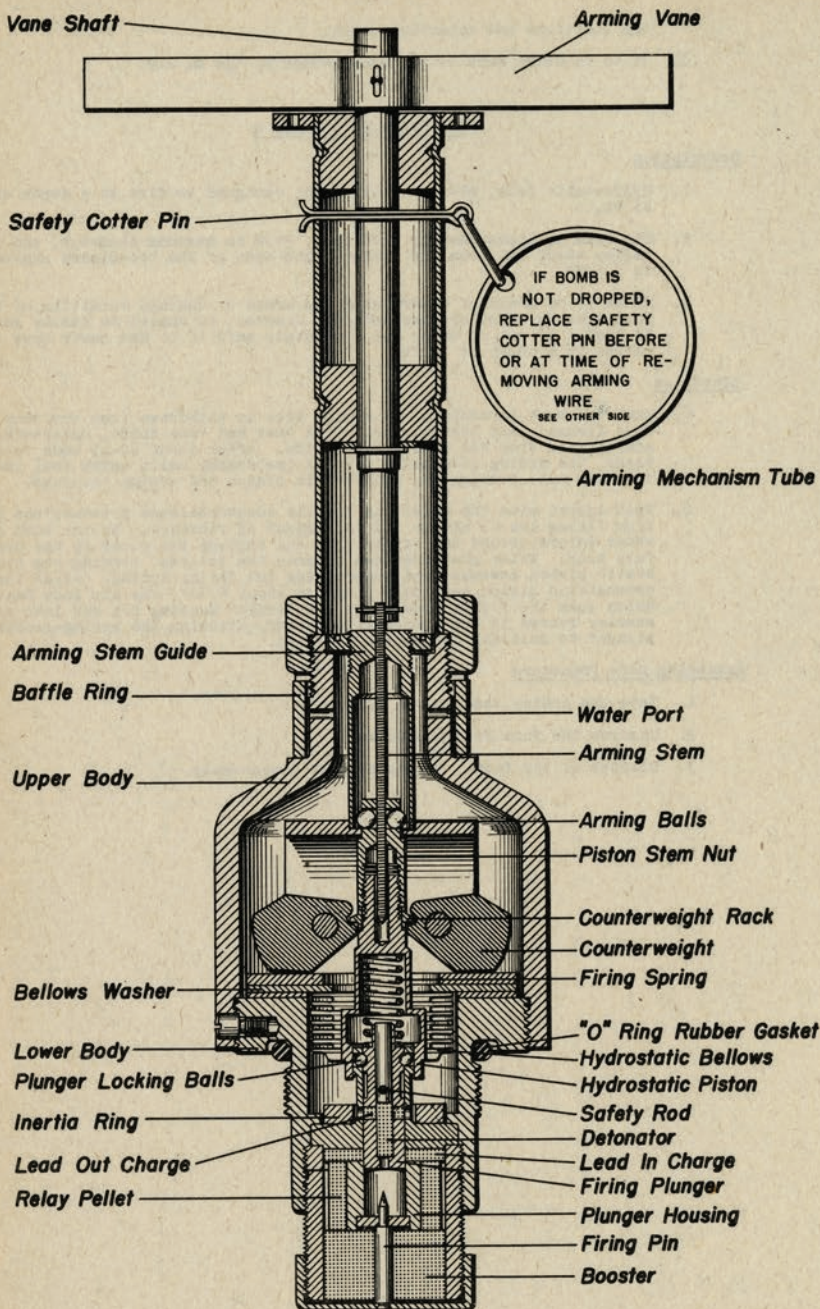


Fig. 6 - Tail Fuze Mk 231-0, Sectional View

# MINE DISPOSAL HANDBOOK

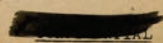
## PART II

### UNITED STATES UNDERWATER ORDNANCE

\* \* \* \* \*

#### CHAPTER 6

##### U. S. AHEAD-THROWN ANTI-SUBMARINE WEAPONS



U. S. AHEAD-THROWN ANTI-SUBMARINE WEAPONS

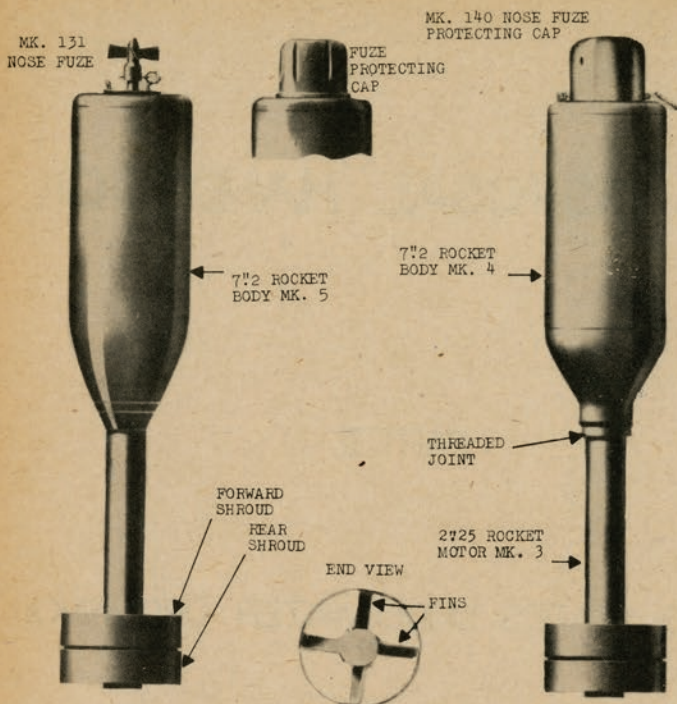


Fig. 1-- 7 1/2 Rocket (Mousetrap)

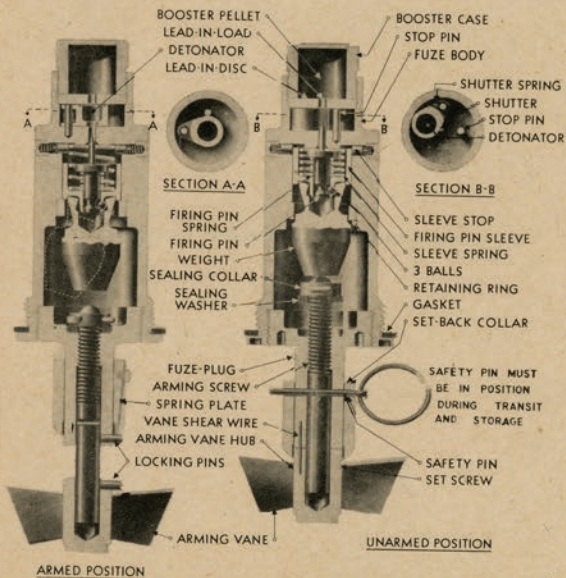


Fig. 2-- Mk. 131 Nose Fuze, Sectional View

CONFIDENTIAL

## U. S. AHEAD-THROWN ANTI-SUBMARINE WEAPONS

### Introduction

1. This chapter includes information on the U. S. Navy 7"2 ahead-thrown rocket, (Mousetrap) the 7"2 ahead-thrown projector charge (Hedgehog) and the fuzes which may be fitted in each.
2. The various services are developing many kinds of ahead-thrown weapons. The two listed above, being anti-submarine weapons, come under the general heading of underwater ordnance, and, as such, should be familiar to Mine Disposal personnel.
3. All the fuzes fitted are very sensitive, and dangerous to handle when armed. For this reason, they should be rendered safe only when absolutely necessary.

### 7"2 Rocket (Mousetrap)

#### General

1. Launched from multiple rail launchers on the forecastle of patrol vessels.

#### Description

1. The complete unit consists of the below listed parts:

##### (a) Body

The body is a cylindrical, welded case, 19" long and 7"2 in diameter, with a flat nose and a conical tail. It was originally designed for nose filling, with a fuze seat-liner pocket being screwed into the nose after filling. Later models are filled through the tail, and, in these, the fuze seat-liner is an integral part of the body.

##### (b) Motor

The motor is a steel tube, 16" long and 7"2 in diameter, secured to the after end of the body by a threaded joint. Four radial fins, set at an angle of ten degrees, are enclosed in a cylindrical shroud band, 7" in diameter, in the rear end. The motor propellant is a single long grain of ballastite which is ignited by an electric squib and a black powder primer.

##### (c) Fuze

One of three fuzes is fitted:

1. Nose Fuze Mk. 131 and Mods.
  2. Nose Fuze Mk. 140 and Mods.
  3. Nose Fuze Mk. 135 and Mods.
2. The complete rocket is 38½" long, 7"2 in diameter, and is painted gray. The charge is either 30 lbs. TNT or ¾ lbs. Torpex, and the total weight of the rocket in air is about 63 lbs.

#### Operation

1. When electric current is supplied to the launchers, the squib, igniter and propellant are fired. The burning propellant generates gases at pressures of several hundred pounds per square inch, forcing them out through a nozzle in the motor thus propelling the unit forward. The propellant burns for about .4 sec., or during the first 33 ft. of flight, momentum carrying the rocket an additional distance of approximately 850 ft. before it enters the water.

#### Rendering Safe Procedure

1. Rendering this rocket safe consists of disposing of the particular fuze that is fitted. A brief description and operation of each fuze, together with the approved procedure for rendering safe, is included below.

### Nose Fuze Mark 131

#### Description

1. Inertia, impact fuze, armed mechanically.
2. Fuze is 7½" long, with a maximum diameter of 2 1/4". The four-bladed water vane has a ¾" span, and the nose of the fuze is painted red to

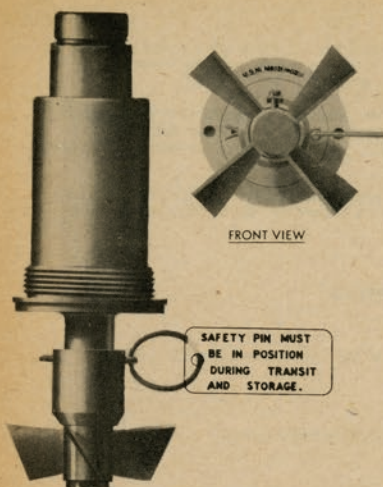


Fig. 3-- Mk. 131 Nose Fuze

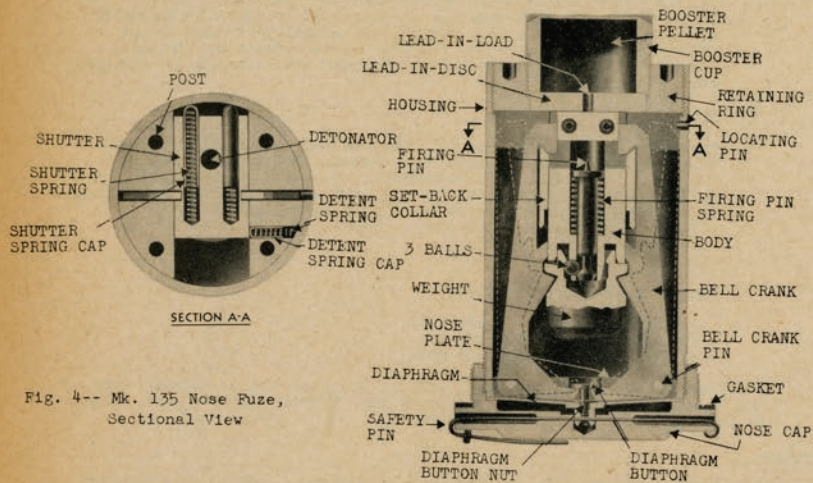


Fig. 4-- Mk. 135 Nose Fuze, Sectional View

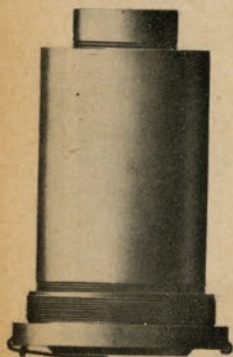


Fig. 5-- Mk. 135 Nose Fuze



U. S. AHEAD-THROWN ANTI-SUBMARINE WEAPONS

distinguish it from the Mk. 136.

3. If the fuze is unarmed, the vane hub will be snugly against the fuze plug. If unarmed or partly armed, there will be a space at this point up to  $\frac{1}{2}$ " wide.

Operation

1. Upon launching, a set-back collar moves aft, releasing the water vane. Impact with the water causes the shear wire through the arming vane hub and the fuze plug to be severed, and allows the vane to rotate. Seven turns of the vane, or between 10 and 15 ft. of water travel, are sufficient to arm the fuze completely, although firing is possible after only four complete revolutions of the vane. This arming process results in the alignment of the explosive train, and unlocking of the firing weight. Impact with a hard surface, either directly or by a glancing blow, will force the firing weight off its seat, releasing the locking balls, and allowing the spring loaded striker to impinge on the detonator.

Precautions

1. Do not move or jar the fuze unnecessarily.
2. Do not attempt to remove armed or partly armed fuzes unless absolutely necessary. Dispose of the complete assembly wherever feasible.
3. Never remove the vane and fuze plug from the fuze body as this will arm the fuze. Always withdraw the complete fuze as a unit.

Rendering-Safe Procedure

1. If the fuze is armed or partly armed, disarm it by carefully screwing the arming vane backward (counter-clockwise looking at the nose of the fuze) until the space (noted in Par. 3 under description) has been reduced to about  $\frac{3}{16}$ ". At this point the vane will no longer turn freely, and it should not be forced.
2. When unarmed, tape the vane securely to prevent rotation.
3. If feasible, destroy the complete rocket by countermanning or sinking it in deep water. If absolutely necessary, the complete fuze may be removed from the bomb, and disposed of. Do not disassemble the fuze.

Note: Although it is contrary to general policy ever to turn an arming vane while rendering a fuze safe, in this case such a procedure is proper because of the construction of the fuze. Four spring-loaded pins lock the firing pin sleeve when the fuze arms, and prevent the firing pin from being forced down onto the detonator when the vane is rotated as described. These pins are installed for the expressed purpose of permitting disarming the fuze by reverse rotation.

Nose Fuze Mark 135

Description

1. Inertia, impact fuze, armed hydrostatically. Formerly designated "HIR type fuze Mk. 35".
2. Fuze is  $5 \frac{3}{4}$ " long, diameter of body is  $2 \frac{5}{8}$ ", and diameter of nose cap is  $3 \frac{1}{4}$ ".
3. There is no way of determining, from an examination of the exterior, whether or not the fuze is armed.

Operation

1. A safety pin, which fits through the nose cap, is withdrawn before launching, thereby unlocking the diaphragm spindle. When the rocket enters the water, the safety-pin hole serves as a water intake, and when sufficient water pressure has been built up, the diaphragm "pops" like the bottom of an oil can from a convex to a concave position. This usually occurs in from 15 to 20 ft. of water, although 30 ft. of static water pressure would be required to make the diaphragm function. Operation of the diaphragm pivots two bell-crank arms outward, aligning the elements of the explosive train, and unlocking the firing weight. The fuze is then armed, and will fire in the same manner as the Mk. 131.

Precautions

1. Do not move or jar the fuze unnecessarily.
2. Do not attempt to remove armed or partly armed fuzes unless absolutely necessary. Dispose of the complete assembly wherever feasible.

U. S. AHEAD-THROWN ANTI-SUBMARINE WEAPONS

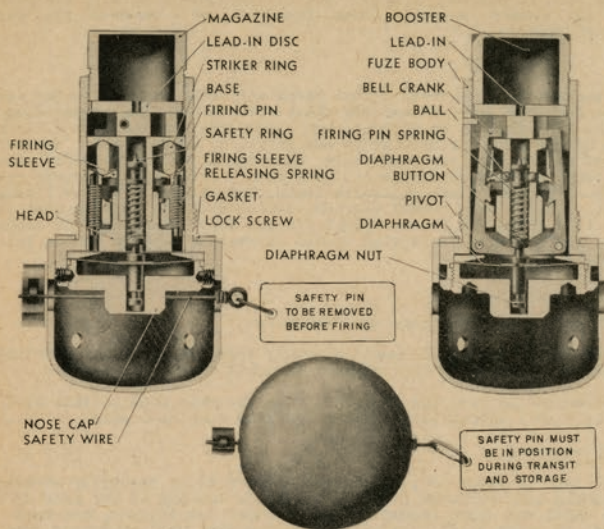


Fig. 6-- Mk. 140 Nose Fuze, Sectional View

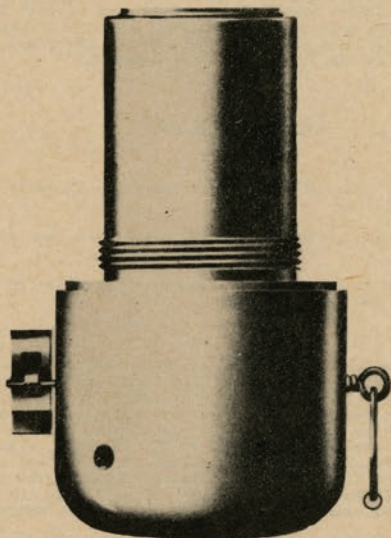


Fig. 7-- Mk. 140 Nose Fuze

U. S. AHEAD-THROWN ANTI-SUBMARINE WEAPONS

3. Once armed, the fuze will not disarm upon release of hydrostatic pressure. It is extremely sensitive to shock when armed, and will fire when dropped 2" on a hard surface.

Rendering Safe Procedure

1. No safe procedure can be recommended. The only possible means of disposal known is to unscrew the fuze from the pocket and destroy it. This should be attempted only in an extreme emergency, and great caution must be exercised at all times.

Nose Fuze Mark 140

Description

1. Inertie, impact fuze, hydrostatically armed.
2. Fuze is 4½" long, and its maximum diameter is 2"7.
3. There is no way of determining, from a visual examination, whether or not the fuze is armed.

Operation

1. The fuze arms in the same manner as the Mk. 135 except that arming is usually completed in from 8 to 15 ft. of water. As is the case in the Mk. 135, 30 ft. of hydrostatic pressure is required to operate the diaphragm. A direct or glancing blow will cause the firing ring to be displaced, releasing locking balls, and allowing the spring loader striker to impinge on the detonator.

Precautions

1. Do not move or jar the fuze unnecessarily.
2. Do not attempt to remove armed or partly armed fuzes unless absolutely necessary. Dispose of the complete assembly wherever feasible.
3. Once armed, the fuze will not disarm upon release of hydrostatic pressure. It is extremely sensitive to shock when armed.

Rendering-Safe Procedure

1. Insert a safety wire through the water intake ports on the nose cap.
  - (a) If the wire goes all the way through, the fuze has not armed, and may be safely unscrewed from the bomb and disposed of.
  - (b) If the wire will not go through, the fuze is armed. No safe procedure can be recommended for this fuze when in the armed condition. The only possible means of disposal known is to unscrew the fuze from the bomb and destroy it. This should be attempted only in an extreme emergency, and great caution must be exercised at all times.

7"2 Projector Charge (Hedgehog)

General

1. Same as Mousetrap.

Description

1. This projectile is very similar to the Mousetrap in that the complete assembly consists of a body, tail tube and fuze, and in that the color, shape, dimensions charge and total weight are essentially the same. The chief external difference is that the tail tube is only 1 3/4" in diameter as compared with the 2 1/4" diameter of the Mousetrap motor.
2. One of two fuzes is fitted:
  - (a) Nose Fuze Mk. 136 and Mods.
  - (b) Nose Fuze Mk. 140 and Mods.

Operation

1. The Hedgehog is fired from projectors similar to those used with the Mousetrap. Electrical ignition of the primer sets up a cartridge in the tail of the projectile, throwing it forward and creating considerable recoil. This recoil and the fact that the projectile is not self-propelled constitute the main difference between the Hedgehog and Mouse-trap, and limit the use of the projectile to ships which can withstand

U. S. AHEAD-THROWN ANTI-SUBMARINE WEAPONS

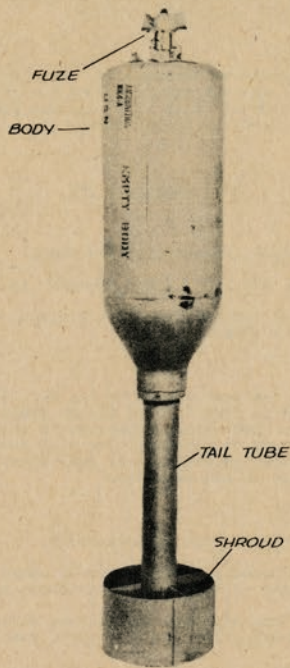


Fig. 8-- 7"2 Projector Charge (Hedgehog)

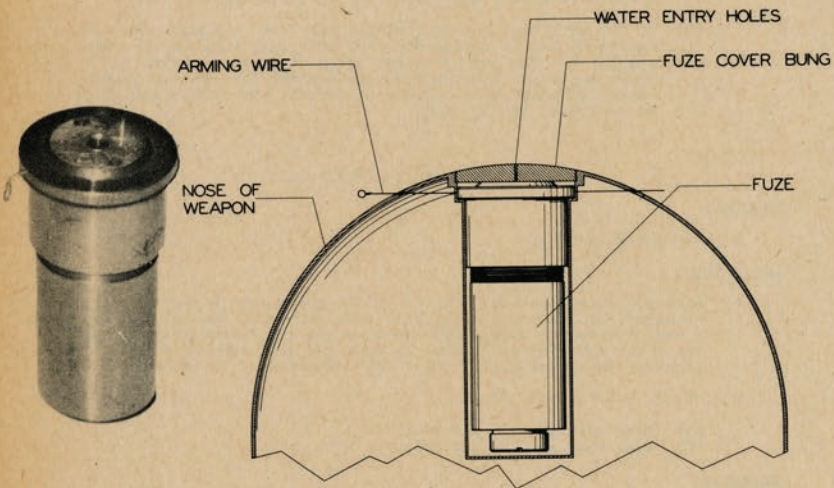


Fig. 9-- Mk. 142 Fuze

Fig. 10-- Mk. 142 Fuze in Weapon

U. S. AHEAD-THROWN ANTI-SUBMARINE WEAPONS

these heavy stresses.

Rendering Safe Procedure

1. Rendering this projectile safe consists of disposing of the fuze that is fitted. A brief description and operation of each fuze, together with the approved procedure for rendering safe, is included below.

Nose Fuze Mark 136-0

1. The Mk 136-0 is identical with the Mk 131-0, except that it does not have red paint on the nose of the vane hub, and has an additional shear wire which secures the set-back collar in the forward position prior to launching.

Nose Fuze Mark 140-0

1. See Mousetrap.

Nose Fuze Mark 142-0

Description

1. Impact-inertia fuze, hydrostatically armed.
2. The fuze is 7 1/8" long, 2 5/8" in body diameter, 3 1/3" in maximum diameter at the nose cap, and weighs six lb. without its explosive elements.
3. The fuze is fitted in the warhead nose pocket of an aircraft-launched, anti-submarine weapon and is held in place by a cover bung. The warhead may be identified by its unusual color markings, being divided longitudinally into two equal sections, one of which is painted gray and the other, white.

Operation

1. The fuze arms and fires in a manner similar to the Nose Fuze Mk 135-0 (Part II, Chapter 6), except that arming is normally completed when the fuze is subjected to a pressure equivalent to a 23 ft. hydrostatic pressure head. The fuze fires, when in the armed condition, if dropped 1/2" on its nose or 8/10" on its side.

Precautions

1. Note the extreme sensitivity of the fuze when in the armed condition. No attempt should be made to withdraw an armed fuze from the warhead.
2. Check the condition of the fuze.
  - (a) If the arming wire is present, the fuze is safe.
  - (b) If the arming wire is not present, the fuze must be considered armed.

Rendering Safe Procedure

1. Unarmed

- (a) Using a pin spanner or other suitable tool, remove the cover bung.
- (b) Withdraw the fuze and destroy intact. DO NOT ATTEMPT DISASSEMBLY.

2. Armed

- (a) Pack the container described in Fig. 11 with C2 plastic explosive. Insert an Army Engineer Special Blasting cap in the explosive and place the container against the cover bung so that the two projections on the container fit into the holes on the cover bung.
- (b) Fire the charge from a safe distance.
- (c) Remove and destroy the warhead.
- (d) Return the rest of the weapon to the nearest Mine Assembly Depot.

U. S. AHEAD-THROWN ANTI-SUBMARINE WEAPONS

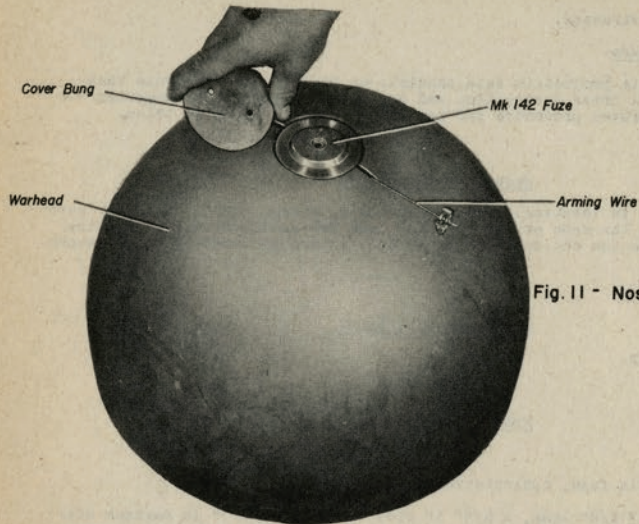


Fig. 11 - Nose Fuze Mk 142-O in Warhead

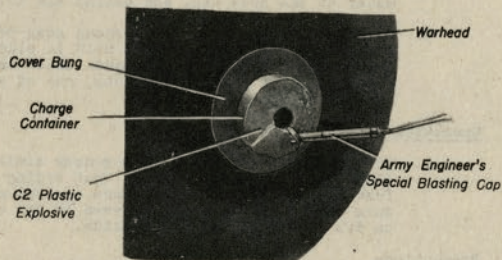


Fig. 12 - Nose Fuze Mk 142-O, Charge Container in Place for RSP

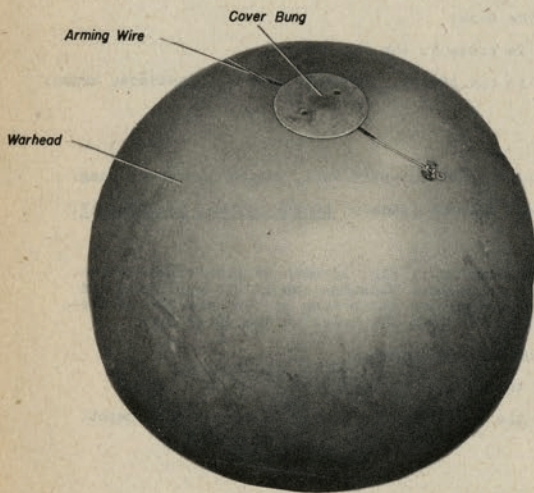
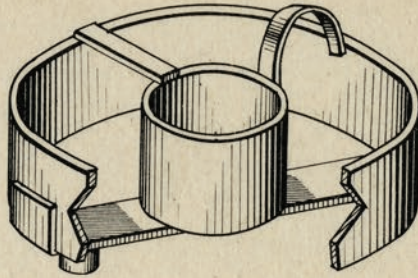


Fig. 13 - Nose Fuze Mk 142-O in Warhead with Cover Bung in Position

U. S. AHEAD-THROWN WEAPONS



MATERIAL -  $\frac{1}{32}$  BRASS

NOTE:  
Solder All Joints

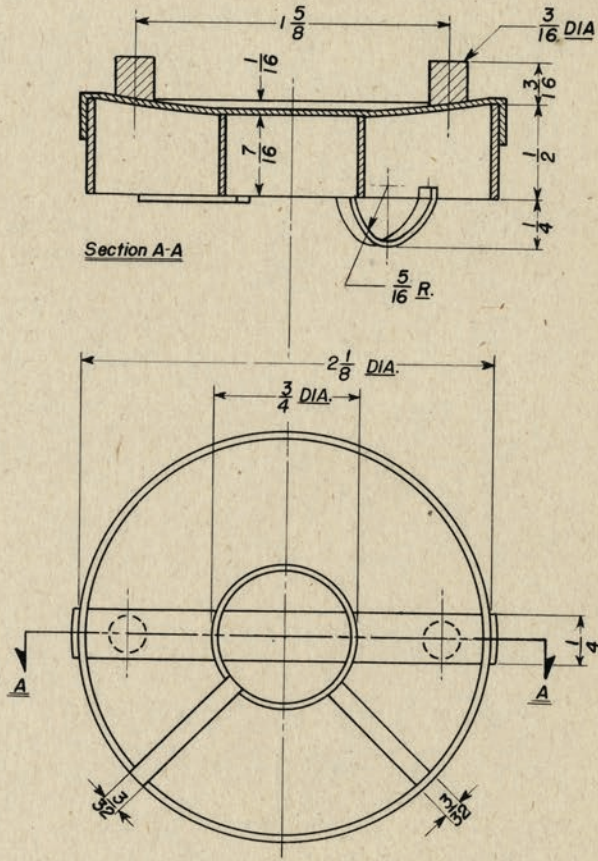


Fig. 14 - Nose Fuze Mk 142-O, Charge Container for RSP

# MINE DISPOSAL HANDBOOK

## PART II

### UNITED STATES UNDERWATER ORDNANCE

\* \* \* \* \*

#### CHAPTER 7

#### U.S. CONTROLLED MINES

October 1, 1944

-1-





U.S. CONTROLLED MINES

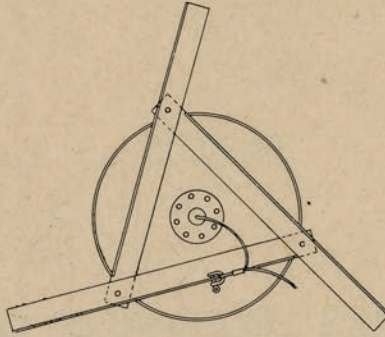


Fig. 1-- Steel Angle Framework

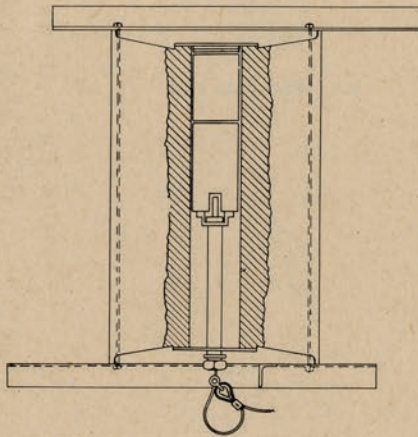


Fig. 2-- Mk. 20 Controlled Mine, Sectional View

## U.S. CONTROLLED MINES

### Introduction

1. These mines are used to protect our own harbors and anchorages from surface craft and submarines. The two types covered in this chapter include one Army model, and one emergency model used by the Navy.
2. Controlled mines fall into two general operational categories:
  - (a) Those which are in effect remote controlled demolition charges. This type consists of a mine case containing a simple firing mechanism and an explosive charge, and connected electrically to a source of power ashore. Either moored or ground type cases are used.
  - (b) Those which contain an influence unit powered from a source ashore. Current from the power source put across the mine unit will arm it, and the unit will fire when subjected to a proper influence. All the known mines of this type are ground mines.
3. All of these mines are relatively safe to handle if cut off from their source of power. Routine precautions should be taken, however, to avoid jarring the electric detonators, and to avoid any sparking which might set up the TNT boosters and charge.

### U.S. Navy Mine Mark 20

### General

1. Emergency, controlled ground mine.
2. Laid by hand from surface craft.
3. Laid defensively in depths of water under 100 ft.

### Description

1. The Mk. 20 case may be any one of the following depth charge cases, fully loaded:
  - (a) Mk. 2-2
  - (b) Mk. 3
  - (c) Mk. 6
  - (d) Mk. 6-1
2. The loaded cases are fitted with one each of the following:
  - (a) Booster can Mk. 6
  - (b) Electric detonator holder Mk. 2 (Depth Charge Adapter)
  - (c) Electric detonator Mk. 1-1
  - (d) A steel angle framework (Fig. #1) consisting of three steel angles 26" long, made of 2" x 2" steel, assembled in the form of a triangle and attached to each end of the case by longitudinal tie rods. This assembly prevents the mine from being disturbed by water currents after planting.
  - (e) A suitable length of double-conducting cable.

### Operation

1. The mine is laid in an armed condition.
2. The mine is fired by remote control from an external source of power such as a blasting machine.
3. No safety features are incorporated.

### Precautions

1. This mine is always armed.

### RMS

1. Cut the firing leads.
2. Remove the detonator holder.
3. Dispose of the detonator, booster and charge.

U.S. CONTROLLED MINES

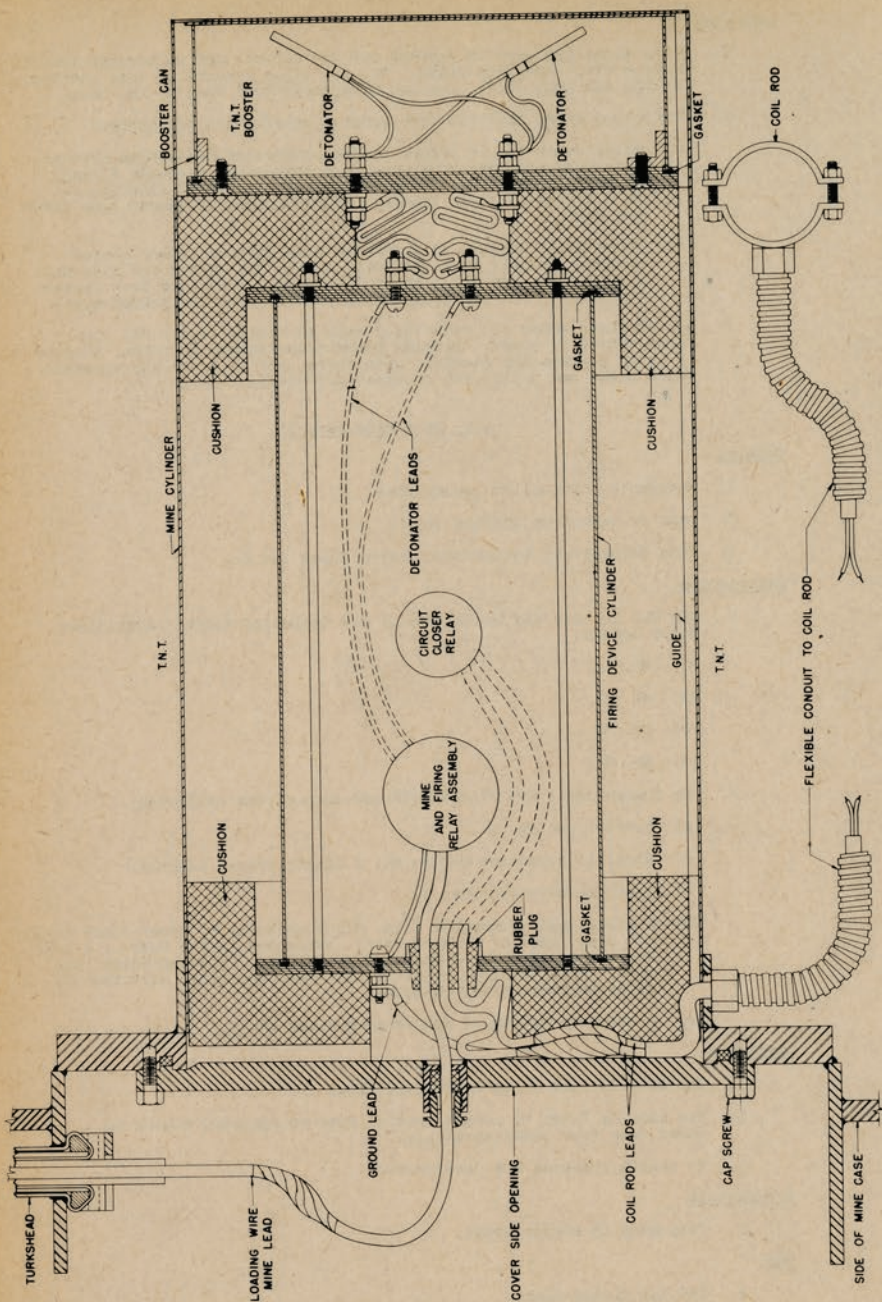


Fig. 3-- Schematic Horizontal Cross Section of Firing Device and Compound Plug for M4 Ground Mine.

U.S. CONTROLLED MINES

Army Ground Mine M4

General

1. Controlled, magnetic induction mine.
2. This mine has a total weight when loaded of over 6000 lbs., and possibilities of recovery operations ever being necessary are very remote. Mine Disposal personnel may be asked for information on it from time to time, however, and the following data is included to provide a rough working knowledge of the cases and units that may be used.

Description

1. Two nearly identical cases are used (M3 & M3A1) with seven different coil rod firing assemblies. The cases are large cylindrical tanks with a truncated cone top section, the cylindrical section being about 90" in diameter and the overall unit being about 60" high. The general assembly set-up for the various coil rod units is shown in Figures 4 and 5. The firing devices fit over the booster in a pocket on the side of the cylindrical section.

Operation

1. All units operate on a sufficient rate of change of the surrounding magnetic field.
2. The mine may be fired in two ways:
  - (a) If set on automatic, the mine fires whenever subjected to a proper influence, and need not be actuated from a control station.
  - (b) When set on control, a magnetic influence will operate an indicator system, and the mine may be fired manually from the control station.

Precautions

1. The mine is safe when cut off from its external source of power.

RMS

1. The mine may be disassembled as follows: (Fig. #3)
  - (a) Remove the side opening cover.
  - (b) Disconnect the ground lead from the terminal.
  - (c) Disconnect the coil rod leads from the firing device red leads.
  - (d) Remove the cushions and firing device from the pocket.
  - (e) Disconnect the detonator leads from the firing device terminals.
  - (f) Remove the booster can from the pocket.
  - (g) Remove the booster can cover, and extract the electric detonators from the TNT booster.
  - (h) Disconnect the detonators from the booster can cover.
  - (i) Dispose of detonator, booster and charge.

U.S. CONTROLLED MINES

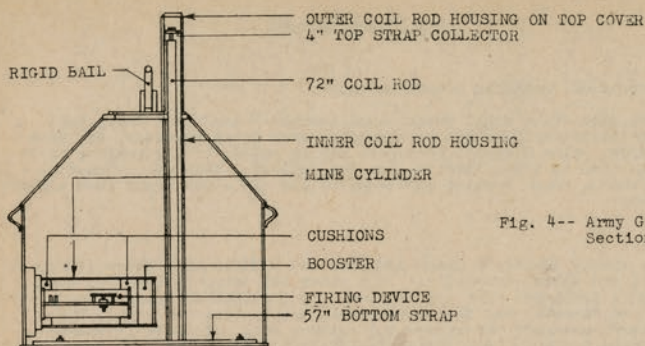


Fig. 4-- Army Ground Mine M4,  
Sectional View

M3-A1 MINE CASE WITH 72" COIL ROD  
ASSEMBLIES C, E, AND G.

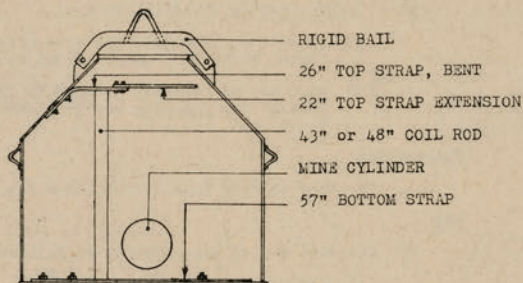


Fig. 5-- Army Ground Mine M4,  
Sectional View

M3-A1 MINE CASE WITH 43" OR 48"  
COIL ROD  
ASSEMBLIES A, B, D, AND F.

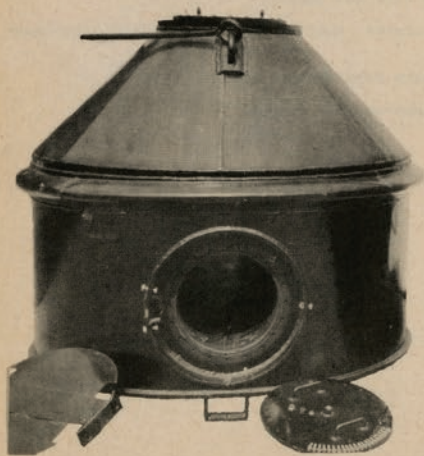


Fig. 6-- Army Ground Mine M4