The History of the Sea Mine and its Continued Importance in Today's Navy

By Diana Schroeder

"A Sea Mine is a weapon which lies in wait for its victim. This silent weapon hides under the surface of the water or on the bottom in the sand and can remain there undetected for months at a time until an unsuspecting vessel comes across it".[1]

Sea mines continue to be important in naval warfare because they can be used defensively or offensively and because of mines' demonstrated success and capabilities.

Early Pioneers in the development of Sea Mines

The term "sea mine" was first applied in the early 16th century when the Dutch loaded vessels with large amounts of explosives and sent these drifting mines against an enemy ship or an enemy's shore fortification. In 1585 Federico Gianibelli, an Italian working for the Dutch, sent two "bomb ships" to drift into a bridge over the river Scheldt at Antwerp, Belgium. The bomb ships exploded against the bridge, tearing a 200-foot gap in it. This was the first time a large explosive charge was used in naval warfare. The successful destruction of the bridge showed the potential for a drifting mine.

David Bushnell has become known as the father of mine warfare. As a student at Yale University, he worked on the development of underwater explosives. In his research, he discovered that gunpowder could be exploded underwater. During the American Revolution Bushnell was authorized to design a sea mine (usually referred to as a "torpedo" by Bushnell)[2] to be used against the British fleet. He filled kegs with gunpowder and assembled a flintlock mechanism adjusted so that a light shock would release the hammer and fire the powder.

Bushnell sent the floating kegs down the Delaware River in December 1777 with the hope that one or all of these kegs would drift into the British ships anchored at Philadelphia. Although this attempt by Bushnell is referred to in history books as the "Battle of the Kegs", there was no actual battle. The keg mines or "torpedoes" did not meet with success. One of the kegs that had been spotted by two boys exploded when they tried to retrieve it, killing them and alerting the British to be on the lookout for the kegs. "The British destroyed the rest of the kegs by firing into them as they floated by".[3]

Robert Fulton continued the development of floating mines. In 1797, he proposed to the British that they use drifting mines to attack the French fleet. "These mines were supplied with a clockwork mechanism which could be started when the mine was released and would explode 5 to 10 minutes later".[4] This attempt failed when the French fired on the small boats carrying the mines and they had to be released early.

In his next experiment Fulton attempted to destroy a French frigate by building a weapon that consisted of a cable with a mine connected to each end. Fulton released the mine and cable such that the cable would snag the ship's bow drawing the mines into contact with the ship's sides as it sailed by. This attempt had also meet with failure when the mines exploded without sinking the ship. He concluded that the experiment failed because the mines were not submerged. In 1805, while working in England, Fulton succeeded in sinking the Dorothea, a 200-ton brig. Fulton made each mine heavier so that it would sink beneath the surface and the connecting cable would draw the mine underneath the ship where it was most vulnerable. This

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[1] Robert C. Duncan, America's Use of Sea Mines (White Oak: United States Government Printing Office, 1965), xi.

[2] Duncan, 3.

[3] Gregory K. Hartmann. Scott C. Truver, Weapons that Wait: Mine Warfare in the U.S. Navy (Annapolis, Naval Institute Press, 1979), 19.

[4] Hartmann and Truver, 9.

successful experiment led to the conclusion that a weighted mine beneath the surface was more effective than a floating surface mine in destroying a ship's hull.

Samuel Colt, later of revolver fame, perfected the use of electric current to detonate a mine in 1844 on the Potomac River. He used an electric current that flowed through a wire to heat the powder and set off the explosion. Colt also invented a moored minefield that could be detonated on command by an operator on shore when a ship passed over. "Colt conceived the moored minefield as a defensive controlled-weapon system and was very concerned about not only firing the moored mines, but about firing each at the right time when a target vessel would be over a particular mine or within damage range".[5]

Sea Mines' Effectiveness in Naval Warfare

Mines are effective in naval warfare because they are not seen until the mines are almost upon a ship's hull. The effectiveness of a mine depends on its being invisible to its target. A submerged mine has the advantage of striking a ship where it is most vulnerable, the underwater portion of the hull. Mines are only effective if they are submerged enough under the water so a passing ship will sail into it setting off the firing mechanism. Stealth is the principal advantage to undersea weapons.

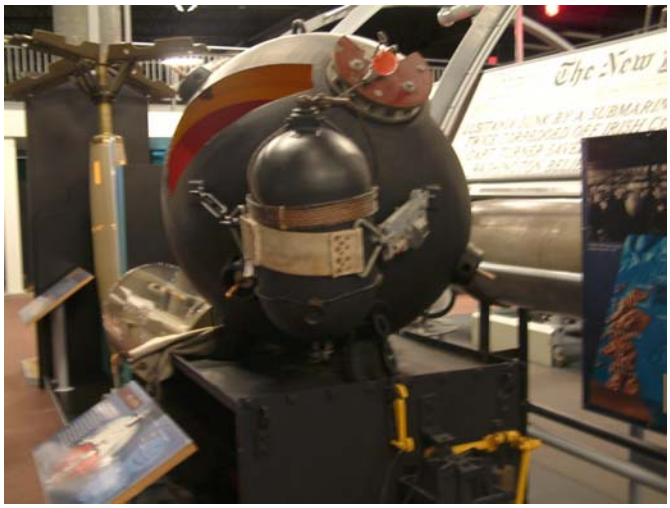
Undersea weapons such as mines are a relatively inexpensive way to wage naval warfare. During the Civil War the Confederate Navy, which lacked adequate funding, used sea mines on a large scale due to their cheapness. The Confederates sought to counteract the effectiveness of the much larger Union Navy by planting minefields in Southern harbors as a deterrent naval tactic. The fact that "twenty-seven federal vessels were sunk by mines, while only nine were sunk by artillery fire"[6] shows the success the Confederate Navy had with this type of weapon.

Mines in the collection of the Naval Undersea Museum

The Frame Torpedo on display at the Naval Undersea Museum

[5] Hartmann and Truver, 30.
[6] Howard S. Levie, Mine Warfare at Sea. (Dordrecht, Martinus Nijhoff Publishers, 1992), 9.

Frame torpedoes were one of the most successful torpedoes (mines) used during the American Civil War by the Confederate Navy. Frame torpedoes are large artillery shells, each with a fuse in its nose, attached to wooden frames and anchored in shallow waterway where an unsuspecting ship might strike and detonate it. "So effective were these frame torpedoes (mines) that all during the war Union gunboats never attempted to force their way up the water approach to a city defended by them".[7]



The Mk 6 Mine on display at the Naval Undersea Museum.

The Mk 6 mine played an important role during World War I by protecting allied shipping. In 1918, the United States and British navies planted more than 76,000 Mk 6 mines in the North Sea. This mine barrage limited the ability of German subs to break out of the Atlantic Ocean and attack Allied shipping.

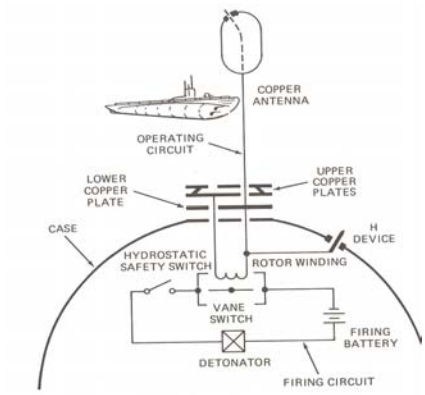


Diagram of a moored mine.

Source: G.K. Hartmann and S.C. Truver. Weapons that Wait. (Annapolis, Naval Institute Press, 1991). 50.

The Mk 6 mine was a moored contact mine. This mine was dropped from rails off the stern of surface vessels in water 30 to 3,000 feet deep. The mine carried 300 pounds of TNT. Detonation occurred when a ship or submarine came in contact with the copper antenna connected to a float above the mine case. Detonation could also occur if a submarine encountered one of the two

[7] Levie, 14.

hertz horns located on the case, thus breaking a glass tube that released electrolyte and completed the firing circuit.

The Mk 25 mine on display at the Naval Undersea Museum.

In World War II the Mk 25 mine was used by Allied nations. These mines were airdropped into position. Japan had laid defensive minefields to keep U.S. submarines from entering and mining the Sea of Japan. In March 1945, U.S. B-29 bombers leapt this barrier. Allied aircraft dropped more than 12,000 mines during "Operation Starvation"- the code name for mining the waters in and around the islands of Japan. These mines carried 1120 pounds of TNT each and by the time Japan surrendered in 1945, airdropped offensive mines had done extensive damage to Japanese shipping.

The Destructor mine on display at the Naval Undersea Museum.

Destructor mines were the first mines used on both land and sea. When dropped on land, they buried themselves in the ground. When dropped in canals or other shallow waterways, they went to the bottom where they lay ready to be set off by a passing vessel. In May 1972 U.S. aircraft planted more than 11,000 destructor mines in Haiphong Harbor. This was key to the January

1973 peace accord ending the Vietnam War. More than 330,000 destructor mines were dropped during the Vietnam War.

Captor mine on display at the Naval Undersea Museum.

Captor Mines, also known as Mk 60 mines, combine the elements of a mine and a torpedo in a single weapon. It is an independent, self-contained, unmanned attack system. Captor detects and verifies submarine presence. When required, it deploys an Mk 46 torpedo to attack and destroy its target.

Mine Classification

Mines can be classified three different ways: by the position they assume in the water, by the method of delivery, or by method of activation.

1. Position in the Water. Mines fall into three different categories when they are classified by the position they assume in the water: bottom, moored, and drifting.

- Bottom mines are most effective in shallow waters. These mines rest on the ocean floor.

- Moored mines are "used for deepwater plants and are effective against submarines and surface ships".[8] The charge and firing mechanism are in a case that floats with a cable attached to the anchor which allows it to position the mine at a predetermined depth.

[8] "Mine History", Categories of Mines, 31 March 2003, http://www.comomag.navy.mil/famil_category.htm.

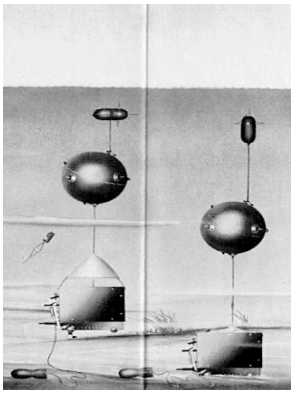


Diagram of an Mk 6 Mine plant.

Source: http://www.ae.edu/~industry/mine/image/mk6plant.jpg

•Drifting mines are not anchored to the bottom and are allowed to float free; the U.S. Navy no longer uses these.

2. Delivery Method. Mines can also be categorized according to the delivery method: aircraft-laid, surface-laid, and submarine-laid.

•Aircraft-laid mines are dropped from an aircraft in the same method as a bomb is. Fins or parachutes that are packed in the back of the mine are used to slow the mine's velocity to lessen the impact when it hits the water's surface. These mines were used extensively in World War II in order to combat waterways held by the enemy.

•Surface-laid mines are planted by surface ships. These mines are used primarily for defensive purposes. The Navy used surface-laid mines in and around allied waterways during World War II to protect the shipping lanes from enemy attack.

•Submarine-laid mines are used when stealth and secrecy are important. Submarine-laid mines are used primarily as offensive weapons. During World War II submarines "planted a total of 576 mines, resulting in 27 ships sunk and 27 damaged, or approximately one ship sunk or damaged per each 10 mines planted".[9]

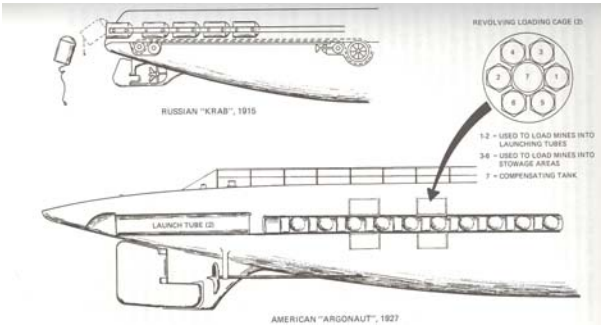


Illustration of Submarine Mine-laying techniques.

Source: G.K. Hartmann and S.C. Truver. Weapons that Wait. (Annapolis: Naval Institute Press, 1991). 44.

3. Method of Activation. (The Influence Sensing Device). "A mine's target detection device (TDD) is the electronic component that observes changes in the underwater environment in order to detect enemy ships and/or submarines and decides whether they are close enough to damage

[9] Mine History, 6.

via the mine's blast effects".[10] These detection devices can use one or a combination of four different types of influence sensors. Pressure, magnetic, acoustic, and seismic are four types of influence sensing devices used to detect changes in the mines' surroundings. If the change exceeds a pre-set level, the sensing device responds and starts a sequence that explodes the mine.

Pressure: When pressure sensors detect a change in pressure, a disturbance in the local magnetic field, or ship noise, they cause a switch to close. This switch closes the firing circuit, enabling electric current to travel from the firing battery to the detonator. The detonator explodes, setting off the main charge in the mine. Completion of this sequence takes a fraction of a second.

Pressure sensors identify a change in pressure in the water caused by a passing ship "as it displaces a given volume of water beneath its hull throughout the course of its passage over the submerged mine".[11]

Magnetic: Magnetic sensors detect changes along the Earth's magnetic field. When the hull of a steel ship disturbs the lines of flux of the Earth's local magnetic field a firing mechanism initiates the detonation of the mine.

Acoustic: Acoustic sensors use a hydrophone to detect propellers, engines, and other machinery that makes noise as the ship moves through the water. The sounds must meet a predetermined acoustic signature for the firing mechanism to initiate.

Seismic: Seismic Sensors also use sound detection technology to initiate the mine's firing sequence. "The extremely sensitive seismic sensor within the mine is designed to detect small movements of the mine case ".[12] This feature is unlike the acoustic sensor where the hydrophone picks up the sound signatures.

Future mine technology

The Naval Surface Weapons Center White Oak, Maryland, Laboratory continues to develop and improve naval sea mines and how to protect ships from them. Research is always being done to improve a sea mine's influence sensor, so that it can differentiate between a "target, a fake, and the background".[13] New developments will allow the sensors to process information they have collected and make a decision on whether to start the firing sequence or wait. This technology will allow mines to more accurately pinpoint a target, destroy it, and keep false readings at a minimum.

Another development that the Naval Surface Weapons Center is working on is how to limit the amount of damage a sea mine can cause to U.S. naval and American owned ships. This is one of the hardest hurdles to cross when dealing with mines, since "certain mine combinations are virtually unsweepable and have to be dealt with, if at all, by the costly, laborious, dangerous, and time-consuming activities of mine hunting and neutralization".[14]

Mine research and development are cheap in cost compared to most of the weapons in the naval arsenal. This is one reason that mine warfare is as important today as it was in the 16th century. Nations are able to use these weapons defensively and offensively without spending a lot of money. Although fewer defensive dollars may be spent on mines, they can protect a nation's inland waterways and save millions of dollars in lost shipping or they can halt an enemy's shipping, costing it millions of dollars in lost revenue and goods.

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[10] Mine History, 7.
[11] Mine History, 2.
[12] Mine History, 10.
[13] Hartmann, 27.
[14] Hartmann, 27.

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"Mine History." http://www.comomag.navy.mil/famil_history.htm 31 Mar. 2003.

"Mk 6 plant." http://www.ae.utexas.edu/~industry/mine/image/mk6plant.jpg 21 May 2003. (Illustration).