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Naval Mines and Their High Blast Explosives

Deshpande Susharad[1], Dhonddev Rushikesh[2]

Students, PES's Modern College of Engineering, Pune.

Abstract – *Since world war, mining is a well tested tactic against off-shore enemy. Nowadays it has a potential to be exploited by the terrorist (pirates). It is a cost-effective weapon of destruction which can effectively foist fear, uncertainty and disruption in maritime nation .To keep these nations free from naval threats it is required to have comparative knowledge of mines available throughout the world. This paper relates to study of naval mines like Brazil's MCF-100, Spain's Mila-6B Sea Mine, Iraq's SIGEEL/400, MDM series, Germany's SM G2 mine, United States MK-52 and Italian Manta Mine. For detonation, explosives also play an important role, this paper also ponders about HBX-1, H-6, TNT and HBX-3 type explosives.*

Key Words: **Naval Mines, Anchors, Detonator, Italian Manta Mine, Explosion.**

1. INTRODUCTION

Simple definition of a mine is 'it is a self contained explosive which will trigger its explosion by means of mechanisms after any physical contact.' Commonly there are two types of mines viz. land mine and naval mine. From past few years naval mining has gone far away from traditional contact type (moored) mines to Homing (mobile) and Influence type of mine. Countries like India who has 7500 Km coastline containing major ports of Asia can have naval threat in war time situation. Also in peace time to restrict terror infiltration from west as well as east through rivers in Kashmir, Assam and West Bengal it is required to have the information of such naval weapon along with best available technology.

1.1 Naval Mines

From past decades naval mines have proved themselves when it comes to guard vast coastlines of maritime countries. They are proven defensive weapon which can be planted in large river basins, harbours, ports and naval bay for example Vishakhapattanam in India. In sixteenth century David Bushnell invented naval mines. He is also famous for inventing one man wooden submersible 'the turtle.' It is vital to know that there are number of sea mines available with different technologies but by understanding parameters of few, will help to determine which mine will work more effectively and efficiently. During world war these types of weapons were used by US and German navies. After cold war naval mines are becoming increasingly complex and advancement in firing system has made naval mines less economical for defence organizations of developing countries for example Seychelles. So to make it more lethal, economical and less complex many developed countries like United States, Germany, Russia have assembled, tested and stowed much safer and easier models than previous structures. If weights are taken into account, due to mature machining processes it has reduced subsequently, like Germany's moored mines used to have weight around 750 Kg but today Italian ground mines have weight of 220-240 Kg.

2. THE PECULIAR TYPES OF MINES

Mainly naval mines are divided into three types: moored, ground (bottom) and contact (floating). When it comes to effectiveness in shallow waters ground mines are preferred over moored and contact mines. Because of large negative buoyancy, ground mines come to rest on ocean bed and stay there. Though moored mines and contact mines cannot be overlooked as option to the pirates because of above reasons, still it is necessary to focus on the study of moored mines to get the basic idea of mining. Due to the ability to place mines at required depth, moored types of the mines hold great resemblance in the anti-submarine and the anti-ship warfare. Opposite to ground mines it has large positive buoyancy. An anchor is attached to the shell of mine which holds it at pre-determined depth. There are many sub types of the ground and moored mines according to the categories of detonation like contact, controlled and influence. Acoustic and magnetic sensors are used along with pressure sensors for detonation. Also some mines fall into the groups where sonar and cable detonation is used. Some typical types of naval mines Used by different nations are tabled below in **Table 1**.

Sr. No.	Mine	Origin	Type
1	MCF-100	Brazil	Moored Contact Mine
2	Mila-6B	Spain	Naval Impact Mine

3	SIGEEL/400	Iraq	Ground Mine
4	MDM	Russia	Moored Influence Mine
5	SM G2	Germany	Ground Influence Mine
6	MK-52	U.S.	Seabed Influence Mine
7	Manta	Italy	Shallow Seabed Influence

Table 1: Country wise peculiar types of mines [1]

3. MINE PLANTING

Since World War 2 mine technology has gone far away but the planting remains the same now also. To know exactly what happens during mine planting and how it achieves its depth let us take the example of Moored mine. Structurally naval mines can be divided into three parts viz. Antenna, Body Case, Plummet and Anchor. Mine cases are usually made up of steels but for some exceptional firing mechanisms non-ferrous metal is used. For ease anchor is self attached integrally to this type of mine but for new generation ground mines depth is achieved by means of sensors. Also it should be noted that the surface-laid assembly has positive buoyancy till anchor floods and mine case gets separated. Also during war some mines are launched from the aircraft in enemy waters have net negative buoyancy and they are unable to reach the surface of water. Mines launched from submarine attend minimum depth around 60 feet and after some delay case is separated from anchor. As manta mines are parachute launched influence mines which lie on the seabed and explodes after sensing the target and can remain active up to one year. **Fig. 1** describes how moored mine is launched. After launch whole unit initially floats on the water for some time (6-10 seconds). Plummet is a cabled weight attached to anchor falls first due to gravity against buoyancy. Then the shearing of pins detaches case and anchor from each other, anchor sinks and that connectively replies until plummet settles on seabed results in locking of cable. Anchor thus continues to sink till it reaches seabed and antenna gets rolled off the cables and streams out which sets mine case in desired position. As antenna senses the sonar signal by any naval vessel or submarine initiates the explosion with the help of detonators.

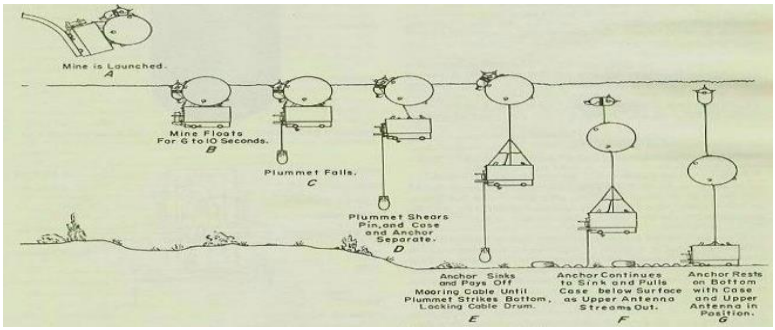

Fig. 1: Planting of a Moored Mine [3]

3.1 Triggering and Fuzes

Traditionally triggering mechanisms used were in the form of 'Horns.' The first United States designed mine named as Mark 5 was of 'Horn Type' which can both used in shallow and deep waters. These horns are made up of soft metals such as Lead. The horns contains potassium bichromate battery acid bound in a glass ampoule, bottom end of horn is connected with the negative electrode of battery. After physical contact of any ship or submarine the horn breaks along with ampoule and the acid energizes the battery and completes the circuit and detonates the mine which is shown in **Fig. 2(a)**. Another well known method of triggering is by physical contact with copper antenna. The antenna is connected to the rotor winding in the casing of mine who's another end is attached with the copper plates. As the antenna and winding are in contact with lower and upper copper plates the physical contact of any naval ship or vessel will initiate the circuit, generated magnetic field in the windings due to the current flowing through the circuit will make the vane switch ON and thus detonation will be initiated shown in **Fig.2(b).** A hydrostatic safety switch is also provided so that the circuit will not be completed in any miss happening.

Modern days Seabed mines like 'Manta Mine' where target is sensed by a magnetic sensor and with the help of acoustic transducer and battery, priming device will connect to main charge and activates firing circuit through boosters present.

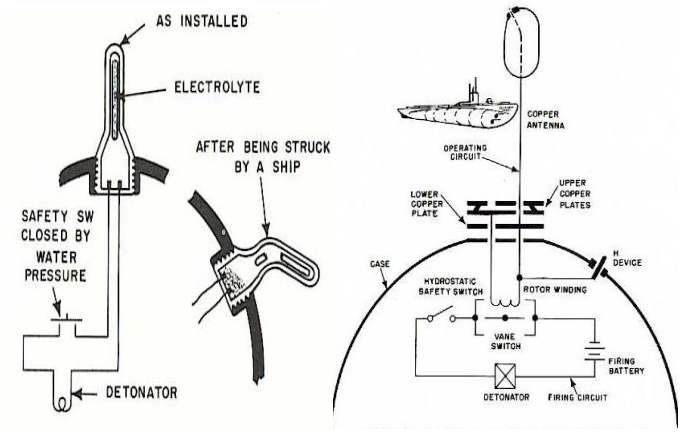

Fig. 2(a) & (b): Triggering by Hertz Horn and Antenna [4]

3.2 Detonation and Important Accessories

A Detonator in simple language is the device whose action is responsible for the explosion of any bomb or explosive. As the target is intercepted with the help of the hydrophone, magnetometer or pressure devices in target influenced mines, the detonator gets activated which thus connected with the charge resulting in mine blast. Along with the *Batteries* and *Self destructive Mechanisms* many other accessories play important role in successful functioning of mines. An *Extender* is a hydrostatically controlled device which will move the detonator in towards booster charge, also prevents premature firing (until mine planting) by maintaining sufficient clearance between them. Likewise *Clock Delay* mechanism presets time after planting and arming is also delayed by using this mechanism. Hand wound and motor wound clocks give ½ to 10 days and 3 to 100 days delay respectively. Another related accessory for safety is *Clock Starter* Mechanism which starts and stops the operation of clock delay mechanism also prevents moment of piston rod extension until required depth is gained. To avoid accidents by nearby shocks and explosion an *Anti Countermining Device* is used which kills mine's electrical circuit for specific period of time.

4. DIFFERENT NATIONS AND THEIR NAVAL MINES

Name of Mine	Property	Specifications
Brazil's MCF-100	Initially it is programmed to certain depth and then activates after some period of delay.	Length: 1400mm Height: 1500mm Weight: 770kg Charge: 160kg Opt. Depth: 3.5m
Spain's Mila-6B	This type of Time fused mine can detonate itself mechanically or magnetically under the water.	Length: 350mm Height: 150mm Weight: 65kg Charge: NA Opt. Depth:0-40m
Iraq's SIGEEL/400	Seabed mine used for both deep and shallow waters; can be heli-launched and can ruin medium as well as small targets.	Length: 900mm Height: 850mm Weight: 535kg Charge: 400kg Opt. Depth: NA

Russia's MDM	Use of acoustic-magnetic sensors leads activation of the main charge; flexible method of delivery; air drop.	Length: 3060mm Height: 790mm Weight: 1500kg Charge: 1350kg Opt. Depth: 300m
Germany's SM G2	Non magnetic casing having acoustic, magnetic and pressure influence sensors.	Length: 2000mm Height: 600mm Weight: 759kg Charge: NA Opt. Depth: NA
U. S. MK-52	Many of the manufactured mines are in inventory; it has most advanced technology with magnetic and pressure sensors.	Length: 3000mm Height: 1060mm Weight: 1010kg Charge: 576kg Opt. Depth:350m
Italy's Manta Mine	A dual influence anti invasion mine shaped to rest firmly on the sea bed even in strong flows. With all safety devices it remains under water for one year; small size leads to have easy transport.	Length: 980mm Height: 470mm Weight: 225kg Charge: 100kg Opt. Depth: 100m

Table 2: Country Wise Description and Specifications of Some Naval Mines [1]

Many important parameters are taken into account while studying performance of some well known naval mines. Method of delivery plays an important role as mine should be launched conveniently from mediums like Air (Plane and Helicopter) or Water (Ship and Submarine). Many safety devices, accessories and sensors (Acoustic, Magnetic and Pressure) mounted also play vital role in mine advancement. Along with the Operational Dept the size, shape, charge and weight also affects efficiency and effectiveness of naval mine which matters while mass transportation during war time situations.

5. EXPLOSIVES FOR NAVAL MINES

Explosives are the most integral part of any destructive weapon. So without consideration of any explosives a naval mine is nothing but a deaden weapon. To fulfill the need of powerful explosion in less charge the various compositions of HBX (High Blast Explosives) types are used for e.g. HBX-1, HBX-3, RDX and H-6. Some important chemicals used in specific percentages as compositions in any type of explosive; they are listed below,

- Ammonium Picrate
- TNT (Trinitrotoulene)
- Powdered Aluminum
- PETN (Penterythrioltetranitrate)

It is also feasible that without getting in actual contact with the target, a projected mine containing high intensity blast explosive will cause severe damage to the target. TNT i.e. Trinitrotoulene is a main component of some explosive compositions as it cannot be used alone due to high rate of combustion. So High Blast Explosives are mainly used in naval mines and the parameters from which the selection of effective explosion which will detonate as quickly as possible with large energy generation. Following are the properties which are considered for a good quality explosives are tabled below in **Table 3.** The More the TNT combination the more effective is the mine; along with it rate of detonation (ROD) and heat of explosion counts when it comes to big explosion in minimum charge available.

Properties	HBX-1	HBX-3	H-6
Composition of TNT (%)	11	8	2
Heat of Explosion (cal/gm)	919	877	923
Heat of combustion (cal/gm)	3882	4495	3972
Rate of Detonation (m/s)	7224	6917	7191
Density (gm/cc)	1.76	1.88	1.79

Table 3: Properties of Explosives [2]

6. CONCLUSIONS

This paper gives basic information about Naval Mines, their types, planting and working using a specific type of mine along with explosives used in these mines. After getting the basic knowledge about mine; some parameters and pre-calculated values were compared and reached on the conclusion as;

- Italian Manta Mine and United States MK-52 gives best results when it comes to endurance, flexible method of delivery, operational depth, high charge and ease of transportation with advanced technology of sensors, accessories and other safety devices. So this study recommends that these mines can be used by developing nations like India, which will ensure the safety of vast coastline in war time situations and infiltration through rivers in peace time.

- Most important component for detonation is nothing but the Explosives; this study also recommends Use of HBX-1 type explosive for naval mines over HBX-3 and H-6 as it has high Rate of Detonation (ROD) i.e. high velocity to fire up and high heat of explosion to make high possible damage.

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BIOGRAPHIES

Deshpande Susharad Mahesh
Student at PES's Modern College Of Engineering, Pune.
Branch: Mechanical Engineering

Dhonddev Rushikesh Ratnakar
Student at PES's Modern College Of Engineering, Pune.
Branch: Mechanical Engineering