History of Naval Mine Warfare

USS Terror (CM-5) website, terror.ringleib.com · November 2026

How naval mines, and the means of laying and countering them, evolved from the earliest written descriptions to the systems in service or development today. The Second World War is treated more briefly here than its importance would otherwise justify. Two companion essays cover American minelaying and minesweeping in that war in detail: “US Navy Minelaying in WWII” and “US Navy Minesweeping in WWII”.

Casualty figures are kept general unless they rest on an official or equally well-sourced account. Where official reports, later histories, and contemporary estimates disagree, the disagreement is noted in the text.

Contents

- Origins: China, Bushnell, Fulton, and the “torpedoes” of 1812
- The Crimean War: Jacobi and Nobel
- The American Civil War: Mobile Bay and Confederate mines
- Late nineteenth century: the Hertz horn, Port Arthur, and Hague VIII
- The First World War: the Dardanelles, the North Sea barrage, and the antenna mine
- Between the wars
- The Second World War: influence mines and a new kind of sea denial
- Korea: Wonsan
- Vietnam: Haiphong and Operation End Sweep
- The Red Sea, 1984
- The Tanker War: *Samuel B. Roberts*, 1988
- The Gulf War, 1991: *Tripoli* and *Princeton*
- The modern era: smart mines and unmanned hunters
- A short look forward
- Technology evolution, at a glance
- A short chronology
- Sources

Origins: China, Bushnell, Fulton, and the “torpedoes” of 1812

The earliest detailed written descriptions of underwater explosive devices used against ships appear in Chinese military texts of the Ming dynasty. The *Huolongjing* (“Fire Dragon Manual”), compiled in the late fourteenth century and given a preface in the Nanyang edition of 1412, describes a weapon it calls the “submarine dragon-king.” A wrought-iron charge, carried on a weighted wooden board and enclosed in an ox bladder, was timed by a thin incense or joss stick floating above the mine in a feathered contain-

er. A length of goat intestine kept the fuse connected to air so the ember would not go out. On a dark night the device was sent downstream toward an enemy ship; when the incense burned down to the fuse, the charge exploded.

Later Ming and early Qing treatises describe other arrangements. Song Yingxing's *Tiangong Kaiwu* (1637) replaces the ox bladder with a lacquered bag and uses a hidden shore observer, pulling a cord, to trip a flint-and-steel wheel and ignite the fuse. Other sixteenth- and seventeenth-century military encyclopedias mention wooden-box "water thunders," drifting timed charges, and tripwire devices. These passages are important, and they are easy to over-read. The dates of first written description are not necessarily dates of invention. The devices range from timed drifting charges and booby traps to shore-triggered mines, and a continuous technical lineage from the "submarine dragon-king" to the moored contact mine of the late nineteenth century should not be assumed. Claims that name a single inventor, or a single year of first use, are neater than the surviving texts will support.

In the Atlantic world the same idea appeared independently in the late eighteenth century, still under a name that would later cause confusion. What later generations called a mine was then a "torpedo": a charge placed in the water, not a self-propelled underwater missile. David Bushnell of Connecticut tried both approaches. In 1776 his submersible *Turtle* attempted to attach a powder magazine to the hull of HMS *Eagle* in New York Harbor. The screw failed to bite. Later writers often blamed the copper sheathing of the British hull; contemporary accounts are less decisive, and the exact reason remains uncertain. The following year a Bushnell magazine, floated against HMS *Cerberus* off New London, missed the frigate, fouled a schooner tending her, and exploded, destroying the schooner and killing several of her people. In January 1778, during the British occupation of Philadelphia, kegs charged with powder were floated down the Delaware. British boats intercepted them. At least one explosion killed a boat's crew. The episode entered American memory as the "Battle of the Kegs," lampooned in Francis Hopkinson's poem of that name.

Robert Fulton took the idea to the great navies of the Napoleonic wars. He offered his submersible *Nautilus*, and explosive "torpedoes," first to France and then to Britain. In October 1805 he demonstrated the destruction of the brig *Dorothea* in a trial at Deal; Trafalgar, six days later, confirmed British command of the surface and removed much of the Admiralty's interest in a weapon that, if it worked, would threaten that command. Fulton later obtained American support for further trials. By about 1810 he was experimenting with anchored, submerged contact charges. During the War of 1812 devices of this kind were still called torpedoes, and American attempts to use them against British ships in coastal waters had mixed and often disappointing results. The older name, however, stuck in naval speech long enough for David Farragut, half a century later, to damn the "torpedoes" in Mobile Bay when he meant mines.

A different line of development was the controlled mine, fired from shore when an observer judged a ship to be over it. Samuel Colt demonstrated the electrical firing of gunpowder underwater as a youth and, in 1842, conducted well-publicized trials of electrically detonated harbor charges for the United States government. The demonstrations worked, but the system was not adopted as a standard weapon. Secrecy around the firing method, the dependence on a human observer, and the passing of the immedi-

ate diplomatic crisis all played a part. Controlled mines would nonetheless return, in Confederate rivers and later in harbor-defense systems, because a mine that fires only when a defender chooses can distinguish friend from foe in a way an automatic contact mine cannot.

The Crimean War: Jacobi and Nobel

The first large-scale use of naval mines in a European war came in 1854–55, when Russia defended the approaches to Sevastopol, Kronstadt, Sveaborg, and Bomarsund against British and French fleets. Two technical families were already in play. One was the shore-controlled or "galvanic" mine, associated with the physicist and engineer Moritz von Jacobi, in which a cable from the beach carried current to a charge when an observer closed a circuit. The other was the moored contact mine, which had to fire itself.

Chemical horns of a type that would be improved, standardized, and still recognized a century later appeared in this war. They are associated with Immanuel Nobel—also written Emmanuel in some accounts—the father of Alfred Nobel, not Alfred himself. Some later summaries have telescoped the two men; the horn work belongs to the father. A soft lead horn on the mine's case held a glass ampoule of acid. When a ship crushed the horn, the acid ran onto a mixture of potassium chlorate and sugar, producing a flame that lit the charge. Early Allied encounters with these weapons produced explosions under or near ships but, in the accounts that survive, little serious damage. That fact should not be over-read as evidence that the mines were harmless. The principle was sound. What the Crimean fields mainly demonstrated was that a weaker navy could force a stronger one to hesitate in confined waters, and that a reliable automatic fuze was worth having.

The American Civil War: Mobile Bay and Confederate mines

The Confederacy, short of ships, made "torpedoes" a principal weapon of harbor, river, and bay defense. Inventors and officers including Matthew Fontaine Maury, Hunter Davidson, Beverly Kennon, and Gabriel J. Rains worked on both controlled and contact devices. Maury's interest in electrically fired mines helped produce the Confederate Submarine Battery Service, which detonated many of the controlled charges from the bank. Contact mines were improvised from casks, boilers, and purpose-made cases. Quality and maintenance varied. A field that looked formidable on a chart could be partly inert after weeks of immersion, corrosion, and wave action—a lesson Union officers would learn in Mobile Bay, and one later officers would relearn whenever they had to guess how many of an enemy's mines were still alive.

The first major United States Navy ship lost to a mine was the ironclad river gunboat *Cairo*. On 12 December 1862, while clearing the Yazoo River in preparation for an attack on Haines Bluff, she struck a "torpedo" detonated by Confederate volunteers hidden on the bank and sank in about twelve minutes. There were no casualties. The wreck, rediscovered a century later, is now a museum ship. *Cairo* was not the last. Confederate mines sank or damaged a substantial number of Union vessels in the Mississippi system, in Southern harbors, and along the Atlantic and Gulf coasts. Published totals disagree: some later

summaries speak of about twenty ships sunk, others of a higher figure in the high twenties. The precise count is less important than the operational effect. Rumors of mines were sometimes enough to keep Union commanders from risking ships in narrow water without direct orders.

The most famous American minefield of the war was laid across the entrance to Mobile Bay. The Confederate Torpedo Bureau, under Rains, planted a line of mines, leaving a gap on the eastern side of the channel so blockade runners and other friendly vessels could pass. Modern accounts, following the contemporary record, often give the number as sixty-seven; some older narratives say eighty or ninety. Either way it was a dense field in a narrow, well-defended channel. On 5 August 1864 Rear Admiral David G. Farragut led a mixed fleet of wooden ships and monitors into the bay. The monitor *Tecumseh*, near the head of the column, struck a mine and sank quickly, with heavy loss of life. As the column bunched and hesitated, Farragut—according to the traditional wording, which has been discussed and slightly varied ever since—ordered the fleet to damn the torpedoes and go ahead. The remaining ships followed through the field, fought and captured the ironclad *CSS Tennessee*, and closed Mobile as a Confederate port. Many of the mines that had not fired were later found to have been made inert by time and water. The battle fixed in American naval memory both the terror of the hidden charge and the possibility that a field might be run.

Late nineteenth century: the Hertz horn, Port Arthur, and Hague VIII

The contact mine became a mature weapon in the decades after the American Civil War, as industrial navies learned to manufacture uniform cases, reliable moorings, and, above all, a fuze that would still work after a long immersion. The decisive device was the Hertz horn, developed in 1868 for the North German defense authorities. Attribution is sometimes given as Herz and sometimes as Hertz; the name of the horn is now fixed even if the spelling of the inventor is not. A lead horn on the mine’s case contained a glass vial of electrolyte, typically a bichromate solution. When a ship crushed the horn, the vial broke, the electrolyte completed a battery already built into the mine, and the current fired a detonator. Unlike the earlier chemical horn, which depended on a flame, the Hertz horn was an electrical switch. It remained usable after long submersion and became the standard contact fuze of almost every navy that laid moored mines into the twentieth century. Mines of this family, with improvements, were still being encountered in Korean and later fields.

Mines also became an offensive weapon, not only a harbor defense. The Russo-Japanese War of 1904–1905 showed what that meant for a battle fleet. Early in the siege of Port Arthur the Japanese laid mines off the harbor entrance and then sought to draw the Russian squadron over them. On 13 April 1904 (31 March in the Julian calendar then used by the Russians), the battleship *Petropavlovsk*, flagship of Admiral Stepan Makarov, struck a Japanese mine and sank. Makarov was killed, and the ship was lost with heavy loss of life. The blow to Russian morale was immediate. Mines did not, however, serve only one side. Japan later lost the battleships *Hatsuse* and *Yashima* to Russian mines, a blow that nearly altered the naval balance off the port. Russian ships were also lost on their own fields, among them the minelayer *Yenisei* and the cruiser *Boyarin*. Western observers watched minelayers and minesweepers contest the approaches to a major fortress and drew the lesson that a cheap, unseen weapon could sink capital ships.

The obvious peacetime danger was the mine that did not stay where it was put, or that remained dangerous after a war ended. The Hague Convention (VIII) of 18 October 1907 tried to set rules. Unanchored automatic contact mines were to become harmless within one hour after the layer lost control of them. Anchored automatic contact mines were to become harmless as soon as they broke their moorings. After a war, the parties were to do their utmost to remove the mines they had laid, and to notify the other side of the position of mines they had laid in enemy waters. The convention was written for contact mines. Influence mines—magnetic, acoustic, and pressure weapons that fire without being touched—did not yet exist as service weapons, and later lawyers and planners would argue over how far the 1907 text could be stretched to cover them. Compliance in later wars was uneven. The convention nevertheless fixed two ideas that have shaped mine design ever since: a mine that breaks loose should go safe, and a minefield is not supposed to last forever. Sterilizers, flooding devices, and self-destruct timers in twentieth-century mines are, in part, a technical answer to that legal and humanitarian demand.

The First World War: the Dardanelles, the North Sea barrage, and the antenna mine

The First World War made the mine a principal weapon of the maritime war, used on a scale no earlier conflict had approached. Fields were laid in the Channel, the North Sea, the Baltic, the Adriatic, the Black Sea, and far overseas. German U-boats carried mines as well as torpedoes and, in 1918, laid them off the American East Coast. Surface ships, submarines, and, increasingly, purpose-built minelayers all took part. Sweeping, which had been a matter of towing a grapnel or a wire, became a service in its own right, with specialized ships, paravanes, and, after the war, a large and dangerous clearance task.

Two campaigns illustrated what mines could and could not do. In the Dardanelles in March 1915, a Turkish minefield, covered by shore batteries, defeated the Allied attempt to force the strait by ships alone. On 18 March the French predreadnought *Bouvet* and the British predreadnoughts *Irresistible* and *Ocean* were sunk by mines; other heavy ships were damaged. The guns made systematic sweeping nearly impossible. The failure of the naval attack led to the Gallipoli landings, which also failed. A relatively small, well-placed, well-covered field had denied a narrow waterway to the greatest navies in the world.

The North Sea Mine Barrage, or Northern Barrage, was the opposite kind of operation: an enormous offensive barrier intended to hinder U-boats leaving German bases for the Atlantic shipping lanes. The idea was discussed in 1916, agreed at an Allied naval conference in September 1917, and carried out in 1918, chiefly by the United States Navy with British assistance. A belt some 230 miles long and fifteen to thirty-five miles wide was divided into three areas. The Royal Navy mined areas B and C, off the Orkneys and toward the Norwegian coast; the United States mined the long central area A. No mines were laid in Norwegian territorial waters. In five months Mine Squadron One, under Captain Reginald R. Belknap, and the British force planted 70,177 mines, of which the Americans laid 56,571. Rear Admiral Lewis Clinton-Baker, who commanded the British minelayers, called it the “biggest mine planting stunt in the world’s history.”

The American contribution depended on a new mine. The Mark 6 was a spherical moored weapon, but it did not rely only on a Hertz horn at the depth of the case. A copper-wire antenna, held up by a float, extended the danger space toward the surface. When a steel hull touched the copper, seawater acted as the electrolyte of a simple battery (the “K-pistol”), a relay closed, and the mine fired. That antenna principle let a single mine threaten both a surfaced U-boat and, depending on the depth of the case and the length of the antenna, a boat running shallow. The barrage was laid in eighteen east–west rows: ten at about eighty feet, to catch surface ships, and others at about 160 and 240 feet for submerged boats. The new mines were not trouble-free. Three to five percent detonated as soon as their safety pellets dissolved, and premature explosions continued for days after some lays.

Whether the barrage was worth the effort has been argued ever since. Official Allied statistics compiled on 1 March 1919 credited it with the certain destruction of four U-boats, the presumed destruction of two, and the possible destruction of another two; eight more boats were known to have been damaged, and some officers were prepared to add a few unexplained disappearances. The last mines were laid only days before the Armistice, so the field never had a long wartime trial. Some writers have held that it weighed on German naval morale in the autumn of 1918; others have pointed out that an unguarded field can be swept or evaded, and that the certain score was modest for so many mines. After the Armistice the same American force, under Rear Admiral Joseph Strauss, spent months sweeping the barrage, a dangerous task made harder by the antenna mines, which could be actuated by a steel sweeper. Special devices and wooden or insulated methods were developed so the field could be taken up. The pattern would repeat after later wars: planting is quicker than clearance.

Between the wars

The lesson that should have been drawn was that mines and mine countermeasures had become a standing part of naval war, requiring ships, trained people, and research in peacetime. The lesson often drawn, in the United States especially, was that the sweepers could be discarded. Tamara Moser Melia’s official history of American mine countermeasures, *Damn the Torpedoes*, makes interwar neglect a central theme: budgets shrank, specialized ships went out of service, and expertise dispersed.

Research did not stop entirely. Britain and Germany, in particular, worked on influence mines that would fire without being touched, using the magnetic field of a steel hull or the sound of its propellers. Aircraft and submarines were recognized as minelayers that could reach waters closed to a surface ship. The Hertz-horn moored contact mine stayed in every major inventory, and the legal framework of 1907 remained on the books, unadapted to weapons that did not yet officially exist. When war returned in 1939, the first unpleasant surprises came from those new fuzes.

The Second World War: influence mines and a new kind of sea denial

The Second World War transformed mine warfare twice: first by making the influence fuze a service weapon, and then by using aircraft to plant influence mines in large numbers in the enemy’s own harbors. The detail of American laying, fuzing, degaussing, sterilization, and postwar clearance is the subject of the two companion essays, “US Navy Minelaying in WWII” and “US Navy Minesweeping in WWII”. What follows is only the thread of the longer history.

In late 1939 German magnetic mines, dropped in British estuaries and shipping channels, began damaging and sinking ships that had never touched a horn. A steel hull distorts the earth's magnetic field; a fuze on the bottom can feel that change and fire a charge under the keel, where it does more harm than a contact explosion at the side. The British recovered examples, learned the mechanism, and answered with degaussing: coils around a ship, carefully calibrated, that canceled much of the magnetic signature, together with periodic "deperming" and runs over magnetic ranges. Acoustic mines, which listened for propeller or machinery noise, followed, and were answered, imperfectly, with noisemakers towed by sweepers. Pressure mines—the so-called "oyster" mines, which felt the hump in the water as a hull passed over—were still harder. They had no good mechanical sweep in 1945. Both the Germans and the Americans treated the pressure fuze as a secret worth holding back, and both introduced it late (the Germans off Normandy, the Americans in the final months of the Pacific war) for fear the other side would copy it. Combination fuzes, which required more than one influence, together with ship counters, arming delays, and sterilizers, made fields that could not be cleared by a single simple sweep.

Laying methods multiplied. Moored contact mines were still planted by surface ships for defensive and barrage work. Submarines laid both contact and influence mines in waters too dangerous for a minelayer. Aircraft, first in Europe and then on a much larger scale in the Pacific, dropped parachute-retarded bottom mines into harbors and straits. The American campaign that best showed what that combination could do was Operation Starvation, the 1945 B-29 mining of Japanese home waters. Army Air Forces bombers, using mines designed, assembled, and in large part planned by the Navy, planted 12,135 influence mines in those waters. Official and official-adjacent accounts credit the fields with sinking or badly damaging on the order of 670 Japanese ships and with a large share of the collapse of Japan's maritime transport in the last months of the war. American and Allied forces as a whole planted on the order of 50,000 mines in the war. Clearing them, in Japanese, European, and other waters, took years and cost ships and lives after the shooting had stopped.

The United States Navy's surface minelaying force in that war was a mixture of conversions and one purpose-built ship. *Terror* (CM-5), designed before the war, built at the Philadelphia Navy Yard, and commissioned on 15 July 1942, was the only American ship purpose-built as a fleet minelayer in the Second World War. Two planned sisters were completed as landing ships. Converted CMs, destroyer-minelayers, auxiliary layers, submarines, and Army and Navy aircraft did the rest of the planting. *Terror*'s own wartime career is outside the scope of this essay.

Korea: Wonsan

The first major postwar test of American mine countermeasures came at Wonsan, on the east coast of Korea, in October 1950. After Inchon and the recapture of Seoul, General MacArthur planned a two-pronged advance into North Korea, including an amphibious landing at Wonsan, with D-day originally set for 20 October. That left less than three weeks to prepare. Intelligence did not anticipate a large, carefully laid field. In fact the Soviets had moved mines south by rail and had sent experienced officers to help mine Wonsan and Chinnampo with a mix of contact, magnetic, and controlled mines, and to instruct North Korean forces. Other ports were also seeded.

Mines had already begun to tell on the east coast. In the last week of September they damaged several United Nations ships and sank the minesweeper *Magpie* (AMS-25). Task Group 95.6, under Captain Richard T. Spofford, was sent ahead to clear channels to the Wonsan beaches, reinforced by Japanese minesweepers—among the most practiced influence-sweeping crews in the world after five years of clearing American fields in their own waters—and by PBM flying boats used to spot mines from the air. The sweepers expected to find relatively few mines in the choke points. Over the following week they charted, in Melia's official account, a mixed field of some 3,000 mines spread over about 400 square miles: unsophisticated Russian contact mines of 1904 vintage in the harbor, and new magnetic influence mines, sensitive enough to react to the engines of wooden ships, closer inshore.

On 11 October the clearance reached the entrance to the harbor. The next morning Mine Division 32, the steel-hulled sweepers *Pirate*, *Pledge*, and *Incredible*, went forward in echelon, all hands in life jackets. Helicopters reported mines ahead but not their exact positions. *Pirate* struck a mine, was broken open, and sank in about four minutes. About five minutes later *Pledge* was mined as well. *Incredible*'s engines failed, leaving wooden vessels to the rescue under fire from shore batteries. South Korean forces had already taken the city on 10 October. There was no longer a need to push packed transports through an uncleared field, and the landing was delayed until a path could be made.

The work took far longer than the few days originally allotted. A channel was reported clear on the evening of 25 October, and Marines went ashore on the 26th: about fifteen days of sweeping for an operation that had been expected to go much faster. Published figures for the number of mines actually swept or destroyed at Wonsan are much smaller than the estimated total in the field—on the order of a couple of hundred in some accounts—with more becoming floaters and the majority left in place once the channels were known. Casualties among the sweeping force were real and painful; later secondary accounts have offered specific totals that do not rest on a single official figure, and they are not repeated here. Rear Admiral Allan E. "Hoke" Smith, who commanded the covering task force, sent a message that has been quoted ever since, and that is preserved in the Naval History and Heritage Command's official H-gram on the operation: "We have lost control of the seas to a nation without a Navy, using pre-World War I weapons, laid by vessels that were utilized at the time of the birth of Christ." The wording was colored, as the H-gram itself notes, but the operational point was not. A large amphibious armada waited on a handful of minesweepers. When the Marines finally landed they were met by South Korean banners and by a sign, recorded in slightly different wordings, to the effect that the beach was theirs courtesy of Mine Squadron Three.

Mines continued to trouble United Nations naval forces for the rest of the war, including at Chinnampo and other west-coast ports. An often-cited later tally, in a National Academies study of naval mine warfare, holds that of fourteen United States Navy ships sunk or damaged by mines since the Second World War, ten were victims in Korea, while in the same postwar period only two Navy ships were damaged by air or missile attack in the comparison the study drew. The comparison is pointed, and it should be read as that study's postwar tally, not as a complete account of every form of damage to the fleet.

Vietnam: Haiphong and Operation End Sweep

American aircraft had already used mines in Southeast Asian waters during the Second World War. The mining that closed North Vietnam's principal port in 1972 was different: it was a planned campaign, with the clearance already designed into the weapons, and it became a bargaining instrument in the war's last year.

On 8 May 1972, after the North Vietnamese Easter Offensive and the stalling of the Paris talks, attack aircraft from *Coral Sea* began Operation Pocket Money, the mining of Haiphong and other North Vietnamese ports. Melia records that the first drop in Haiphong consisted of thirty-six magnetic-acoustic mines. They did not arm at once. Seventy-two hours later they did, sealing twenty-seven foreign merchant ships in the port. A few ships, including Soviet and British vessels, got out before the arming delay expired; the rest stayed. The mines were chosen and set so that they could be swept and so that most would, after a set time, either destroy themselves or go inert—a deliberate answer to the Hague requirement that a minelaying state be able to remove the threat it has created, and a practical necessity if the United States expected to have to clear the fields as a condition of a settlement. When talks broke down later in the year the fields were reseeded. A National Academies account credits the mining with interdicting a very large share—the study says 95 percent—of North Vietnam's seaborne resupply. That figure is the study's, and it is cited here as such. In early August 1972 a number of the mines detonated spontaneously; later scientific work has attributed at least some of those explosions to a geomagnetic storm, a reminder that a magnetic fuze lives in the same world as the earth's own field.

The Paris cease-fire agreements of 27 January 1973 included an American obligation to clear the mines. Operation End Sweep, from 6 February to 27 July 1973, was the fulfillment of that obligation and the first operational deployment of a United States Navy airborne mine-countermeasures capability. Rear Admiral Brian McCauley commanded Task Force 78. Ocean minesweepers swept the deep approaches; amphibious ships carried CH-53 helicopters of the Navy and Marine Corps, which towed magnetic hydrofoil sleds and, where a lighter tow was needed, the Magnetic Orange Pipe, a buoyant magnetized pipe that less experienced pilots could handle. The tank landing ship *Washtenaw County*, stuffed with foam and reduced to a volunteer skeleton crew kept topside, served as a "guinea-pig" check sweeper in waters thought to have gone inert. Only mines known to be sweepable had been used, and most had already sterilized themselves; the force still had to demonstrate that the channels were safe. The operation was suspended more than once as the prisoner-of-war releases and other provisions of the accords were argued over, then resumed. Two helicopters were lost, and one sweeper suffered fire damage. End Sweep officially ended on 27 July 1973. Contemporary and later official comments, including those of the Chairman of the Joint Chiefs, Admiral Thomas Moorer, held that the ability to offer and then to carry out clearance contributed to the timely release of American prisoners. The campaign is one of the few in which the same navy that planted the mines also, by prior design, took them away.

The Red Sea, 1984

In the summer of 1984, at least seventeen merchant ships were damaged by mine-like explosions in the Gulf of Suez and the Red Sea, between 9 July and 15 August. A contemporary intelligence heading, preserved in a later CIA *Studies in Intelligence* account of the episode, spoke of nineteen ships; the body of

the same analysis says at least seventeen. The precise count of damaged ships is therefore slightly uncertain. No one at first knew who had laid the mines, or even, with complete confidence, that they were mines.

An international mine-countermeasures effort assembled quickly: twenty-six ships from six countries, a rare peacetime coalition for a hazard in a commercial artery. On 12 September the British minehunter HMS *Gavington* located a mine and brought it into shallow water to be disarmed. It proved to be a Type 995, an export-style Soviet magnetic-acoustic bottom mine with a warhead of about 750 kilograms of RDX/TNT, larger than some of the early damage estimates had implied. The find confirmed the nature of the hazard and gave clearance teams a type to hunt.

Attribution was a different problem. Suspicion settled early on Libya, in part because of the movements of the Libyan-flagged roll-on/roll-off ship *Ghat*, whose track and timing could be made to fit the first incidents at both ends of the Red Sea, and in part because of Libya's broader record of covert operations in those years. Iran was also discussed and, in the CIA account, later discounted on several grounds, including official Iranian denials and a poor fit with Iranian interests in the canal. The CIA's own reconstruction, written with the benefit of later document releases, still describes the initial case as substantially circumstantial: a suspicious ship, a motive that could be argued, and a Soviet-designed mine of a type that had been supplied to Libya. Later comments and admissions have been taken by some writers as confirmation. They do not erase the caution with which the 1984 investigators had to work. For the history of the weapon, the episode matters in another way. A few modern bottom influence mines, laid covertly from a merchant ship in an international strait, were enough to alarm insurers, draw a multinational sweeping force, and show that the old logic of cheap sea denial had survived the age of missiles.

The Tanker War: *Samuel B. Roberts*, 1988

During the Iran–Iraq War the tanker route through the Persian Gulf became a battlefield. Both sides, and especially Iran in the later years of the conflict, used mines as well as small-boat and missile attacks. United States warships were in the Gulf to escort reflagged tankers under Operation Earnest Will.

On 14 April 1988 the guided-missile frigate *Samuel B. Roberts* (FFG-58), having just finished an escort and heading to a replenishment, found herself in a field of moored contact mines in water that was supposed to have been swept, about fifty-five miles northeast of Qatar. The official Dictionary of American Naval Fighting Ships account describes the sequel in detail. A lookout spotted mines ahead. The commanding officer, Commander Paul X. Rinn, sent the crew to battle stations without sounding the general alarm, ordered men up from below, and tried to back out along the ship's own wake. At 1649 the ship struck a mine set deep. The explosion blew a hole some twenty-one feet across in the port side, lifted the ship, broke engines from their mountings, flooded the engine room, and started fires. Ten sailors sustained severe wounds; others were injured, some of them badly burned. There were no fatalities. *Samuel B. Roberts* was saved by damage control, was carried home, and was repaired. The Navy's official history of the ship is the source for those casualty and damage figures.

The mines were Iranian. They are commonly identified in later accounts as export moored contact mines of the M-08 family, a design whose ancestry runs back to the Hertz-horn era. The tactical humiliation, as a later National Academies study put it, was the image of American warships following, rather than leading, the tankers they were there to protect. The strategic reminder was older than the frigate: a cheap, unsophisticated mine can still break a modern warship's back.

The Gulf War, 1991: *Tripoli* and *Princeton*

Iraq laid extensive minefields in the northern Persian Gulf after the invasion of Kuwait, in international waters as well as closer inshore, to hinder an amphibious landing and to keep battleships and mine-countermeasures ships at a distance. The American and allied sweeping force included ocean minesweepers, the new mine-countermeasures ship *Avenger*, British and other allied sweepers, explosive-ordnance-disposal teams, and airborne minesweeping helicopters embarked in *Tripoli* (LPH-10).

On the morning of 18 February 1991, within a few hours of each other, two major American combatants struck Iraqi mines. At 0436 *Tripoli*, flagship of the airborne mine-countermeasures group, was hit on the starboard bow by a LUGM-145 contact mine. The explosion tore a hole on the order of sixteen by twenty feet in the hull. After hours of damage control the ship was stabilized and remained on station for days, but damaged fuel tanks kept her from continuing to operate her MH-53E minesweeping helicopters, and she had to be relieved. At 0715 *Princeton* (CG-59), a cruiser with the Aegis combat system, was patrolling some twenty-eight nautical miles off Failaka Island, on the flank of a decoy amphibious force. Two Italian-made MN103 Manta bottom influence mines detonated, one under the port rudder and one forward; the second explosion is usually described as sympathetic. The blasts cracked the superstructure, buckled plating, jammed the rudder, and damaged a propeller shaft. Accounts of the damage describe three crew members injured, one seriously. Weapons and the Aegis system were brought back on line within minutes, but the ship was a mission kill as a maneuvering combatant and had to be guided out of the field by the minesweeper *Adroit*.

Both ships survived. The amphibious landing they had been helping to shape did not go forward as a major assault; the mines were only one reason, but they were a sufficient reminder that a landing through uncleared water was not a risk the theater commander would take lightly. The pattern of Wonsan had repeated in a different gulf, against a different navy, with weapons that now included modern influence mines bought on the international market. After the war, clearance of the Iraqi fields was again a long, international business.

The modern era: smart mines and unmanned hunters

Since 1991 the technology has moved in two directions at once. Mines have become more selective, more mobile, and, in some designs, more nearly weapons that wait for a particular target rather than for any steel hull. Countermeasures have moved off the decks of manned wooden sweepers and onto helicopters, unmanned vehicles, and standoff sensors—slowly, and at greater cost and delay than successive programs promised.

The Cold War produced one distinctive American deep-water mine, the Mark 60 CAPTOR (Encapsulated Torpedo). In service from 1979 to 2001, CAPTOR was a moored capsule, plantable by aircraft, submarine, or surface ship, that listened for a submarine in deep water and, if the signature matched, released a Mark 46 torpedo. It was intended, among other things, for barrier use in waters such as the Greenland–Iceland–United Kingdom gap. It has had no direct successor in service. A program called Hammerhead, described in official fact sheets as an encapsulated-torpedo "effector" for intermediate and deep water, has been developed as a conceptual replacement, with unmanned undersea vehicles such as the Orca extra-large UUV discussed as a delivery method. Program status and timelines have shifted, and they should be treated as unsettled.

The mainstay of the present American inventory is the Quickstrike family of aircraft-laid shallow-water mines. An official Navy fact file, as archived in 2026, lists two types of mines as in service: the Quickstrike series and the Mark 67 Submarine Launched Mobile Mine (SLMM), the latter first deployed in 1987. Some unofficial accounts have suggested that the SLMM is out of production or only residual; the official fact file still lists it, and the uncertainty is noted here rather than resolved. Quickstrike itself comes in three service marks: the Mark 62 and Mark 63, which are converted 500-pound and 1,000-pound general-purpose bombs, and the Mark 65, a purpose-made thin-walled 2,000-pound mine case. Fuzing is of the modern influence kind—acoustic, seismic, and pressure, in combination and with target-discrimination logic—rather than a simple horn. A developmental extended-range version, identified in the same official fact file as the Mark 64 Mod 5 Quickstrike-ER, fits a 2,000-pound bomb body with mine components, a wing kit, and a tail kit for standoff delivery. Published professional accounts have described a winged Quickstrike gliding on the order of forty nautical miles from high altitude; designations and exact ranges in unofficial writing do not always match the official fact-file wording, and the precise reach should be treated as a published approximation, not as a figure to be over-specified. Another developmental weapon, the Mark 68 Clandestine Delivered Mine, is intended for covert placement.

Other navies, and the export market, have long offered mines that the United States has not put in the water in the same form: rising or rocket mines, which wait on the bottom and then drive a warhead or a small undersea vehicle up at a passing ship; encapsulated-torpedo mines in foreign marks; and "smart" or networked mines that can be programmed, in principle, to talk to one another or to a controller, to let some traffic pass, and to wake on a particular signature. Finland, Italy, Russia, China, and others have been active designers and, in some cases, exporters. A responsible public history can describe the types without pretending to a classified inventory of who holds what.

Hunting and sweeping have been harder to modernize than the catalogs suggested. The Avenger-class mine-countermeasures ships and MH-53E helicopters, both of 1980s origin, carried much of the burden for a generation and have been reduced only slowly. The Littoral Combat Ship mine-countermeasures mission package—intended to pair an LCS or an expeditionary base with helicopters, unmanned surface and undersea vehicles, and sensors—was long delayed. A first partial deployment to the Middle East was reported in 2021. Not all of the planned systems have reached a clean initial operational capability, and public assessments have been mixed. The direction of travel is nonetheless clear: put fewer sailors in the

minefield, find the mine with a sonar or a small vehicle, and neutralize it at a distance. That is mine *hunting*, as distinct from sweeping a path and hoping the influence sweep has spoken in the right language to the fuze.

The Black Sea war that began with Russia's full-scale invasion of Ukraine in February 2022 has brought the old weapon back into commercial news. Both sides have used mines. Ukraine laid defensive fields to help deter an amphibious stroke against its coast; Russia has used mines as part of its effort to constrain Ukrainian ports and traffic. Floating and drifting mines, some of them almost certainly moored weapons that broke loose in weather, have appeared far from their original fields, prompting notices from the International Maritime Organization and forcing grain and other shipping into carefully routed corridors. Open-source attributions of particular floating mines are often uncertain. Uncrewed surface vehicles, used notably by Ukraine against Russian ships and ports, are a related form of cheap sea denial, but they are not the same thing as a traditional mine, which waits. The lesson is familiar: in confined waters a weaker naval power can still impose delay, insurance cost, and caution, and clearance is slow.

A short look forward

The next chapter is already visible in outline. Aircraft will plant shallow-water mines from standoff ranges. Unmanned undersea vehicles will be asked both to lay mines covertly and to hunt them. Deep-water encapsulated torpedoes, if they return to service, will again turn a minefield into an antisubmarine barrier. Influence fuzes will grow more selective, and may be networked, which will make simple sweeping even less sufficient than it is now. Legal rules written in 1907 for contact mines will continue to sit uncomfortably with weapons that can, in principle, be switched on and off, or aimed at a class of target.

None of that makes the older lessons obsolete. A mine is still an explosive charge in the water, cheap relative to the ship it can sink, patient, and indifferent to who is winning the war in the air. From the incense-timed "dragon-king" to a Quickstrike on a wing kit, the idea has been remarkably stable. What has changed, again and again, is the fuze, the delivery vehicle, and the cost of being unready to sweep.

Technology evolution, at a glance

Period	Types	Fuzing	Countermeasures
Origins (Ming to early nineteenth century).	timed drifting charges, tripwire or shore-pulled mines, Bushnell and Fulton "torpedoes."	incense timers, flint wheels, simple contact, early electrical firing from shore.	lookouts and small boats; no specialized sweeping gear.
Crimean War and mid-nineteenth century.	Jacobi's controlled (galvanic) harbor mines; moored contact mines.	shore cables; chemical horns (acid on chlorate and sugar).	cautious navigation and early attempts to destroy visible or moored charges.

Period	Types	Fuzing	Countermeasures
American Civil War.	Confederate controlled river and harbor mines; improvised and purpose-made contact “torpedoes.”	electrical firing from the bank; contact fuzes of uneven quality.	rafts, nets, crude sweeping; running a field, as at Mobile Bay, when many mines had already failed.
Late nineteenth century to 1907.	industrial moored contact mines, used defensively and, off Port Arthur, offensively.	the Hertz horn (electrolyte vial and integral battery).	wire sweeps and cutters; Hague Convention VIII on unanchored and broken-mooring mines and on postwar removal.
First World War.	massed moored contact fields; the American Mark 6 antenna mine of the North Sea barrage; submarine-laid mines.	Hertz horns; antenna or “K-pistol” battery fuzes.	paravanes, dedicated minesweepers, and large postwar clearance, including methods that let steel ships work among antenna mines.
Interwar years.	improved moored contact mines; experimental magnetic and acoustic influence mines; aircraft- and submarine-laid designs.	horns still standard; influence fuzes in development.	widely neglected in peacetime fleets, especially in the United States.
Second World War.	moored contact mines; magnetic, acoustic, and pressure bottom influence mines, often in combination; aircraft-laid fields on a new scale (including Operation Starvation).	horns and antennas; influence mechanisms with arming delays, ship counters, and sterilizers.	degaussing and magnetic ranges; acoustic noisemakers; mechanical and influence sweeps; “guinea-pig” ships against pressure mines; years of postwar clearance. See the companion essays for American practice.
Korea and Vietnam.	mixed old contact and modern magnetic mines at Wonsan; aircraft-laid magnetic-acoustic mines at Haiphong, designed to self-destruct or go inert.	horns and influence fuzes; timed sterilization built into the 1972 campaign.	wooden and steel sweepers, Japanese-assisted influence sweeping, airborne spotting, and, in 1973, helicopter-towed magnetic sweeps and check ships in End Sweep.
1980s–1991 (Red Sea, Tanker War, Gulf War).	export Soviet bottom influence mines (Type 995); Iranian moored contact mines; Iraqi mixed fields including LUGM contact mines and Italian Manta influence mines.	magnetic-acoustic influence; traditional horns.	multinational hunt-and-sweep forces and helicopters, still leaving unswept water dangerous, as *Samuel B. Roberts*, *Tripoli*, and *Princeton* showed.
Present and near term.	Quickstrike aircraft-laid shallow-water mines (Marks 62, 63, 65); SLMM (Mark 67), still listed as in service in official fact sheets; developmental Quickstrike-ER, Hammerhead, and clandestine-delivered mines; foreign rising, rocket, and networked mines; defensive and floating mines in the Black Sea since 2022.	multi-influence, target-discriminating, programmable; encapsulated-torpedo triggers in deep-water designs.	minehunting sonars, unmanned vehicles, airborne systems, and lingering manned sweepers; programs have been slow, and clearance in a live war remains dangerous.

A short chronology

Period	Event
Late fourteenth century.	The *Huolongjing* describes the “submarine dragon-king,” a timed drifting mine. Later Ming and Qing texts describe shore-triggered and tripwire water mines.
1776–1778.	Bushnell’s *Turtle* fails to attach a charge to HMS *Eagle*. A Bushnell magazine destroys a schooner astern of HMS *Cerberus*. Floating kegs on the Delaware produce the “Battle of the Kegs.”
1805–1812.	Fulton demonstrates anchored explosive “torpedoes” in Britain and the United States. The name is still used for mines in the War of 1812.
1842.	Colt demonstrates electrically fired controlled harbor mines for the United States government; the system is not adopted as standard.
1854–1855.	Russia uses Jacobi’s controlled mines and Nobel’s chemical-horn contact mines in the Crimean War.
12 December 1862.	*Cairo* is sunk by a Confederate controlled mine in the Yazoo River, the first major United States Navy ship lost to a mine.
5 August 1864.	*Tecumseh* strikes a mine and sinks at Mobile Bay; Farragut takes the fleet through the field.
1868.	The Hertz horn is developed, giving moored contact mines a durable electrical fuze.
13 April 1904.	The Russian flagship *Petropavlovsk* is sunk by a Japanese mine off Port Arthur; Admiral Makarov is killed. Japan later loses *Hatsuse* and *Yashima* to mines.
18 October 1907.	Hague Convention VIII sets rules for automatic contact mines and for postwar removal.
18 March 1915.	Allied predreadnoughts are sunk by mines in the Dardanelles; the naval attempt to force the strait fails.
1918.	The North Sea Mine Barrage is planted: 70,177 mines, 56,571 of them American, including the new antenna-fuzed Mark 6. Postwar sweeping takes months.
1939–1945.	Magnetic, acoustic, and pressure influence mines enter service; degaussing becomes a standard defense. In 1945, Operation Starvation plants 12,135 American influence mines in Japanese home waters. *Terror* (CM-5) is the only United States ship purpose-built as a fleet minelayer in the war.
October 1950.	A field of some 3,000 mixed mines delays the landing at Wonsan; *Pirate* and *Pledge* are sunk on 12 October; Marines go ashore on 26 October.
8 May 1972 – 27 July 1973.	Pocket Money closes Haiphong and other North Vietnamese ports with magnetic-acoustic mines designed to be swept or to go inert. End Sweep then clears the fields after the Paris accords.
July–September 1984.	Seventeen or more merchant ships are damaged in the Red Sea and Gulf of Suez. An international force hunts the mines; HMS *Gavington* recovers a Type 995 on 12 September.
14 April 1988.	*Samuel B. Roberts* strikes an Iranian mine in the Persian Gulf, is grievously damaged, and is saved.
18 February 1991.	*Tripoli* and *Princeton* strike Iraqi mines in the Persian Gulf, both mission kills.
1979–2001.	The Mark 60 CAPTOR deep-water encapsulated-torpedo mine is in American service. Quickstrike aircraft-laid mines follow in 1983; the Mark 67 SLMM is listed as deployed from 1987.

Period	Event
2021 onward.	Unmanned and LCS-based American mine-countermeasures packages begin limited operational use, still short of a complete replacement for older hunters and sweepers.
2022 onward.	Mines in the Black Sea, including floating hazards, disrupt naval operations and commercial traffic, including grain exports, in the war following Russia's full-scale invasion of Ukraine.

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