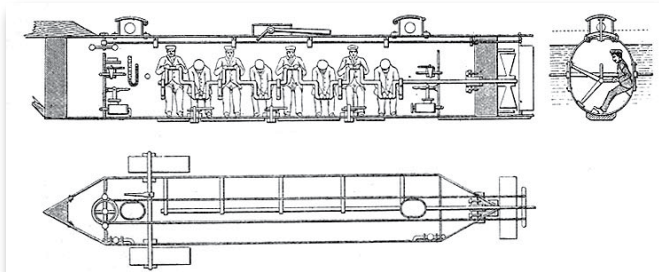




THE DAYBOOK®

CIVIL WAR NAVY SPECIAL EDITION-TECHNOLOGY

Speaking in 1865, Scottish engineer and shipbuilder Sir William Fairbairn remarked to his fellow members of the Royal Society of Engineers that “Americans are a very singular and a very clever people; full of ingenuity and contrivances to meet the demands of the moment, and availing themselves of every improvement that happens to touch upon the question before them.” One of the British Empire’s leading engineers, Fairbairn’s praise for American innovation was based on the work done by American maritime engineers during the Civil War.



Engineer H.L. Hunley’s “fish torpedo boat,” 1863.




The late war, double turreted monitor USS Onondaga, 1864.

Many historians have correctly referred to the American Civil War as the first modern war. It was the first American war to include mass mobilization of both the population and industry. It was also a war where, for the first time, technology was a major participant. Technology had a far stronger influence on the naval war than on ground engagements. Both sides looked to their respective brain trusts to solve certain strategic problems caused by thousands of miles of waterways.

Union and Confederate engineers did their best to create workable solutions. They even attempted to adapt hurriedly when new problems arose. They did not wait for “the next war” to apply their new solutions.

In this second Civil War special edition of *The Daybook*, you will be introduced to some of these technological innovations. Like the first Civil War special edition, this issue simply serves as an

introduction and is by no means the last word. We encourage you to further explore what historians and the engineers themselves have said over the last 150 years on this important subject. 



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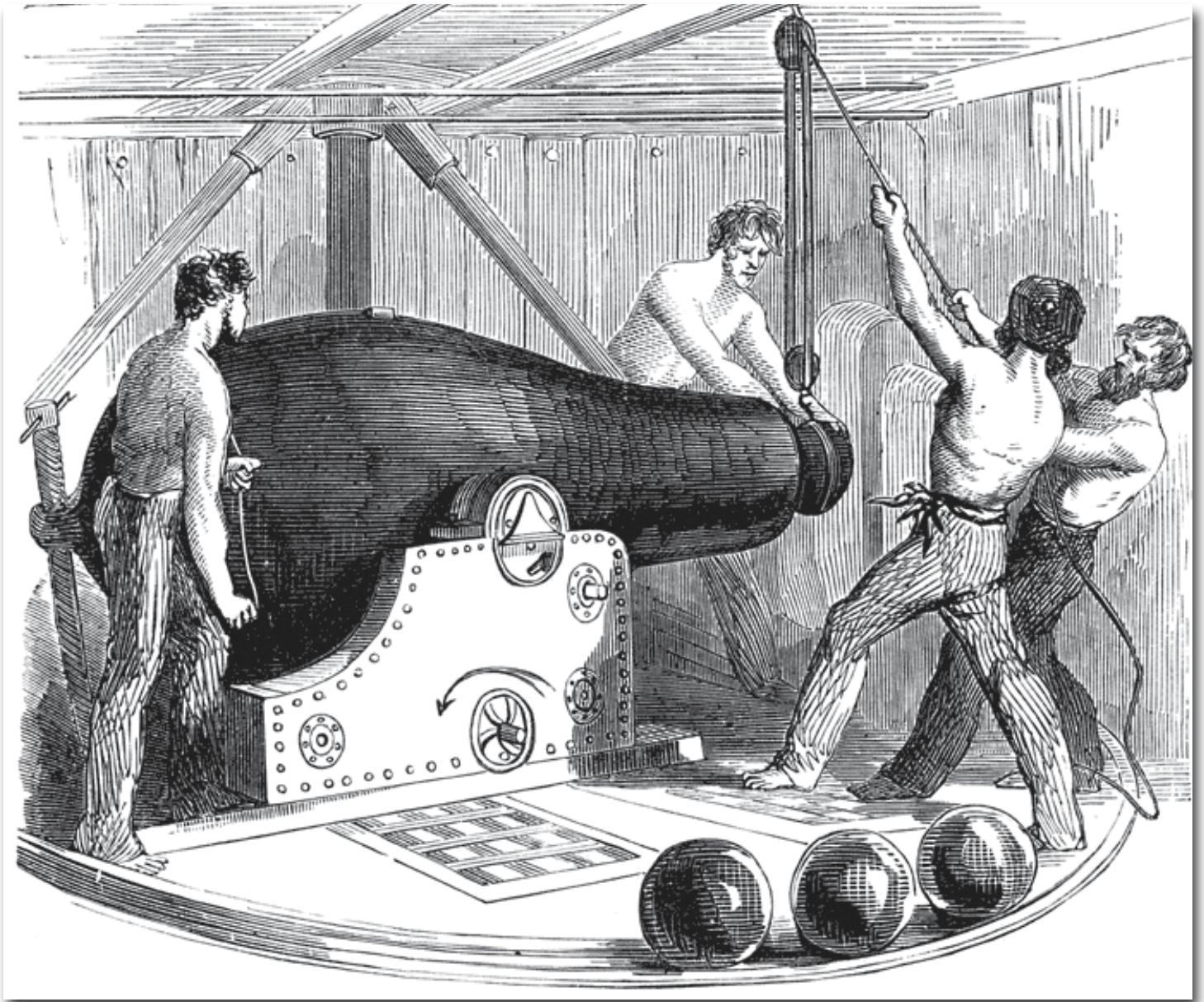
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The Daybook’s purpose is to educate and inform readers on historical topics and museum related events. It is written by staff and volunteers.

Direct questions or comments to the Hampton Roads Naval Museum editor. *The Daybook* can be reached at 757-322-2993, by fax at 757-445-1867, e-mail at gordon.b.calhoun@navy.mil or write *The Daybook*, Hampton Roads Naval Museum, One Waterside Drive, Suite 248, Norfolk, VA 23510-1607. The museum is on the World Wide Web at <http://www.hrn.m.navy.mil>.

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Part 1-Weapons

“A gunboat drawing six feet of water and well armed with good rifled guns can do more and better service than a forty-gun ship, or than such ships as the [steam frigate] *Niagara* and [steam sloop] *Richmond*.”
-Colonel Harvey Brown, 5th U.S. Artillery, 1861

“Iron clads are said to master the world, but torpedoes master the Ironclad.” -Brigadier General Gabriel Rains, C.S.A., 1863

Guns, Guns, Guns-Parrott, Dahlgren, & Brooke

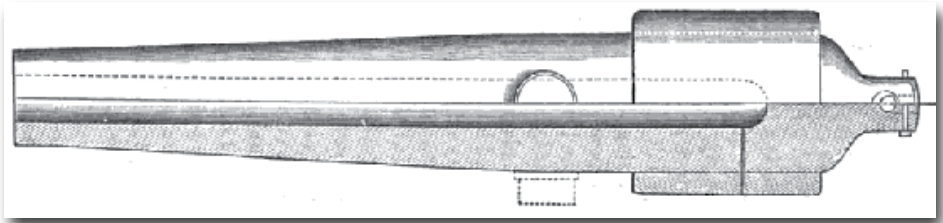
The Parrott Rifle

On October 4, 1861, the U.S. Patent Office awarded Robert Parker Parrott Patent Number 33,431 for his “new and useful Invention in the Manufacturing of Ordnance.” Specifically, Parrott had invented a method that allowed for the manufacturing of a “wrought iron” gun that translated into accurate, high-powered artillery. During the war, the inventor and West Point graduate offered his guns at wholesale prices to the U.S. Government. For the Navy, Parrott designed several calibers of rifles that fired anything between a 50 pound bullet to a 200 pound one. The rifling in the barrel coupled with the one-piece, reinforced iron band on the breech of the gun, allowed for a large shell with a large amount of power to be packed into the weapon.

The Navy praised Parrott’s design for its accuracy and range, and the weapon became the Navy’s first mass produced rifled ordnance. One model could accurately fire a 100 pound shell four miles. The 100- and 150-pounder designs were useful as pivot guns for the fleet’s larger ships engaged in artillery duels with Confederate forts. The Navy’s ordnance department shipped Parrott’s guns out to the fleet as fast as Parrott’s Cold Springs, New York, foundry could make them.

Once used in the field, however, flaws appeared in Parrott’s design. The first complaints came from U.S. Army artillery chiefs who noticed cracks in the barrels. Similar complaints from Naval commanders began to flow into Washington. The most famous early example of the problem occurred during the 1862 Battle of Fort Darling, when a 100-pounder rifle exploded just after two shots aboard the USRC *Naugatuck*. The breaches occurred on a large scale during the U.S. Navy’s mass bombardments of the Charleston forts in 1863 and Fort Fisher in 1864-65. During the Fort Fisher attack, Admiral David Dixon Porter ordered that Parrott Rifles not be used after several of them burst during the early stages of the bombardment.

Theories abounded on what caused Parrott’s guns to fail. One engineer suggested that if the gun was fired in the rain, the cold water from the rain would cause the iron in a hot gun to crack. Other engineers conducted a more scientific test in 1865. Testers concluded that if the rifle was not properly cleaned and lubricated, gunpowder residue would build up in the rifling. This was particularly true during operations such as Fort Fisher where sailors loaded and fired in rapid succession.



Ordnance inventor Captain Robert Parker Parrott. An 1824 graduate of West Point, he went into business for himself and made weapons for the U.S. Government. (West Point Museum image)

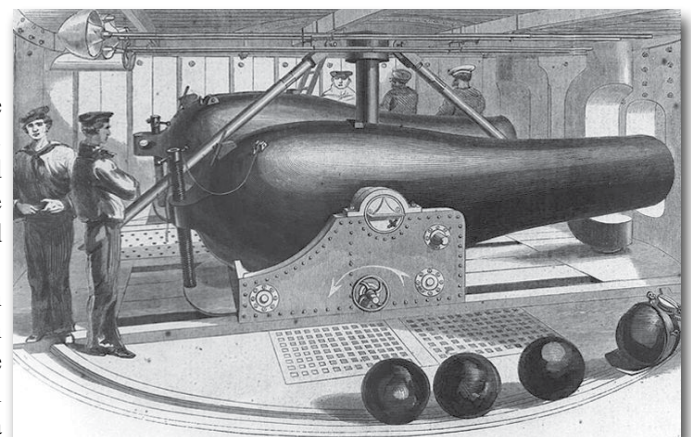
The Dahlgren Cannon

The most familiar piece of Civil War Naval ordnance was the Dahlgren smoothbore. Designed by John Dahlgren, the U.S. Navy adopted the “soda bottle” shaped guns in the 1850s, and deployed several hundred of them by the start of the war. Both navies liberally used the guns to arm their ships and forts.



The Navy’s leading ordnance expert, John Dahlgren. (HRNM image)

In his work *Arming the Fleet*, historian Spencer Tucker correctly called John Dahlgren “the most influential figure in the development of nineteenth-century naval ordnance.” Dahlgren not only designed a bigger gun, but developed an entire system with new pieces of equipment, such as new firing locks and new types of shells.



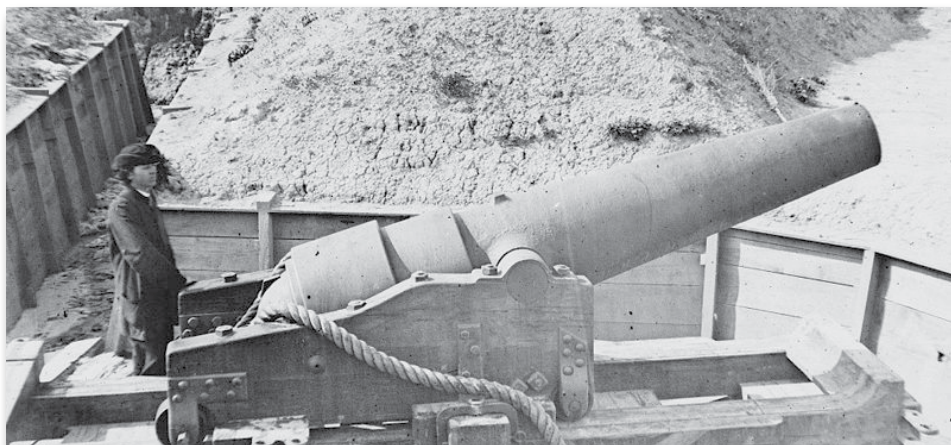
The Navy deployed the IX- and X-inch Dahlgren (the caliber of Dahlgrens, unlike every other piece of artillery, is always referred to in Roman numerals) in the 1850s and began upgrading the fleet to the XI-inch by 1861. USS *Monitor* went into action not only as a turreted, armored warship, but also as one of the first ships to be equipped with XI-inch guns. When asked by Congress how the U.S. Navy planned to defeat Confederate ironclads, Assistant Secretary of the Navy Gustavus Fox simply replied that it was only an issue of designing and building a big enough gun. Against Dahlgren’s wishes, Fox instructed him to design a bigger gun. The result was the monster XV-inch Dahlgren, a weapon so big that future ironclads had to be redesigned to handle it.

The Brooke Rifle

During the early days of the Civil War, the Confederate Army and Navy purchased much of their equipment from overseas firms or captured pieces from Union arsenals. The Confederacy simply lacked the North's financial backing and industrial capacity. Southern forces had to close this disparity through the use of creativity. Nowhere is this skill shown more readily than in the invention of the Brooke Rifle, completely made in the South.

The weapon's inventor, John Mercer Brooke, differed from other designers like Robert Parker Parrott, John Dahlgren, and the Englishmen Sir William Armstrong and Captain Alexander Blakely. Brooke had neither training nor experience in weapon design. He was noted internationally for oceanographic inventions and mapping skills. His bathometer, for example, accurately measured both the depths and contours of the ocean floor. Brooke possessed a rare ability to invent the exact item needed to solve a given problem. When he aligned himself with the South, its government immediately put him to work doing everything from answering mail to assisting in the design of the future ironclad CSS *Virginia*. Brooke quickly earned the status as being one of the most brilliant thinkers in the Confederacy.

While overseeing the manufacture of armor for *Virginia*, he realized that the ironclad needed more firepower. With assistance from Blakely and Confederate Secretary of the Navy Stephen Mallory's approval, Brooke designed a 7-inch rifled



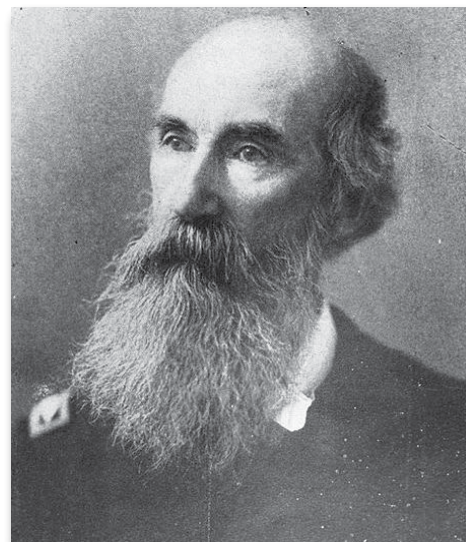
An 8-inch Brooke Rifle is shown here on the James River. The weapon was one of the few original pieces of Confederate military equipment that was both designed and built exclusively in the South. (NHHC image)

gun for the ironclad. He ordered sixteen of them to be manufactured. Upon first glance, Brooke's weapon appeared to have been a plagiarized copy of a Parrott or a Blakely rifle. But its superiority lay on the inside.

Brooke used a triangle rifling pattern on the inside of the barrel, giving the weapon a muzzle velocity higher than any of its competitors (See Carl Park's work *Ironclad Down* for a more detailed description). Additionally, Brooke correctly anticipated that his guns would be pointed at Federal ironclads and designed a special armor-piercing shot.

Richmond's Tredegar Ironworks forged the guns and had them out in the field by the end of 1861. Throughout the war, the guns did considerable damage to the U.S. Navy.

After the war, Brooke settled down to teach future officers at the Virginia Military Institute. As he borrowed much from Blakely's patents, he never sought one for his own guns. He did get one for the design



Among the most brilliant of American maritime inventors, John Mercer Brooke invented everything from a new way to rescue overboard sailors to new types of ordnance and warships. After the war, he taught engineering at the Virginia Military Institute. (NHHC image)

of CSS *Virginia* (C.S. Patent #100). He proudly displayed the patent at his V.M.I. office.

Eyes Only: The Biggest Military Secret of All

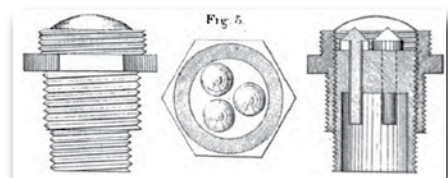
The most secret of all military inventions during the 19th century and the Civil War was not a new type of ship design, rifled cannon, spar torpedo, or armor-piercing shell. Rather, both Civil War navies kept the art and science of fuses a highly protected asset.

Fuses were considered to be the most high tech device of the day. Like many advanced electronic devices of the late 20th and 21st centuries, progress was measured by size. That is, new types of fuses ignited powder just like the old fuses, but in a more compact, reliable size. By the 1860s, a fuse was typically no bigger than

four fingers put together, but still required several chemical reactions to ignite a large amount of powder.

Before the war, U.S. Naval officers and sailors were under strict standing orders not to divulge the design of fuses used in the first generation of U.S. Navy shell guns. Technicians at the Washington Navy Yard assembled the fuses. Only when a ship was about to deploy did the laboratory in Washington deliver the fuses. During the Civil War, Confederate General Gabriel Rains closely guarded the manufacturing of his fuses at a laboratory in Richmond.

Nonetheless, famed English ordnance



Confederate general Gabriel Rains' fulminated mercury fuze for underwater mines. (Sketch from *Torpedoes and Torpedo Warfare*)

engineer Joseph Wentworth admitted to a public audience in 1861 that keeping fuses a secret was impossible, as they were easy to steal from the factory floor. The trick, he said, was to keep the machines and techniques used in making fuses a secret. Those items were much harder to replicate without drawings and instructions.

Damn Torpedoes-Confederate Torpedoes Even the Playing Field

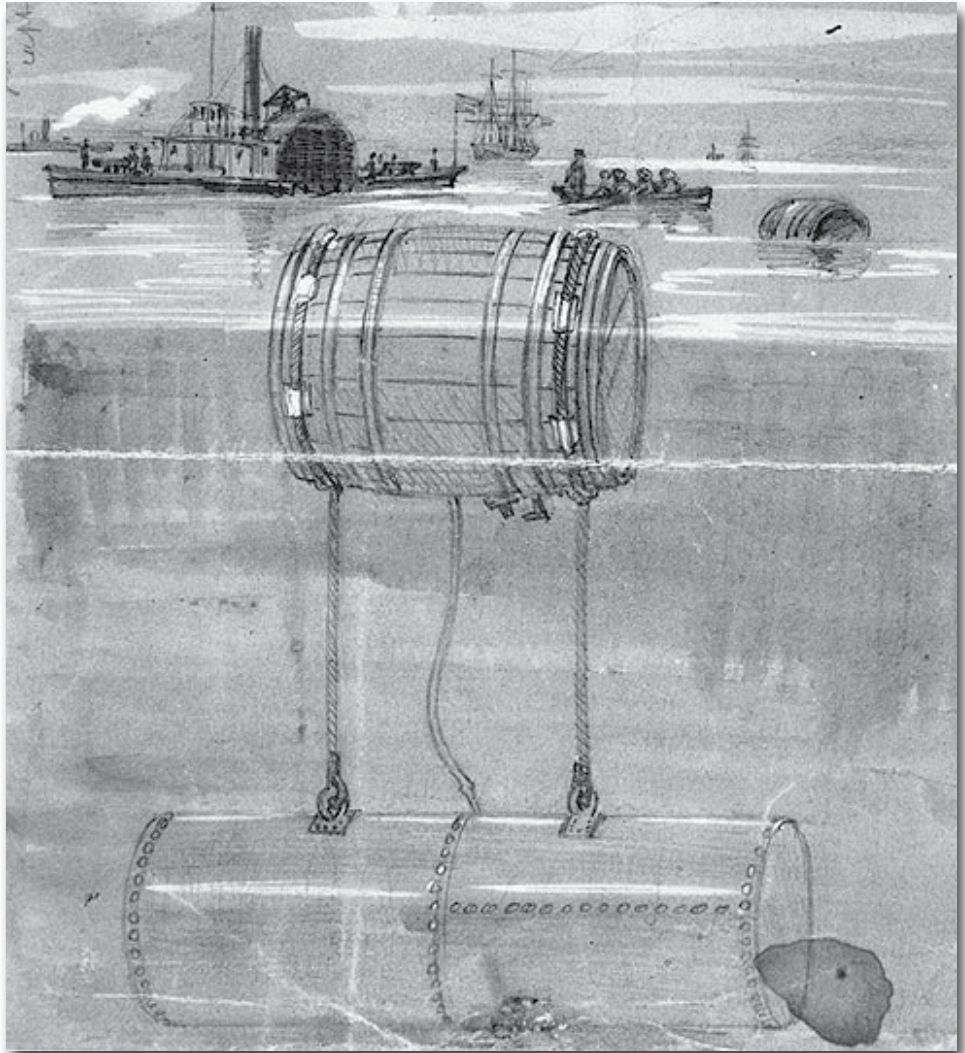
Through the history by Foxhall Parker, Admiral David Farragut has forever fixed the word “torpedo” into the lexicon of every American with his phrase “Damn the torpedoes, full speed ahead/ahead eight bells!” Torpedoes are now one of the most familiar weapon to the American public, Farragut was referring to a different type of weapon.

The admiral’s torpedo was what is now called an undersea mine. The weapon has a popular device among the world’s militaries, particularly ones with small navies. Passive in nature and cheap to build, a single mine/torpedo could sink the largest of ships. During the Civil War, no Confederate gun or ship did more damage to the U.S. Navy than underwater torpedoes. Before the war was over, Confederate torpedoes sank twenty-nine U.S.N. ships, including seven ironclads (*Cairo*, *Tecumseh*, *Patapsco*, *Baron De Klab*, *Osage*, *Eastport*, and *Milwaukee*), with several more damaged.

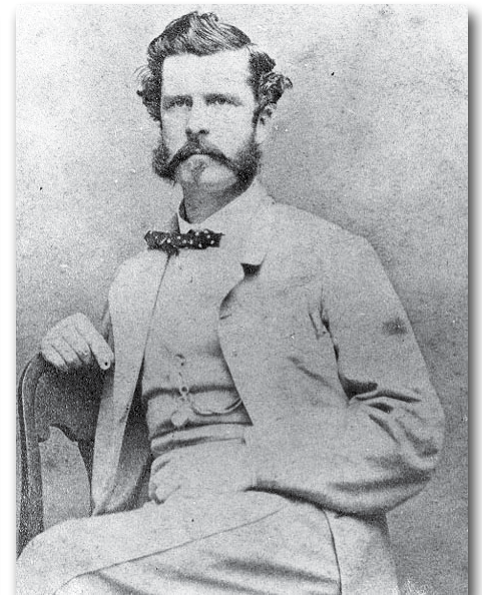
From the start of the war, Confederate operatives used these torpedoes as weapons. Early attempts included pushing barrels full of gunpowder down waterways like the James River. Additionally, several different Confederate inventors designed their own torpedoes.

Confederate Secretary of the Navy Stephen Mallory formalized torpedo inventions with the Naval Submarine Battery Service under the direction of world famous scientist Matthew Fontaine Maury, and later Hunter Davidson. At the same time, the Confederate States Army created the Torpedo Bureau under the direction of mine expert Brigadier General Gabriel Rains. The Torpedo Bureau nominally developed land mines, but the practice of such weapons was considered barbaric by both sides, and it was stopped. Many in the Confederate government even considered even underwater torpedoes to be unethical. Nonetheless, the C.S.N. and C.S.A. leadership went forward with mining the South’s harbor and rivers as both services recognized the U.S. Navy’s vast superiority in numbers.

The Confederates developed and deployed three basic types of torpedoes: frame, floating, and electric. The frame torpedo was a system consisting of a wooden frame with four casings, each with twenty-seven pounds of powder, sunk



An early torpedo/mine in the Potomac River. The early torpedoes were simply explosives packed inside a wooden barrel. Men in small boats, the most effective counter-measure to such weapons, search the river for them. (NHHC image)



Matthew Fontaine Maury and later Hunter Davidson led the Confederate’s “Submarine Battery Service.” The two men developed and often personally deployed undersea mines during the war. (NHHC images)

underwater. The Confederate military units in Charleston deployed several of these torpedoes in Charleston Harbor. One part of the harbor had frame torpedoes deployed four rows deep and twelve across. Given that the U.S. Navy never got past the forts, the frame torpedo was never tested.

The second, and most widely used type, was the floating mine. This torpedo was a wooden barrel packed with seventy to one hundred twenty pounds of gunpowder. Technicians typically anchored the explosive to the floor of the river or harbor with another barrel. Like the frame torpedo, a passing ship had to make contact with the torpedo in order for it to explode.

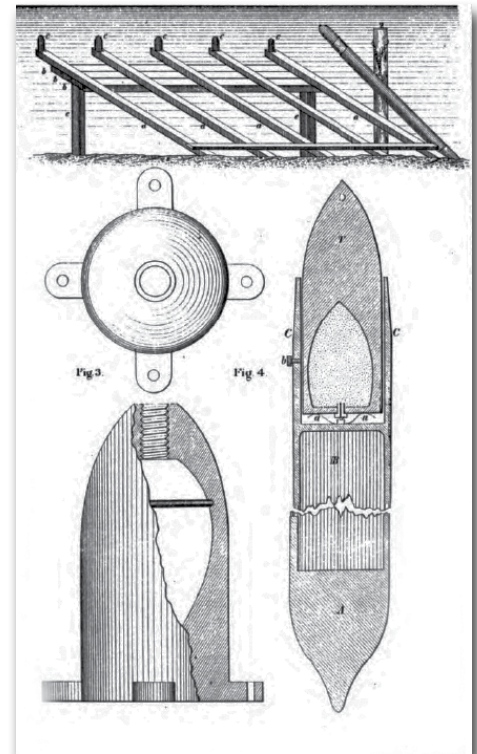
The third type was the most advanced: the electric torpedo. A shore operator detonated the explosive with an explosive charge. Operators had the option of being able to set it off at a time of their choosing for maximum effect. The early electric torpedoes packed several hundred pounds of gunpowder inside an old boiler tube and used first generation electric batteries as the charge. As the war progressed, Confederate operators received the English-made "Weatstone Magnetic Exploder." This device produced an electric charge that ignited with the smallest amount of powder, making it more reliable.

Placing explosives underwater was not a new idea, but it rarely worked properly. Even as late as the 1850s, fuses

were a complicated series of chemical reactions that all had to work in order for the explosive to detonate. Maury began to work on the problem early on during the war, using his home washtub as his laboratory. It was Rains' invention, however, that eventually solved the problem. The Confederate general designed and oversaw the assembly of fuses that were only 2 1/4-inches long and had a primer simply made up of fulminated mercury (found in any rifled musket primer) and ground glass.

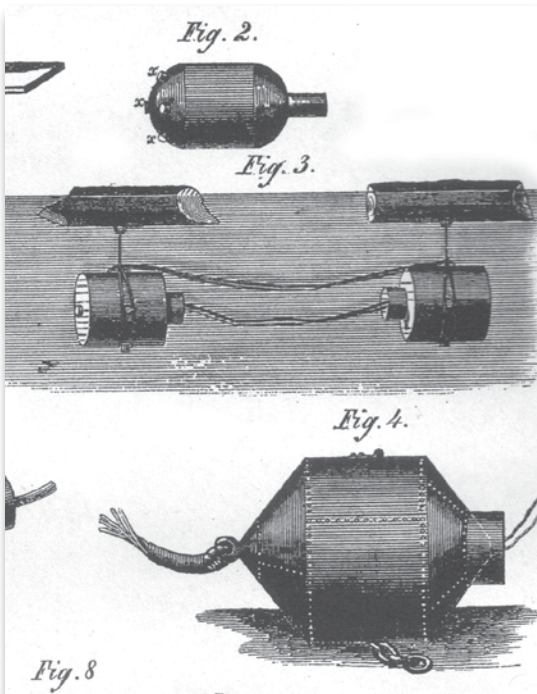
The men who deployed and operated these weapons were members of the Confederate secret service. On paper, they were attached to the Confederate Army so they would be treated as prisoners-of-war and not murderers should they be captured. However, they were sworn to secrecy and were not to tell anyone what they really did for a living.

Beginning in late 1861, these operatives deployed torpedoes in almost every river and harbor in the South. For the electric torpedoes, teams of operatives would stand watch on shore for a U.S. Navy ship to appear and then fire the weapon. Sometimes they had spectacular and well-publicized attacks, such as the sinking of USS *Cairo* on the Yazoo River, and the destruction of the gunboat USS *Commodore Jones* on the James River. Other times, luck was on the side of the U.S. Navy, such as when USS *New Ironsides* unknowingly anchored on top of a huge torpedo during an 1863 bombardment of Fort Sumter for more than an hour. Operatives attempted several times to ignite the bomb, but faulty wiring prevented them from succeeding.



A frame torpedo-This system used a wooden frame with small explosives anchored in shallow water. When a ship made contact with one explosive, the other explosives would ignite. (Sketch from Submarine Warfare)

In the end, the weapon had a terrible effect on the mental psyche of U.S. Naval officers. On more than one occasion, ships under a full head of steam, preparing to attack, veered off course because someone thought he saw a torpedo in the water. Torpedoes were by far the most effective tool the Confederacy used against the vast number U.S. Navy ships. Torpedoes were cheap, effective, and gave Federal sailors more pause than any ironclad ever did.



Shown here are the many different types of floating (fig 2 and 3) and electric torpedoes (figure 4) discovered by U.S. Navy sailors in the James River, 1864. (Scientific American image)



In the clash between emerging technologies, the monitor USS Tecumseh struck a torpedo and sank quickly during the opening stages of the Battle of Mobile Bay. It was this episode that led Farragut to utter "Damn the torpedoes!" (HRNM image)

The Wood / Lay Torpedo System

The fear of mines led to at least some research and development on the U.S. Navy side to develop counter-measures. The Navy asked USS *Monitor* designer/prolific inventor John Ericsson to develop a device to stop the torpedo threat. His design was a system of wooden poles placed in front of a monitor-type ironclad that would float on and below the water. The “raft” would then catch or prematurely set off a torpedo.

In what would be a disturbing trend for many years to come, mine counter measures were never taken seriously. Far more resources went into designing and improving ironclads than looking into better ways to detect and clear Confederate mines. The best counter-measure for the entire war was watchful eyes. This often involved sailors in small boats detached from the main ship with decidedly low tech harpoons or other long sticks.

After the destruction of *Commodore Jones*, U.S. Navy sailors patrolled the shores and captured several Confederate operatives. Fearing they would be

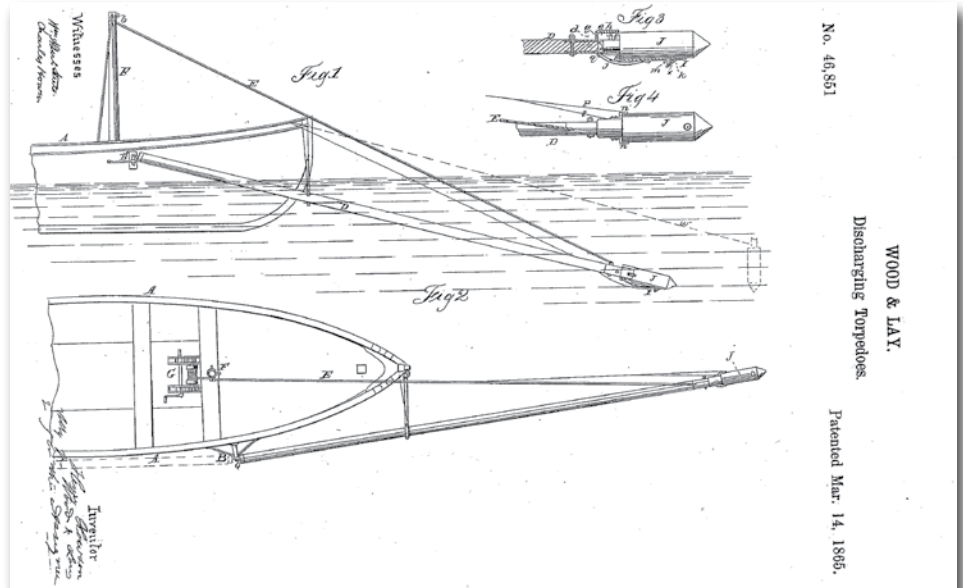


Ericsson's invention to counter Confederate torpedoes was a wooden raft that would set off the torpedo prematurely. It is shown here on USS Weehawken (Harpers Weekly engraving)

executed, the operatives disclosed the location of several of the torpedoes.

While the Confederate Torpedo Bureau and Submarine Battery Services came up with new ways to terrorize Federal ship captains, the U.S. Navy also began work on a torpedo delivery system. A lack of targets stifled innovation as torpedoes during the Civil War tended to be defensive weapons. Nonetheless, Confederate success with both offensive and defensive torpedoes made Union thinkers want to respond in kind.

Being on the attack most of the time, the U.S. Navy needed an offensive torpedo system similar to the spar torpedo used by Confederate vessels. This resulted in the futuristic-looking crafts *Alligator* and *Intelligent Whale*. The most successful project to come out of this movement was the Wood/Lay system. John Lay first



The U.S. Patent Office awarded Patent Number 46,851 (one of four awards) to U.S.N. engineers William W. Wood and John L. Lay for their “Improved Picket Boat and Method Discharging Torpedoes.” While the system of using the explosive was complicated, the device was versatile enough to deploy on ship. (U.S. Patent Office)

developed the concept of an offensive torpedo while serving on the blockade as an assistant engineer. Chief Engineer William Wood helped Lay develop the weapon, and the two men shared credit. Like many engineers, the two men demanded perfection to the most minute detail. What should have been a simple device turned

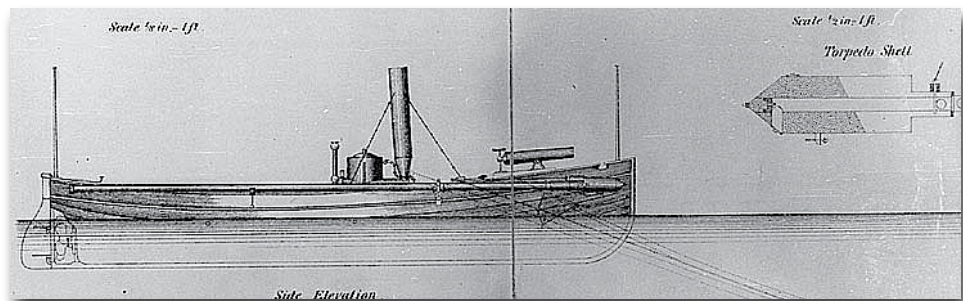
and Wood's system placed a small amount of air in the war head. This allowed the submerged explosive to float up and underneath the target.

While complex, it was versatile enough to deploy on almost any vessel. Using the Wood/Lay system, workers outfitted ten small steam picket boats with the explosive bomb at the front. The system found spectacular success in North Carolina waters. In October 1864, using *Screw Picket Boat Number One*, Lieutenant William Cushing and company carried out a successful attack against the ironclad *CSS Albemarle*.

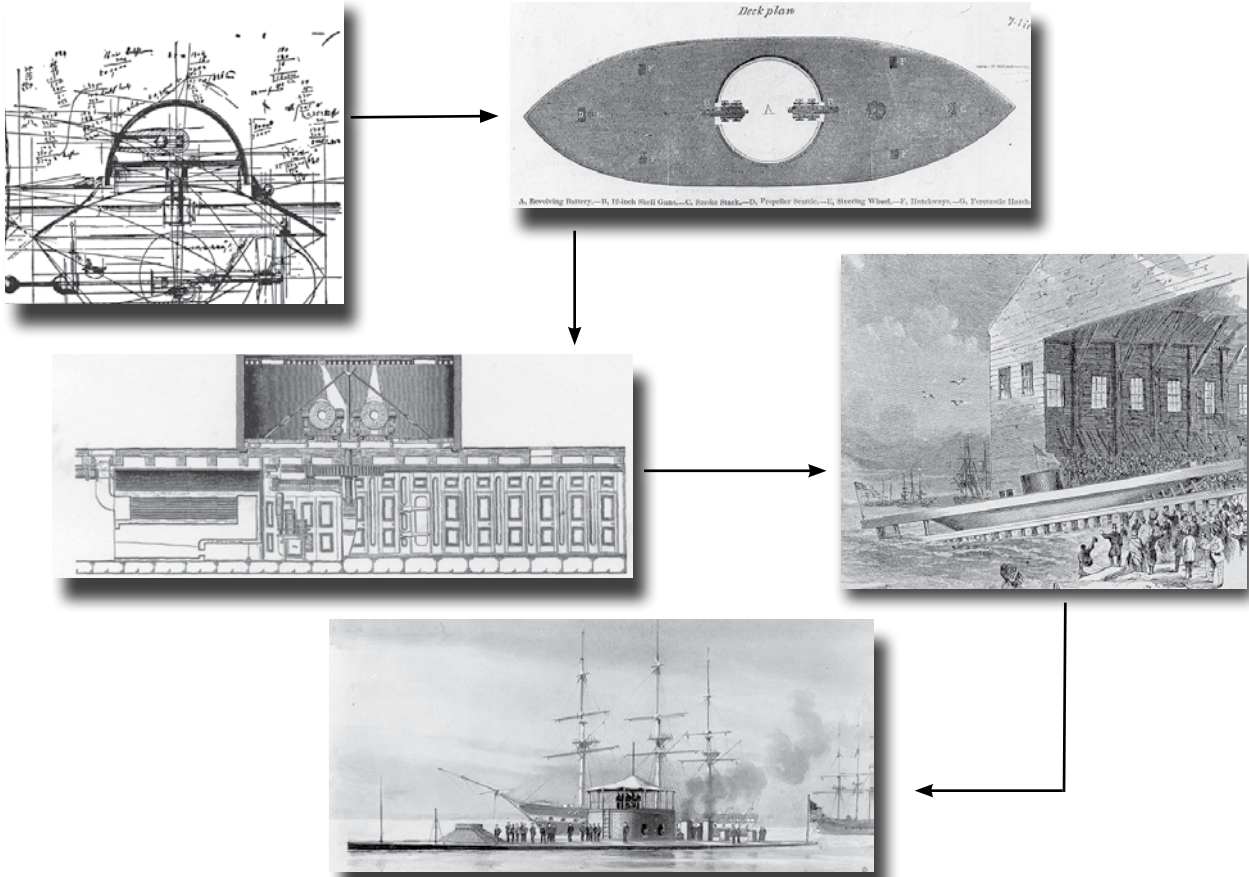
A similar plan was almost carried out by the company of USS *Monticello* against the ironclad *CSS Stonewall* toward the end of the war. Likewise, the monitor USS *Manhattan* had one affixed to her before the Battle of Mobile Bay. Wood and Lay attempted to improve on the system by designing the torpedo craft USS *Spyten Duvil*. Lay spent much of his life after the war trying to develop a self-propelled torpedo.

into a complex machine. The U.S. Patent Office would later award the two men with four patents for the device.

The weapon packed anywhere between forty to one hundred pounds of grape shot in a cast iron tub and required one person to pull hard on a rope attached to the warhead to arm the weapon. Lay



In contrast to the more complex torpedo boats developed by Confederate engineers, the U.S. Navy's most successful torpedo boat was a small river steamer. Equipped with the Wood/Lay torpedo system, Lieutenant William Cushing sank the ironclad *CSS Albemarle*. (NHHC image)



The Evolution of USS *Monitor*

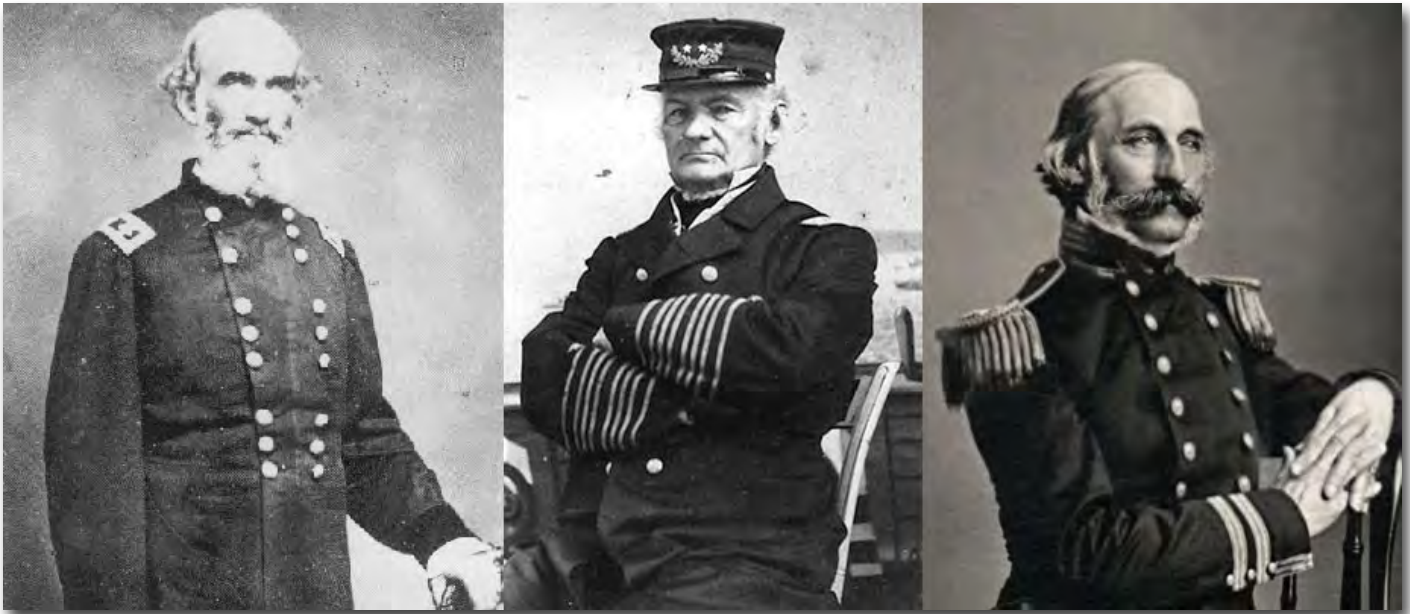
Part 2

Design & Construction

“**T**he man who goes into action in a wooden vessel is a fool, and the man who sends him there is a villain.”-Admiral Sir John Hay, 1861

“**W**ooden ships may be said to be but coffins for their crew, but the speed of the former, we take for granted, being greater than that of the latter. They can readily choose their position out of harm’s way entirely.” - Ironclad Board, 1861

“**L**et not your heart be troubled: ye believe in God, believe also in the gunboats.” -Niece of Rear Admiral Andrew Foote, 1862



The U.S. Navy's "Ironclad Board"—Commodore Joseph Smith, Commodore Hiram Paulding, and Commander Charles Davis. (NHHC images)

The Wit and Wisdom of the Ironclad Board

In August 1861, Secretary of the Navy Gideon Welles tasked three veteran Naval officers, Commodore Joseph Smith, Commodore Hiram Paulding, and Commander Charles H. Davis, to lead the Navy into the uncharted waters of ironclad ship design. On paper, these three men would not seem qualified to determine what technology Welles should purchase. All three were line officers by training with little to no experience with naval engineering or construction. Two of them, Smith and Paulding, had actually served in the War of 1812! Yet the three men of the Ironclad Board were remarkably adept at picking the right technology.

The Board recommended three ships—John Ericsson's *Monitor*, Merrick & Sons' *New Ironsides*, and C. S. Bushnell's *Galena*. The Board was not entirely pleased with any of the designs submitted. They considered Ericsson's and Bushnell's concepts unseaworthy and Merrick's design too complex for American ironworks to build. The Board deferred judgment on a design from prolific inventor Edward Renwick.

As for the other concepts, the Board placed them in the "not recommended" category and threw them away. This group included two monster ships that each displaced about 15,000 tons, were about 325 feet in length, and drew 25 feet of water; one that was far too small, as it only displaced 90-tons; one that was outright

fraud as the proposed cost seemed too low and the plans were amateurish; two that had defective armor schemes; and one where the engineer proposed building a "rubberclad" with rubber armor instead of iron.

In addition to their ship design recommendations, the Ironclad Board gave some unsolicited advice about how the U.S. Navy should approach technology and naval warfare for the next few years:

Smoothbore vs. Rifled Guns

"As yet we know, superior to the large and heavy spherical shot is its destructive effects on vessels, whether plated or not. Rifled guns have greater range, but the conical shot do not produce the crushing effect of spherical shot."

On Armor Schemes

"It is possible a backing of some elastic substance (soft wood, perhaps is the best) might relieve the frame of the ship somewhat from the terrible shock of a heavy projective, though the plate should not be fractured."

Brown Water Navy First

"Our immediate demands seem to require, first, so far as practicable, vessels invulnerable to shot, of light draught of water to penetrate our shoals, rivers, and bayous. We therefore favor the construction of this class vessels before going into a more perfect system of large iron-clad sea-going vessels of war."

Ironclads vs. Forts


"No ship or floating battery, however heavily she may be plated, can cope successfully with a properly constructed fortification of masonry. The one is fixed and immovable and though constructed of material which be shattered by shot, can be covered if need be, by the same or much heavier armor than floating vessels can bear. The other is subject to disturbances by winds and waves, and to the powerful effects of tides and currents. Armored ships or other batteries may be employed advantageously to pass fortifications on land for ulterior objects of attack."

Foreign Warship Purchases

"We are of the opinion that every people or nation who can maintain a navy should be capable of constructing it themselves."

Don't Forget About Wooden Ships

"Wooden ships may be said to be but coffins for their crews when brought in conflict with iron-clad vessels; but the speed of the former, we take for granted, being greater than that of the latter, they can readily choose their position and keep out of harm's way."

Civil War historians have criticized the older generation of naval officers for being out of touch. However, as many of these opinions came true, the three old warhorses apparently understood naval warfare better than anyone else. 



This is a fictional portrayal of a squadron of U.S. Navy ironclads. Unsure of which technology would be the best choice, the U.S. Navy initially chose several different designs. Eventually, however, leadership went with the design of USS *Monitor* and demanded many more ships just like her. (Harper's Weekly engraving)

Building Ironclads

The ironclads are the most recognizable piece of technology to be produced during the American Civil War. They were a radical departure in design and material from several hundred years of ship design, which made them stand out in both photos and literature. Using iron as building material for warships was not a new idea. But like many ideas in history, an incentive was necessary to make the idea a reality.

The Civil War provided justification for the construction of armored warships. Stephen Mallory committed early to a program of ironclad rams as an equalizer against the numerically superior U.S. Navy. After studying the problem, his northern counterpart committed to a more complex program of ironclads, incorporating several new pieces of technology, not just the use of iron.

The U.S. Navy ironclad project produced two very different programs to procure ships. The first program sought to design and build ironclads to secure the blockade in the South's coastal waters. Under this program came the famed USS *Monitor* and her many sister ships, the indestructible USS *New Ironsides*, the ill-fated USS *Galena*, and several oddities such as USS *Keouk* and USRC *Naugatuck*.

This program began with a certain amount of humility. In his memoirs of service, Ironclad Board member Commodore Hiram Paulding remarked, "I justly appreciated the trust imposed upon me. Congress appropriated a million and a half dollars for the building of ironclad vessels and, as no ironclad had ever been built in this country and it was necessarily in a great measure experimental, it occasioned much embarrassment."

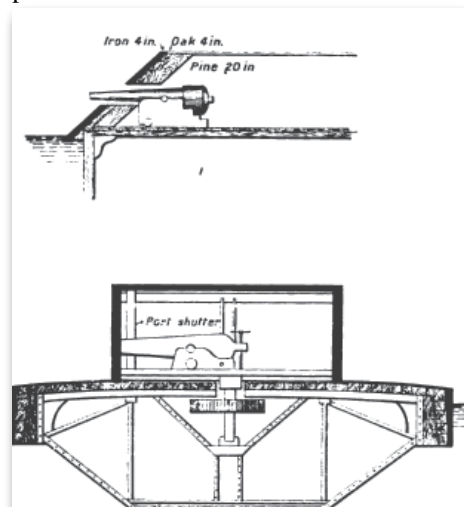
Paulding was being asked to predict the future of warfare and commit the Navy to millions of dollars of contracts and possibly determine the fate of the Union. Paulding's dilemma is one faced by many military and business leaders when presented with new, ground-breaking technology. Is this technology the right choice, and how much does one commit to it?

Thus, the Ironclad Board, despite the secession crisis at hand, decided to take a slow approach to ironclad design. Paulding later recalled that he thought *Monitor* with her turret was the best choice because of her simple design, and therefore it would be easy to mass produce. His fellow board member Commodore Joseph Smith disagreed and chose the broadside design *New Ironsides* because she carried more firepower. The two men compromised and decided to build one of each.

The epic battle between CSS *Virginia* and USS *Monitor* on March 9, 1862, settled the dispute for many decision makers. In an emotionally-driven decision, the U.S. Navy needed-and the Northern public wanted-more USS *Monitors*. Likewise in the South, CSS *Virginia*'s casemate design produced by the team of John Brooke, John Porter, and engineer William P. Williamson was copied many times over in the Confederacy.

Monitor may have seemed like a simple design. However, one contemporary observer noted that John Ericsson probably would be awarded no fewer than twenty-seven patents for the ship. There may not have been that many patents, but the monitors were complicated machines where only a few moving parts could be allowed to break.

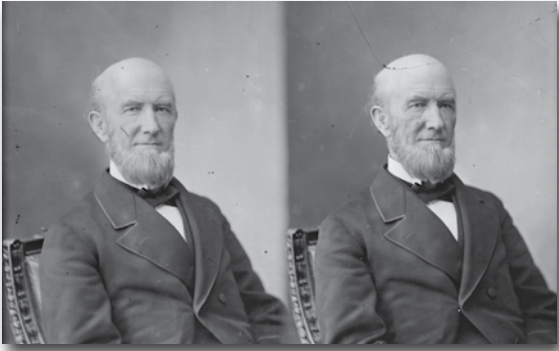
Under the control of Rear Admiral Alan Stimers, the inspector general of the monitor program, several monitors were divided into different classes and pushed onto a three-year construction pipeline. Stimers, a Naval engineer by training, had become popular for successfully getting *Monitor* built, out to sea, and into battle. Now the Navy expected more from him. The goal was to have as many as fifty-five monitors out on the battleline as soon as possible.



Shown here are the armor schemes of CSS *Virginia* and USS *Monitor*. In the short term, the two ships' designs laid the foundation for the type of ironclad each navy would build to protect or capture Southern harbors for the next four years. (Sketch from *Ironclads in Action*)

But the program ran afoul. After a series of failures by the Union ironclads against the forts of Charleston (which Stimers blamed solely on Rear Admiral Samuel Du Pont), officers reported flaws in the ironclad's design. Additionally, the Navy wanted a new type of monitor for river use.

In his work *Civil War Ironclads*,



St. Louis' James Eads had the ability to design and build complex projects including Mississippi River bridges or warships. Parts for his ironclads came from eight different states and were all shipped into yards around St. Louis. Within one hundred days, Eads had seven ironclads finished. (Library of Congress image and Harper's Weekly engraving)

historian William Roberts noted Stimers had two choices: modify the ships while building them or finish the ships, send them into battle, and then fix them. Staking his professional reputation on the project, Stimers wanted the monitors perfect before launching. Additionally, Roberts noted that since private shipyards built all the monitors, they demanded more resources quickly when changes were needed. The result was that far fewer monitors reached the blockading squadrons than anticipated. Since monitors were under-gunned (equipped with only two to four guns), many had to be built in order for the design to be effective in battle.

Stimers' reputation was ruined after the U.S. Navy discovered that one particular class of monitors had been built to the wrong specifications. Despite all

Western Gunboat Flotilla. The origins of the "City"-class river ironclads (in quotes because there was no USS *City*) had a very different path than the ironclads that served with the blockading squadrons. James Eads was a civil engineer by training, based out of St. Louis. Most of his projects related to that part of the country, including bridge construction or boat design.

Like Ericsson and Stimers, Eads was a brilliant engineer with several patents to his credit. However, Eads also had the ability to manage the projects he designed. While Ericsson had to rely on others to manage the construction of the monitors, Eads did it all. This became particularly important because St. Louis did not have the industrial capabilities of New York. Eads first turned to Samuel Pook to draw up the specific ship plans. Pook came up with

a relatively straightforward design of sloping sides and a flat bottom that could carry fourteen guns. After some bureaucratic wrangling, the Federal Government formally awarded Eads the construction rights to build "Pook's Turtles."

Eads then placed orders for thirty-five boilers and twenty-one steam engines from

factories in Cincinnati and Pittsburgh. Wood came from eight different states and iron plating from foundries small and large in four different states. All the material was then shipped to St. Louis. One report estimated that Eads personally coordinated a workforce of 4,000 men in eight different states.


The project was a remarkable success. In just over one hundred days, the Western Gunboat Flotilla had seven powerful

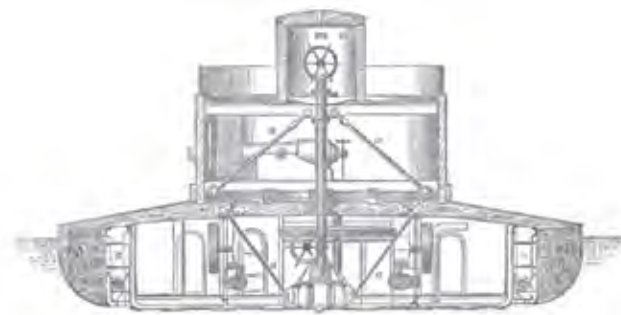
ironclads. All would see heavy combat and five survived until the end of the war. Even after this project was finished, Eads won the right to build several more ironclads. However, unlike the monitor program managers, Eads listened to comments from the ironclads' captains. Additionally, Eads never strayed far from Pook's original design.

For his part, Ericsson did not think much of his Mississippi River counterpart. Ericsson wrote, "Nothing could induce me to read anything that is said to emanate from the pen of J. B. Eads. I was brought



Alan Stimers, manager and perfectionist of the U.S. Navy monitor construction program (NHHC image)

in close contact with that 'eminent mechanical engineer' during the war, and I found him to be a huge sham sustained by hired brains." If Eads' contemporaries in the North refused to acknowledge him, Confederate Naval historian John Thomas Scharf, however, gave him the greatest praise after the war. Scharf wrote, "This was a powerful squadron, aggregating a tonnage of 5,000, heavily armored, fully equipped, and mounting one hundred large guns, without which all the armies of the great West would not have been able to have regained and held the navigation of the Mississippi River." 



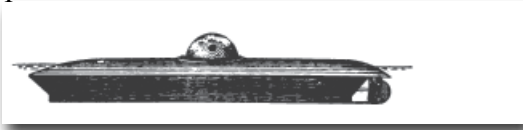
Always interested in what their American counterparts were up to, Great Britain's Royal Society of Engineers produced this drawing of the "light draught" monitor USS Chickasaw and all of the ship's many moving parts. (Sketch from the Proceedings of the Royal Society of Engineers)

of Stimers' diligence, this class of ships sat too low in the water. No one caught the mistake until after the project went into mass production. As a result, the ships were useless and Stimers was fired. The Navy never deployed more than six monitors during any given action.

In stark contrast to the construction and repair management of the monitors was the construction of the ironclads for the

Ironclad Designs

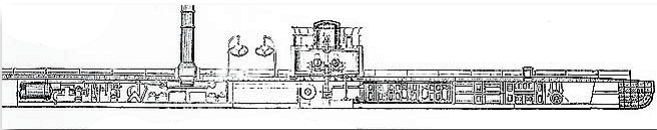
Iron was the new frontier for warships. How to best apply it was up for debate. Here are a few of the designs that were put forward.



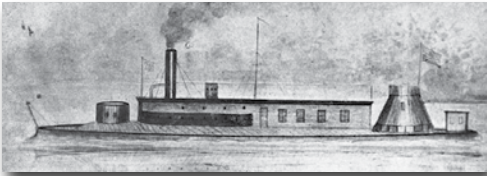
-Monitor as conceived, 1854



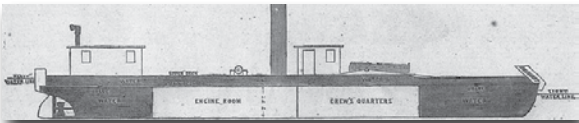
-Monitor as built, 1862



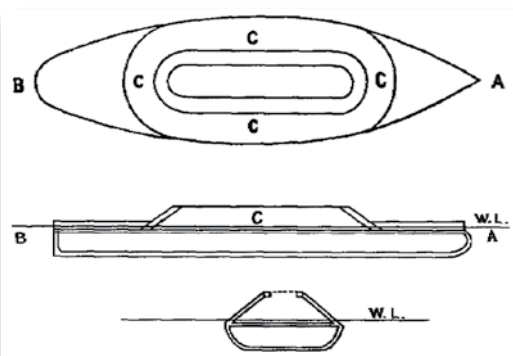
-USS Nausett, 1865



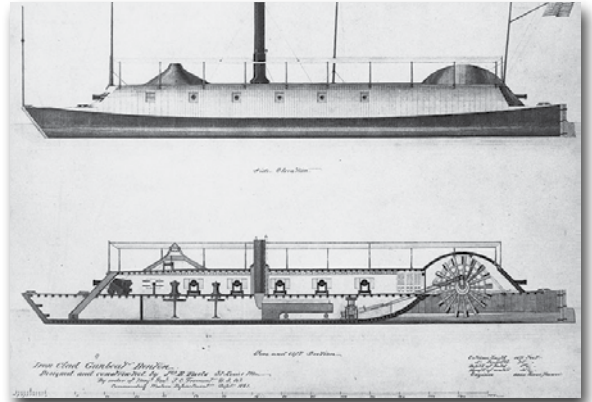
-USS Osage, 1864



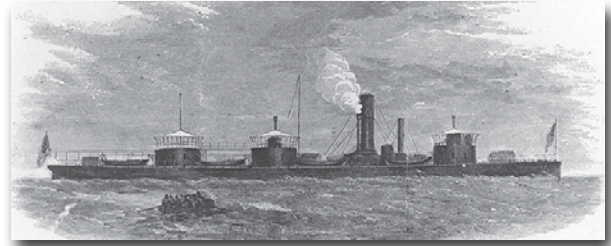
-USRC Naugatuck, 1862



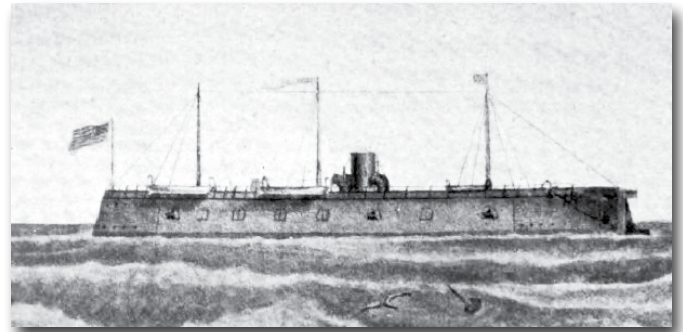
-Confederate States Patent Number C.S. 100- "Ship of War"- Issued to John Mercer Brooke



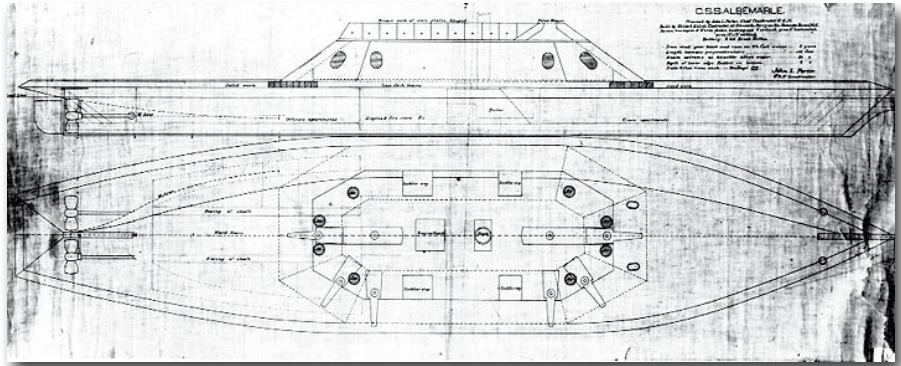
-USS Benton, 1862



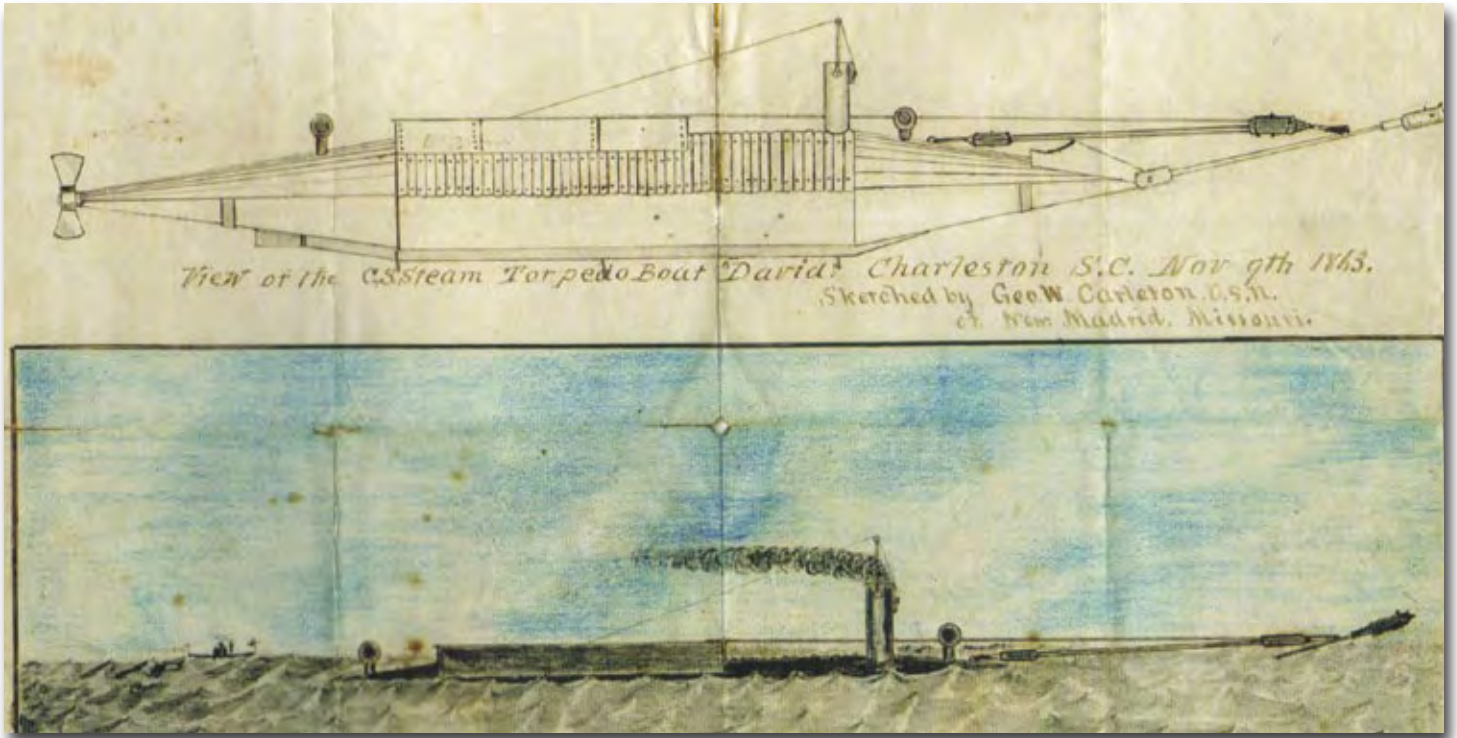
-USS Roanoke, 1863



-USS New Ironsides, 1862



-CSS Albemarle, 1864



The torpedo boat David was among the first self-propelled torpedo boats built. She pioneered the use of small warships armed with explosives to sink larger vessels. (Museum of the Confederacy image)

Confederate Torpedo Boats and the Civil War “X” Prize

Often inventors need a financial incentive to improve creativity. From the 1700s to the modern day, wealthy patrons and non-profit groups such as the X Foundation often offered a cash prize to anyone who achieved certain goals, such as the first solo flight across the Atlantic or cheap manned space flight. In 1862, Charleston, South Carolina cotton exporter George Alfred Trenholm did something similar. Among the richest men in the Confederacy, Trenholm offered \$100,000 (\$3,000,000 in 2012 money) to anyone who destroyed Yankee ironclad USS *New Ironsides* or the steam frigate USS *Wabash*. He would pay \$50,000 if someone destroyed a monitor-type ironclad. Some might consider this more of a bounty than an incentivized competition. To Confederate inventors and engineers, it may have been a little bit of both.

Charleston engineer David Ebaugh later recalled that when he first heard about the prize, he was already thinking about ways to sink *New Ironsides* because of the amount of damage the ship had caused his hometown. The prize money, he recalled, moved him to act. A fellow industrialist provided him \$1,000 in start-up money and Ebaugh got to work.

Using only off-the-shelf technology, Ebaugh designed a steam-powered vessel

that ran low in the water and used an explosive charge on the end of a long pole known as a spar torpedo. He acquired a boiler located at Fort Sumter, engines from a nearby railroad shop, and several thousand pounds of scrap iron left over from ironclad construction to use as ballast. Using a shop at the government-owned nitrate factory that he managed, his workers assembled a self-propelled torpedo boat.

In a bold way of putting his own signature on the invention, he christened the ship after himself: *David*. Historians, and even Ebaugh’s own wife, would later dispute the source of the name claiming the vessel was named after the Biblical King David (i.e. *David* vs. *Goliath/New Ironsides*). On this matter, however, Ebaugh was insistent. In an 1892 letter to an amateur historian researching the project, Ebaugh wrote, “P.S. *David* was named after me.”

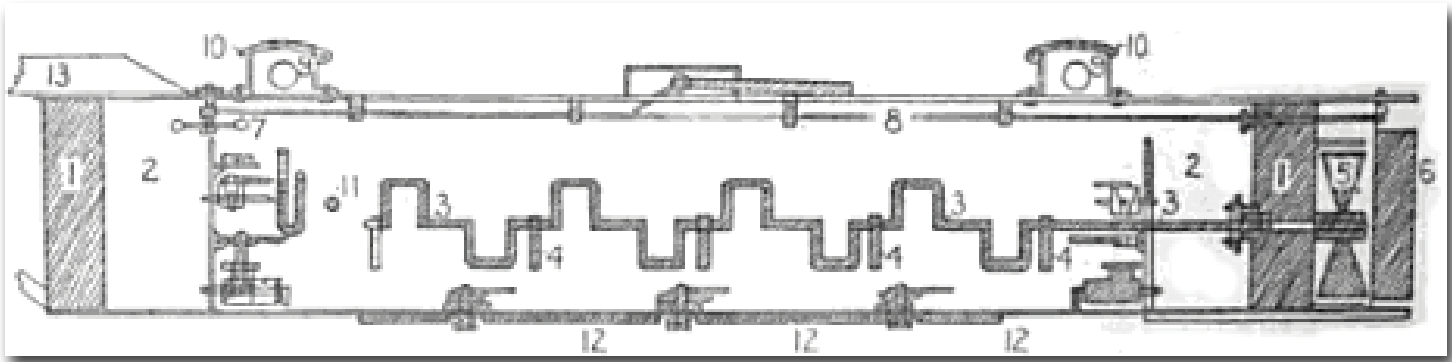
Ebaugh handed the ship over to Confederate Naval officers. Under the command of Lieutenant William Glassell, *David* charged *New Ironsides* on the night of October 5, 1863, and plunged her weapon into the ironclad’s side. The resulting explosion damaged, but did not sink, the ironclad. At the very least, *New Ironsides* was forced to retire for repairs. Ebaugh later blamed last minute changes

to *David*’s design by the Confederate Navy, which caused her to fail the mission. Ebaugh believed that his original design would have placed the torpedo lower in the water.

David conducted two more attacks during the war. The vessel went after the steamer USS *Memphis* first and then *Wabash*. In one case, the torpedo failed to ignite and in the other, the ship moved out of the way.



South Carolina native David Ebaugh managed lumber and nitrate factories before being spurred into entering the warship business. He named his invention after himself: *David*. (NHHC image)



Engineer William A. Alexander's cut-away drawing of the "fish torpedo boat"/submersible Hunley (above) and a cross section of the vessel (right). Alexander was a member of Hunley's design team and was supposed to be on board when the vessel attacked Housatonic. At the last minute, he was replaced. (Drawings from Munsey's Magazine)

Confederate shipbuilders built several more similar vessels, which were all called *dauids*, in the same respect that turreted armored vessels became known as monitors. While Ebaugh never received his prize money, his design is considered to be among the first prototypes of modern submarines and torpedo boat designs. In that respect, he received a far greater prize.

About the same time Ebaugh designed *David*, industrialist Horace Hunley and engineers James McClintock and Baxter Watson were hard at work in Mobile, Alabama. Like Ebaugh, the three men had also heard about the bounty/incentive. It is not clear whether or not they were directly influenced by it. General P.G.T. Beauregard, commander of the Confederate department that oversaw the defenses of Charleston, had personally requested that the invention under construction in Mobile be shipped to Charleston.

But also like Ebaugh, Hunley, McClintock, and Baxter had already been tinkering with ideas in New Orleans, long before the prize money had been announced. They had designed and produced a hand-powered submersible torpedo craft named *Pioneer*. When Union forces captured New Orleans, the three men moved their operations to Mobile.

Like *David*, this vessel was a combination of invention and resourcefulness. William A. Alexander, an engineer who joined the team late, described the vessel after the war:

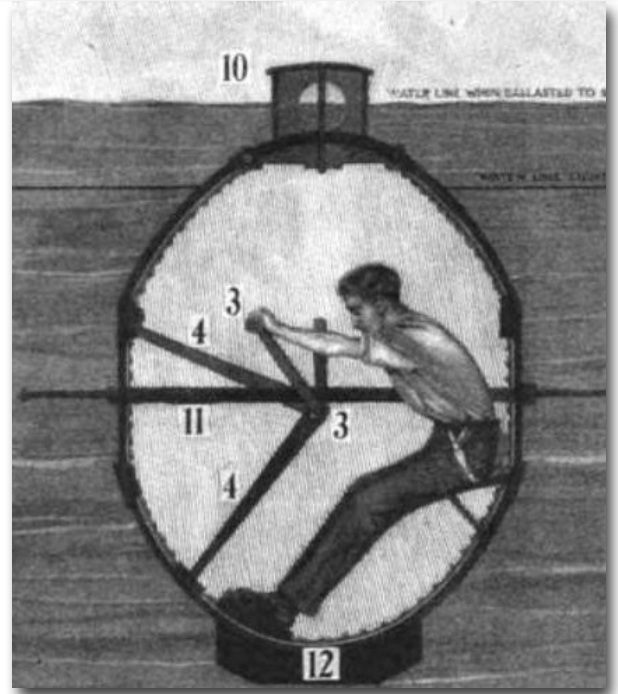
"For the hull we took a cylinder boiler which we had on hand, forty-eight inches in diameter and twenty-five feet long. A part of it was separated into two water tanks, for ballast, which could be emptied and filled by valves. Heavy pieces of cast iron were also fastened to the bottom by bolts which could be removed by the crew

inside, thus allowing the castings to sink, when it was desired to come to the surface quickly. Perhaps the oddest feature of the craft was an appendage which acted on the same principle as the tail of a fish. It consisted of two iron blades, each five feet long and eight inches wide, joined to a shaft and projected behind the stern, one on each side of the propeller. The shaft was jointed to a lever passing into the hull, so that by moving this lever the "tail" could be raised and lowered, changing the depth of the boat below the surface without disturbing the water level in the ballast tanks. The rudder was operated by a wheel and levers connected so that the captain or pilot, forward, could steer the craft from his position."

It was cruder in design than *David* or other similar craft were designed up until that time. However, there was one critical difference: Hunley's machine could change its depth in the water.


The project sank three times with all hands during trials runs. During the second sinking, Hunley himself was among the casualties. Alexander recalled that they almost lost everyone (including himself) a fourth time when the vessel became stuck on the bottom of Charleston harbor. After sitting in the dark for over two hours and close to hypoxiation, an observant Confederate soldier spotted them and the men were rescued.

The project went forward despite the setbacks. The newly named *H. L. Hunley* deployed for her first combat mission on February 17, 1864. Beauregard allowed



the deployment only on the condition that *Hunley* not submerge again. Alexander was replaced before the mission began, much to his annoyance. Beauregard chose the steam sloop USS *Housatonic* as the target, as she was guarding a passage used by blockade runners, and the ironclads had deployed anti-torpedo boat nets.

Hunley approached the steam sloop and rammed her contact torpedo into the ship. Like *Wabash*, *Housatonic* attempted to slip her cable and dodge the attack. However, the steam sloop moved too slowly, and the ship sank in two minutes. The shock wave from the explosion sank *Hunley* a fifth and final time.

The successful attack was a first that writers and historians rank on the same level as the *Monitor/Virginia* encounter. *Hunley* holds the honor of being the first submersible in the world to sink another ship. There is no information, however, on whether or not Trenholm paid the prize money to the inventors' widows. 



A mass of wooden warships back up the ironclad squadron off the coast of Charleston, 1863. Many of the wooden warships were emergency wartime construction projects built in mass quantities by Northern shipyards. (Harper's Weekly engraving)

Stamping Out Warships: Union Shipbuilding Goes Into Overdrive

The Civil War marks the first American war when government conducted mass mobilization of both manpower and industry. President Abraham Lincoln set the tone for the war at sea when he issued his proclamation declaring ports in most Southern states under a state of blockade. To carry out this mandate, the U.S. Navy's leadership made plans to fight a war in the littorals. That is, the war would be fought on the rivers and the coastlines. Having built a fleet meant to fight European fleets, the Navy was not only short of ships, the ships it did have were ill-equipped for the task. The ironclads that came online were not up to the task either. Ironclads excelled at attacking other warships and forts, but were less than ideal for patrol duties.

To address this problem, Department architects drew up a series of shallow draft gunboats. Worried that the Navy's own yards were overextended, the Department turned the gunboat plans over to private contractors.

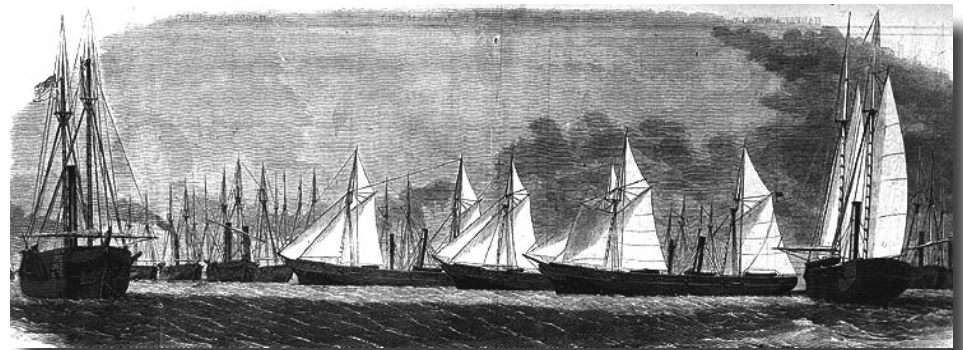
The first two classes of ships were the *Udilla*-class "90-day" gunboats and the *Sassacus*-class "double-ender" gunboats. The "double-enders" received their name from the ability to move forward and backward with equal ease. They were flat-bottom vessels with twin paddle wheels and could operate in the shallow waters of the South's coastline and rivers.

These ships did not have the best qualities for a warship and were lightly armed. However, they were simple in design, easy to build, and most importantly, the right ships for the mission. Unlike the ironclad program, there was little haggling over the technology. The designs of the ships were new, but the basic concept of a steam gunboat was a proven concept and workers built from a common plan.

The two men largely responsible for this successful wooden ship construction were John Lenthall, the Navy's chief ship designer for many years, and Benjamin Isherwood, the Navy's chief engineer. Lenthall provided the yards with the ship's hull plan and Isherwood provided the with the machinery plans. New York industrialists John Englis, William H. Webb, Jacob Aaron Westervelt (Westervelt & Company), and Cornelius Poillon (Bridge Street Yard) are credited with making the Navy's plans a reality. Other shipyards in New York, Philadelphia, and

and many served the Navy after the war.

While the Navy's own yards were busy mostly with outfitting and repairing commissioned ships, they also built new ones. Small warships were good at blockade and patrol duties, but larger warships were still needed to tackle forts and patrol the high seas. Continuing the trend started in the 1850s, the Navy designed several new wooden-hulled, steam sloops for wartime use. Reversing its pre-war reputation for sluggish construction speeds, the Navy Yards typically only took six months to turn out a 2,000-ton warship. By late




A line of new Udilla-class gunboats sits at anchor in New York harbor. Northern shipyards had twenty-three of these "90-day" gunboats built by the end of 1861. (Harper's Weekly engraving)

Boston also received work.

By mid-1862, the American industry launched, outfitted, and commissioned twenty-three *Udilla*-class gunboats and twelve double-ender gunboats. Within another year, twenty-four more double-ender gunboats were added.

The shipbuilders did take one major shortcut to finish the job, particularly with the *Udilla*-class. Wood used in any kind of construction project is usually allowed to dry after being cut down. Shipbuilders decided to skip this step and used green wood. Normally, this shortcut would make a ship's hull weaker and less seaworthy. But somehow all the ships stayed together

1862, twelve new steam sloops joined the Fleet, including ships such as the famed USS *Kearsarge*.

Along with the purchased ships, the Union's ability to turned out dozens of new warships in a short amount of time allowed the U.S. Navy to increase its fleet from fifty to over six hundred. After the war, industrialist and shipbuilder John Roach proudly lauded the work of the American shipbuilding's contribution to the war. He stated, "Who ever heard before of a double ender in the navies of the world. It was a Yankee idea! There never was so much energy shown anywhere I think as was shown by our people at that time." 



The Civil War produced the requirement for a lighter material for speed-hungry blockade runners. Thus, British shipyards began using steel in large quantities in their new blockade runners (shown here are Armstrong at left and Banshee at right). While blockade runners reached the desired speed, the ships would often enter port with the hulls literally falling apart. (Museum of the Confederacy and NHHC images)

Blockade Runners and the Beginnings of the Steel Revolution

Unbeknownst to the ironclad warship personnel fighting in America's harbor and rivers, their ships were about to become obsolete. Light, corrosive resistant steel became more common and made a humble entrance with blockade runners. The concept of making steel had been known for hundreds of years, but no one could make it cost effective. In 1855, English industrialist John Bessemer invented a process that made steel as inexpensive as wrought iron.

Steel was perfect for Civil War blockade runners. These ships were designed for speed, not combat. They were a wonder of technology, as they were among the fastest ships afloat. British maritime architects designed sleek ships that were equipped with powerful engines. A blockade runner's length to beam ratio was often 10 feet to 1 foot or more. By comparison, a typical U.S. Navy steam sloop had a 6 feet to 1 foot ratio and a "90-day gunboat" had a length to width ratio of about 7.5 feet to 1. The result for a blockade runner captain was a speedy ride.

But the sleek, narrow design came with drawbacks, particularly involved ship handling and sea keeping traits. The ship was very difficult to steer, leaving little room for navigation errors. Additionally, the ships did not handle well in rough weather. U.S. Navy warships captured several blockade runners not by destruction, but simply by forcing the blockade runner captain to make a mistake and run aground.

As the search for more speed continued, architects soon discovered that they could not make the ship narrower without making the ship completely unseaworthy. The only other option was to

reduce the ship's displacement. Trying to reduce displacement with a smaller cargo capacity was out of the question, as the ships still needed to carry a certain amount of cargo to make a profit and make the run worth their while.

Instead of trying to rework the ship's hull, the firm of Jones, Quiggins & Company out of Liverpool, England, decided to use steel to lighten the vessel, and thus make it faster. By the firm's calculations, blockade runners made of steel only needed half the amount of metal when compared to iron.

The firm launched the steel-hulled *Banshee* in May 1863. She arrived in Bermuda, making her the first steel-hulled ship to cross the Atlantic. Like all new technologies, not everyone was convinced that steel was such a good idea. Upon inspecting *Banshee*, one Confederate naval officer commented, "Considering how frail the vessel was, the wonder is, not that the *Banshee* was driven back (in a heavy storm), but that she ever got across the Atlantic at all."

Architects failed to anticipate how hard blockade runner captains would push their ships in their daring attempts to avoid capture. As a result, several steel-hulled blockade runners literally fell apart during high speed chases. The engineers at *Scientific American* magazine commented,

"At first the frames of these vessels were of so light material that with their large engine power the hulls were strained very badly when the vessels were put to the top of their speed, as they often were on being chased by some of the blockading fleet. They have often arrived at their destination with the seams of the plating


of the underbody opened so much, that it was with difficulty that the pumps kept the vessels afloat."

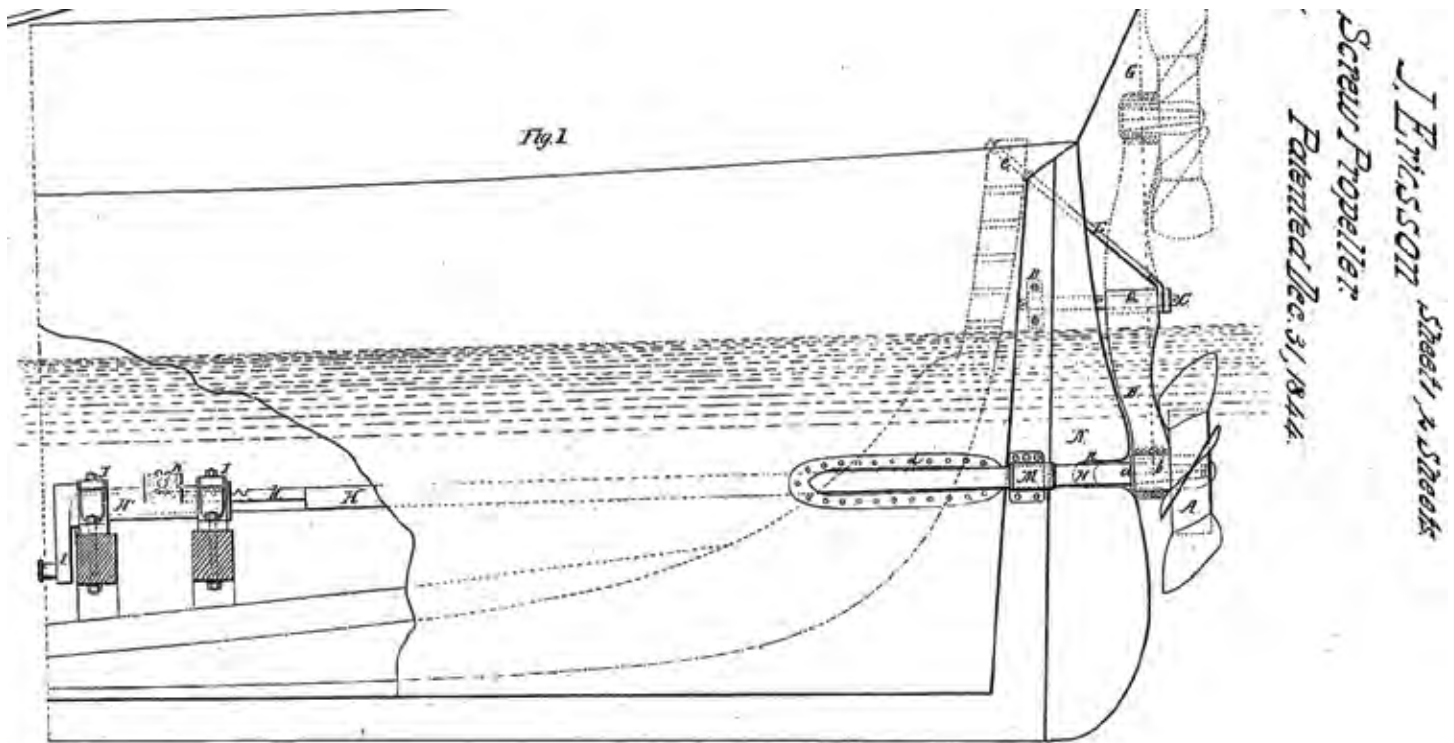
Nonetheless, *Banshee* and her flimsy hull made seven successful runs into Wilmington. USS *Grand Gulf* captured her on the eighth attempt and placed her into blockade duty. Thus, the newly christened USS *Banshee*, and not the "ABCD" ships of the 1880s, became the first steel-hulled U.S. Navy warship.

Despite the issues, the success of *Banshee* convinced English shipbuilders that steel was the way to go. As the war progressed, architects designed better and bigger blockade runners with steel forged in a more uniform quality. Before the war was finished, English yards had built forty steel-hulled blockade runners.

Writing in 1866, an English shipbuilder believed that for all the flaws steel-hulled blockade runners had, one should not be discouraged by the new technology. He wrote,

"These vessels have disappointed their builders and owners in several ways not anticipated, and such experiments have discouraged the use of steel unreasonably, for I am prepared to believe that there are cases in which ships of steel would be very valuable, provided we had sound data on which to construct them with certainty. At present the difficulties of steel shipbuilding are more formidable than those of steel engineering."

The writer would be prove to be correct. Within fifteen years after the Civil War, ironclads were considered obsolete. In their place stood armored steel-hull warships that remain the mainstay of fleets worldwide. 



Patent Number 3,689 “Screw Propeller,”
Awarded to J. Ericsson of New York, December 31, 1844.

Part 3

Mobility

“I have plans to convert a steamer into a battering ram and enable her to fight not with guns, but with her momentum.” -Charles Ellet, Jr., 1855

“It is my plan to head straight for *Cumberland* and ram her, for she is the only one with rifled guns.” -Commodore Franklin Buchanan, 1862

“Get under way and close in upon the Confederate monster and destroy it!” -Rear Admiral David Farragut’s order to attack *CSS Tennessee*, 1864

A New Breed of Sailor: Engineers and Firemen

An undeniable fact about technology and “progress” in any time period is that with every new invention, there needs be specially-trained people who know how to operate, maintain, and fix the hardware. As ships in general, even sailing ships, consist of a series of machines, navies must have sailors trained on parts of the ships.

With the practical application of boilers and steam technology, the U.S. Navy had to create a new type of limited duty officer to manage the equipment. These men were similar to other non-combatant officers such as surgeons and pursers, who required a certain amount of classroom training before checking onboard a ship. They had to be men who were less versed in foreign protocol and more versed in the finer points of Boyle’s Law on ideal gasses. Thus was born the Naval engineer.

At the beginning of the Civil War, the U.S. Navy’s Bureau of Steam Engineering was only nineteen years old. Fortunately, senior leadership understood the need to recruit qualified men to serve as engineers and established standards from the start. But of all the branches of the Navy during the Civil War, the engineers received the least respect. Stationed below decks, the engineers were largely out of sight from the action and thus out of sight from historians, illustrators, and anyone else documenting a naval battle for future generations.

One entry from the chief engineer of the steam sloop USS *Lackawanna* during the 1864 Battle of Mobile Bay serves as



With uniforms unbuttoned, facial hair unkempt, and unsquared hats, three engineers from the Civil War-era steam sloop-of-war USS Pensacola talk to a line officer before going on watch. (Sketch from The Steam Navy of the United States)

a good example. While the line officers were up on the deck engaged in combat, the chief engineer wrote in his log, “7:00 got up steam, 8:00 stop, 8:15 start, 8:20, stop,” etc. until the battle was over several hours later.

Naval engineers were indeed a different lot than their line officer counterparts. Maybe a little less dashing and less patient, and more unkempt, engineers were (and still are) constantly

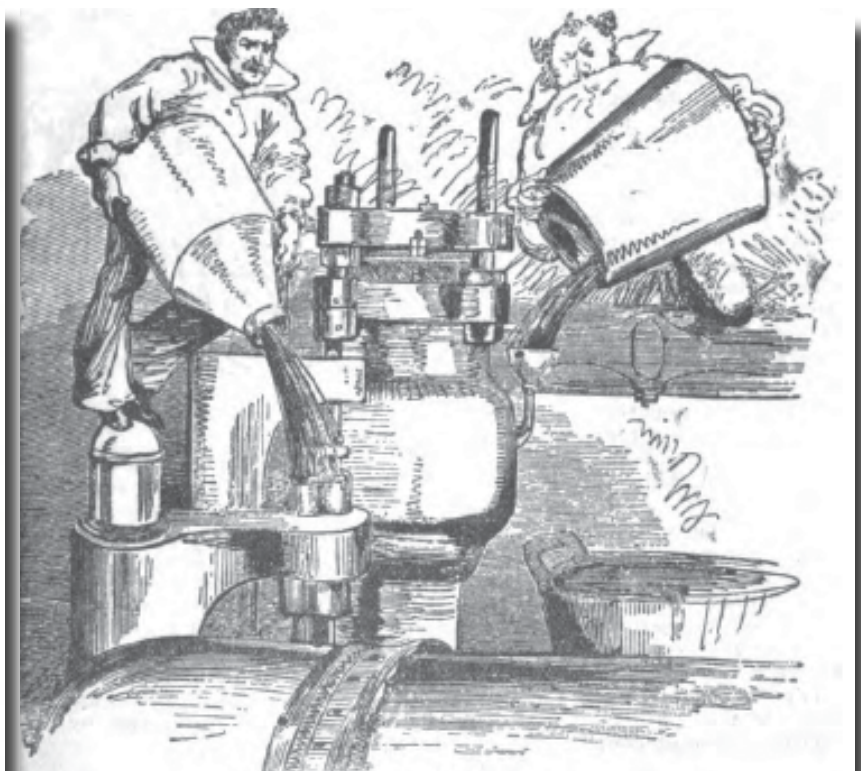
at war with the machines left in their care, and with line officers who demanded the machines always work, all the time. As a result, they were often short-tempered with those who simply did not understand the complexity of this “modern” technology.

One example of the conflict between line and engineering comes from the ironclad CSS *Virginia*. In April 1862, Confederate Commodore Josiah Tattnall wanted *Virginia* to make another assault on the blockading squadron in Hampton Roads. The burden of saying that this was not possible fell to the ironclad’s chief engineer Ashton Ramsey. He wrote to Tattnall:

“At the time I was ordered to the vessel I was informed that it was not the intention to take the ship where a delay occasioned by a derangement in the machinery would endanger her safety, and that she would always be accessible to the navy yard for repairs; this is the reason why I have deferred making this report until this time; and I also was under the impression that the Navy Department was aware of the defective nature of the machinery, and [that] her movements would be directed with a reference to this. Each time that we have gone down I have had to make repairs which could not have been done aboard



“Going on watch, Going off watch”-Temperatures inside a 19th century boiler room often reached 135 to 150 degrees. The design of ironclad warships made the situation even worse. (Sketch from The Steam Navy of the United States)



1864 cartoons from USS Pensacola's engineering division-At left firemen attempt to cold crank the boiler with sledgehammers at the ready. At right, firemen feed the thirsty boiler monster large quantities of oil. (Sketches from The Steam Navy of the United States)

ship very well, or, if done at all, would have required a great deal of time.”

Some writers did feel empathy for America's overworked naval engineers. Here is an 1864 satire using the steam sloop-of-war USS *Pensacola's* engineering division as the story's basis. The division is trying to cold crank the ship's boiler in thirty minutes while the captain went on shore to go shopping:

“I think she will start,” said I to the Engineer. ‘Probably’ said the Engineer.

So saying, he pushed with tremendous strength upon a monkey-tail. This latter, I noticed, was connected by rods and bell-crank levers with the valve spindle being pushed.

‘The thermometer marks 153 degrees in the shade,’ said a vigilant assistant.

‘All right,’ said the Engineer. ‘Lend me that black bottle,’ he added, addressing the man in the corner. Receiving the bottle, he drank from it for five minutes.’

To assist the engineer, the Navy created a new type of enlisted sailor: the fireman. The fireman's job was similar to his counterpart in other departments, as his job required hours of backbreaking labor. The irony, of course, was that technology supposedly made life easier. It did make it easier for the captain getting his ship

from Point A to Point B. For the fireman, however, life was harder than anything that occurred up top.

The most laborious part of a fireman's job was as coal heaver. With a shovel in hand, this man had to constantly feed the boiler with fuel, namely coal. According to one engineering report, a large ship like USS *Minnesota* or *Wabash* required over two tons of coal an hour, or eleven pounds of coal *a second* in order to maintain a speed of eight knots.

Commodore Foxhall Parker made David Glasgow Farragut legendary by documenting the quote “Damn the

Torpedoes, Ahead Eight Bells!” in his work *The Battle of Mobile Bay*. Parker, however, did not forget the engineering department that made Farragut's will a reality:

“And in this faith all men went to their posts; for in a fleet where a single shell, exploding in the boiler of a vessel, might subject the engineers and firemen to the fate of Marsyas [a mortal from Greek myths who was eternally punished for losing to Apollo in a contest of music], or a torpedo or infernal, exploding under her bottom, sending all hands journeying *ad astra*, no one could properly be considered a non-combatant.”



“The Coal Heaver” by Alfred Waud. (1862 sketch, Library of Congress)

Breaking Free From Poseidon's Grip

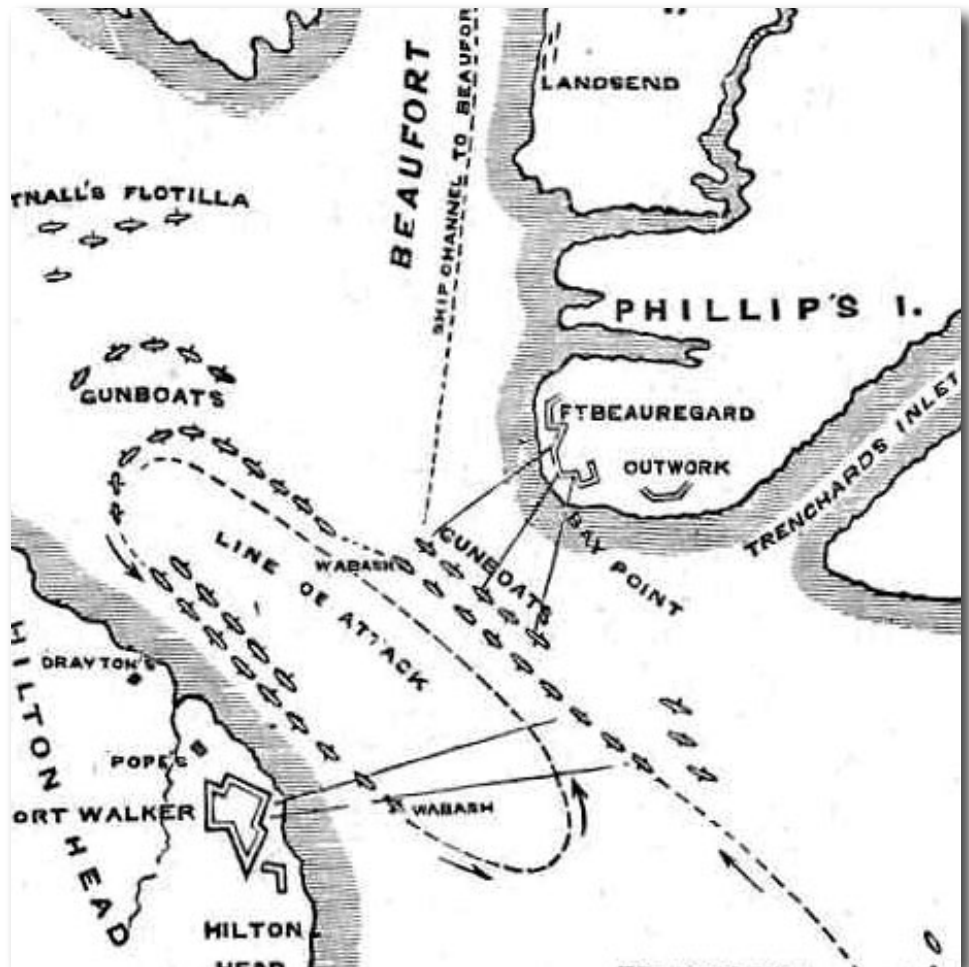
At the John Ericsson Memorial in Washington, D.C., there are three inscriptions praising the Swedish-American inventor for his work with maritime technologies. One is dedicated to his most famous work--the design of USS *Monitor*. The other two are worthy of note and possibly had more influence on the path the Civil War navies took. The inscriptions read, "He revolutionized navigation" and "For the invention of the screw propeller." Ericsson and many others in steam and propulsion technology helped Civil War naval officers fight a very different kind of war than their fathers had.

During the Age of Sail, commanding officers may not have formally worshiped the ancient Greek god of the sea, Poseidon, for fair winds and following seas, but their concerns and issues were the same as the ancient Greek mariners. Nature continued to have a strong influence on Age of Sail ship masters. It influenced everything from how warships lined up in battle to where merchant ships would trade. A captain who was ready to get underway from home port after months of preparations sometimes had to wait weeks for the wind to cooperate before the ship could leave.

While a ship captain in 1861 still had to keep charts and an eye on the weather, steam and allied technologies gave him the ability to at least have a say where and when the ship could go. For warship commanders, steam technology changed everything, and Civil War commanders took full advantage of it.

U.S. Naval officers got some practice with steam propulsion during the Mexican-American War. Thus when the Civil War came, both U.S. and Confederate officers had an idea of what ships equipped with steam propulsion could do. The two early U.S. Naval campaigns of Port Royal and Hatteras Inlet are both distinguished by the tactics used by their respective commanders. Both had their respective squadrons steam in an elliptical pattern, making ships harder to hit. Using steam-powered gunboats and transports, U.S. Navy and Army forces were able to quickly conduct a follow-up campaign with the Burnside Expedition in 1862, securing northeast North Carolina for the remainder of the war.

On the Mississippi River, David Farragut and David Dixon Porter used the fleet's mobility in a different way to defeat



The 1861 Battle of Port Royal (above) and the earlier Battle of Hatteras Inlet in North Carolina were both characterized by the U.S. Naval squadron's ability to attack stationary forts in an elliptical pattern. Steam propulsion made this possible. (Sketch from *The Steam Navy of the United States*)



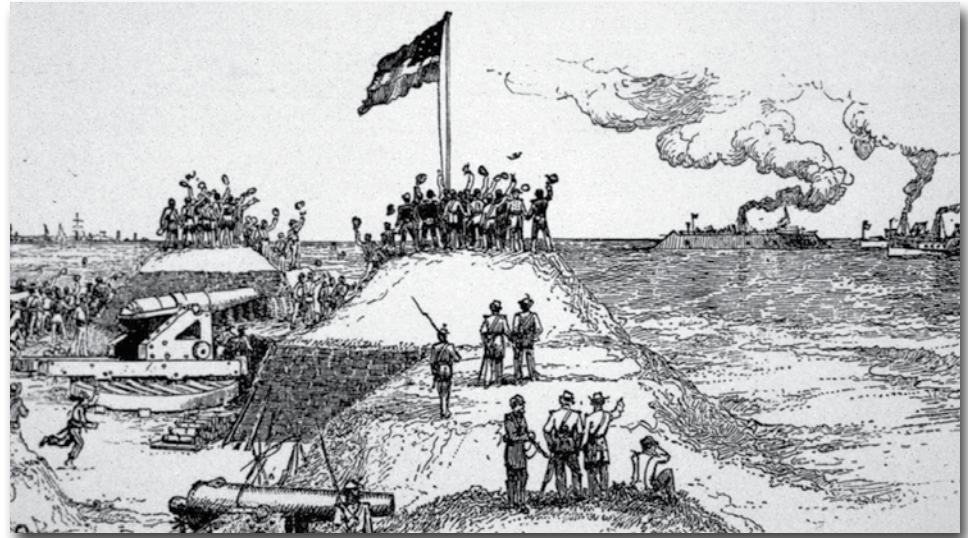
With steam propulsion, Farragut's squadron was able to better navigate the Mississippi River. The squadron bypassed, rather than directly engaged the Confederate forts guarding the lower Mississippi River. This doctrine of bypassing Confederate forts and cutting them off would be repeated several times on the Mississippi River throughout the war. (Battle and Leaders of the Civil War engraving)

Confederate forts. Instead of using steam propulsion to engage the forts, they simply bypassed them. The Confederate forts guarding the lower Mississippi river were impressive stone and brick fortifications mounting several dozen guns. Also working against Farragut were the river's natural bends and the three and a half knot current. In the end, Farragut's squadron was able to pass by the forts, cut them off, and defeat the Confederate ships waiting upstream.

This move of bypassing Confederate forts on the Mississippi River was repeated several more times, and was successful most of the time. The lone and glaring exception was an attempt to pass the guns at Port Hudson. Here Farragut's ships ran aground and Confederate gunners pounded the U.S. Navy ships with withering gunfire.

The Confederate States Navy, of course was not idle during this time. What made the capture of the burnt out hull of USS *Merrimack* at Gosport Navy Yard so valuable was not the ship's large wooden frame, but the John Ericsson-type screw propeller.

As a result, when the ironclad CSS *Virginia* sortied into Hampton Roads on a calm and clear day, she had the ability to move. Her two victims, USS *Cumberland* and *Congress*, did not. If this attack had occurred fifty years before, *Virginia* would have had to wait for the weather to



Underway under steam power—On a windless, clear day CSS Virginia steams upriver towards USS Cumberland. Virginia may have only been able to do four or five knots, but that was more than the U.S. Navy sailing ships could. (Battles and Leaders of the Civil War engraving)

cooperate. As the Union ships could not get out of the way or come to help each other quickly, *Virginia* was able to pick off two ships and almost pick off a third ship.

Confederate commerce raiders illustrated the effects of steam propulsion with their long-range raiding campaigns. So long as Confederate cruisers had the cooperation of neutral ports, which they almost always did, they were able to roam the world in search of targets due to their steam engines. As a result, eight cruisers were able to find their targets, destroy them, and move on before any U.S. Navy cruiser could stop them. The result was

that a few Confederate cruisers conducted one of the most efficient commerce raiding campaigns in military history.

The benefit versus the high monetary cost of steam propulsion had been debated for decades (a typical steam ship cost the U.S. Government 50 to 100% more than a sail-ship). But, the Civil War once and for all spell the death of sails. After the war, admirals insisted that new steel-hull cruisers have sails "just in case" the propulsion failed (which it often did). But steam propulsion produced a freedom of movement that no commander would ever want to be without.



The effect of steam propulsion on naval warfare can be seen in this map of the legendary duel between the steam sloop USS Kearsarge and the cruiser CSS Alabama off the coast of Cherbourg, France in 1864. In their respective attempts to outmaneuver each other, the two ships circled each other in a waltz-like fashion. (Library of Congress image)



The CSS Virginia's ram, and not her guns, was her most effective weapon. Using it against the sloop-of-war USS Cumberland, Virginia was able to destroy the wooden warship in a short fight. (HRNM image)

Ramming Speed: An Old Tactic Gets New Life

Before the invention of cannons, steam boilers, ironclads, or gunpowder, the navies of ancient Rome, Greece, Persia, and others had only one sure way to sink an enemy vessel: the ram. Architects of ancient times designed vessels with special points on the bows for such a purpose. Even with the invention of large naval artillery guns and underwater explosives, steam technology made the ship itself potentially the most powerful weapon of all.

Ramming and the ram lost favor with the invention and perfection of warships

powered by the wind. To ram another ship required a reliable source of kinetic energy, and the wind was far from a reliable source. However, with the invention of the steam engine and its application to naval warships, architects cleaned off 2,000 years of dust, reread their Homer and Thucydides, and built warships with ramming in mind.

In New Orleans, a Southern patriot took it upon himself to build such a weapon using his own money. In 1861, Captain John A. Stephenson took a tugboat meant to be an ice breaker and converted her into a cigar-shaped ironclad ram. Desperate for some type of a defense against the U.S. Naval squadron massing at the Head of Passes in Mississippi, Confederate Naval officers took control of the vessel and named her CSS *Manassas*. Stephenson believed that *Manassas* with her ram was the future of naval warfare, not the past. According to his obituary, Stephenson believed he could “construct such a vessel that would be able to drive off or sink the most powerful man-of-war without the use of cannon or other old instruments of warfare.”

Confederate Naval officers put

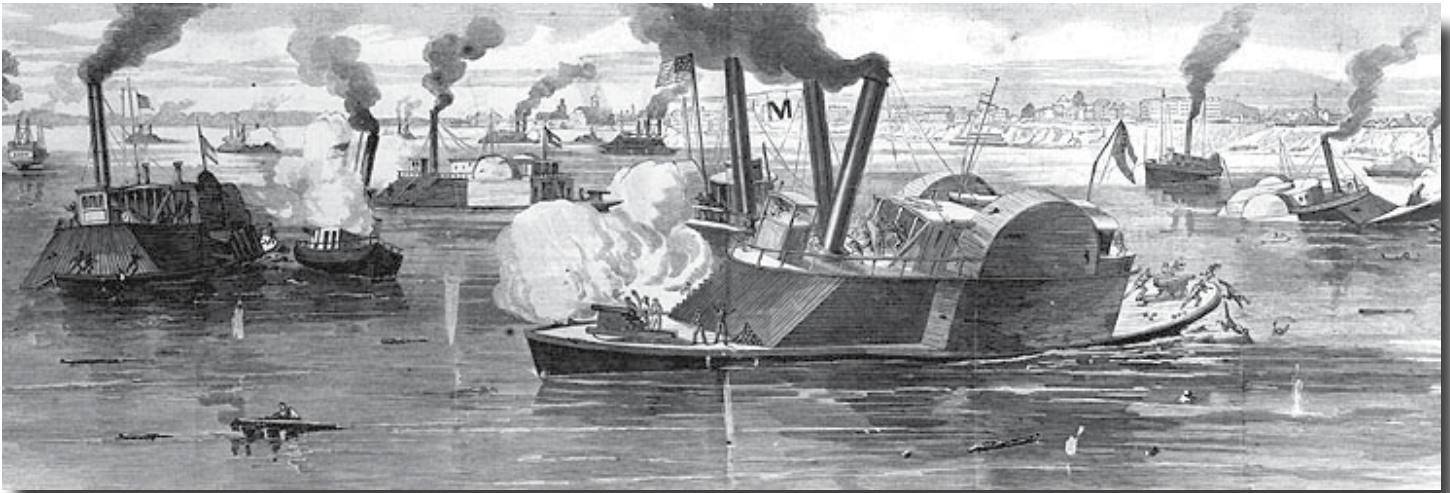
Stephenson's vessel to the test early in the war when *Manassas* engaged and rammed the steam sloop USS *Richmond* at the Head of Passes. During the defense of New Orleans, *Manassas* rammed two more formidable ships, USS *Brooklyn* and *Pensacola*. The Confederate ironclad damaged, but did not sink, all three ships before being disabled by the paddle frigate USS *Mississippi*'s guns.

As much as he favored and encouraged new technology, Confederate Secretary of the Navy Stephen Mallory also saw the power of this ancient weapon. In addition to four inches of iron and ten guns, workers at Gosport added a 1,300-pound cast iron wedge onto the ironclad CSS *Virginia*'s bow. In his final instruction to *Virginia*'s commanding officer, Flag-officer Franklin Buchanan, Mallory wrote that *Virginia*'s “powers as a ram are regarded as very formidable and it is hoped that you may be able to test them. Like the bayonet charge of infantry this mode of attack will commend itself to you in the present scarcity of ammunition.”

Using *Virginia*'s iron armor as his protection, Buchanan took Mallory's advice and committed early on in the first



During operations north of Roanoke Island, U.S. Navy gunboat commanders were encouraged to ram Confederate gunboats to save ammunition. (Harper's Weekly engraving)



On the Mississippi River, both sides purposely built ships with the ramming tactic in mind. At the Battle of Memphis, Union and Confederate ships rammed each other. Better tactics, coupled with a few mistakes by the Confederate squadron, led to a decisive victory for the North. Here Ellet's flagship *Monarch* rams and sinks the Confederate ram *CSS General Beauregard*. (Naval History and Heritage Command image)

day of the Battle of Hampton Roads to ram the sloop-of-war *USS Cumberland*. By ramming *Cumberland*, Buchanan quickly removed what he believed to be the most formidable warship in the Union squadron. The ram allowed him to avoid getting into a gun duel.

Virginia's top speed was only about five or six knots. But combined with the ship's displacement and the cast iron wedge, five knots was plenty of kinetic energy to drive a hole into *Cumberland* and sink her.

The next day, when *Virginia* faced off with *USS Monitor*, the Confederate ironclad attempted to ram the Union's turreted warrior when gunfire did not succeed. Here, *Virginia* was not successful, as *Monitor* had the best defense against ramming that *Cumberland* did not: the ability to get out of the way. The attempt, however did make the U.S. Navy take notice of *Monitor's* vulnerability to getting hit by another ship. Future monitor ironclads incorporated a change to the lower hull that made them more stable in the open ocean and less prone to getting sunk in a ramming attack.

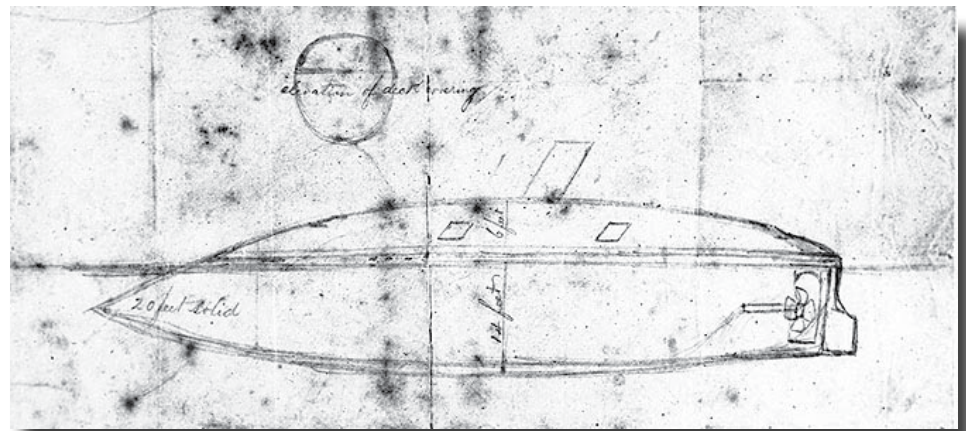
Nonetheless, *Virginia's* success on March 8, 1862 led Mallory to order up several more ironclads built along *Virginia's* lines. Historians classified these casemate ironclads by their main weapon: rams.

At about the same time as *Manassas* took on Farragut's entire squadron, engineers in the North had been tinkering with the idea of a ram as well. Early in the war, civil engineer Charles Ellet, Jr. had been urging the Federal government to procure rams to defeat Confederate

ironclads. Pointing to *Virginia's* success, Ellet tried to get the U.S. Navy to build similar ships. It was Secretary of War Edwin Stanton, however, who took note of Ellet's letters.

With Stanton's endorsement, Ellet began to retrofit nine paddle steamers and tow boats into a series of wooden ram steamers for use on the Mississippi River.

Confederates took the initiative. As U.S. Navy "City"-class ironclads laid siege to Fort Pillow in 1862, several Confederate steam rams hoisted their anchors and charged. Despite withering fire from the Union ships, the Confederate wooden ships rammed the ironclads *USS Cincinnati* and *Mound City*. Both ships were knocked out of action for a year.



An 1861 sketch of Captain John A. Stephenson's vision of the future of naval warfare—the ironclad ram *CSS Manassas*. Converted from an ice-breaking tug and equipped with only one gun, *Manassas* rammed and damaged three different U.S. Navy warships before being disabled by gunfire. (Naval History and Heritage Command image)

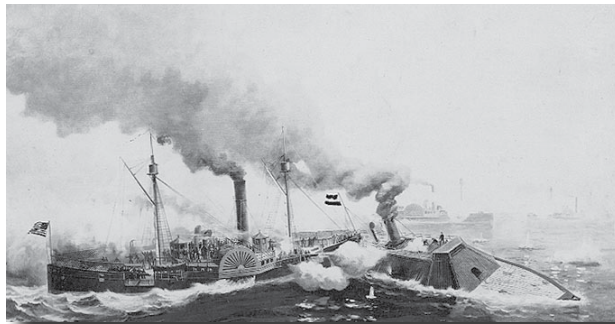
In his own words, each vessel had “three heavy solid timber bulkheads, from 12 to 16 inches thick, fore and aft, from stern to stern, placing the central one directly over the keelson...making the whole weight of the boat add its momentum to that of the central bulkhead at the moment of collision.”

By May 1862, Ellet's Mississippi Ram Fleet was ready for service on the Mississippi River, but the Confederates struck first. While Ellet and the U.S. Navy's local commander, Flag-officer William C. Davis, argued over future strategy, the

Union forces did get their revenge. Without waiting for Davis' ironclads, Ellet took his ram squadron and engaged the very same Confederate squadron found at Fort Pillow off the river shores of Memphis a month later. Using the momentum of the river current, Ellet's ship, along with his brother Alfred's ship, charged at the Confederate squadron. Both squadrons fired a few cannon shots and then the battle disintegrated into a mass ramming melee that was fought more like a demolition derby than a naval battle. *USS Queen of the West* rammed and disabled the Confederate

ram CSS *Lovell*; CSS *General Beauregard* in turn rammed and disabled *Queen of the West*; USS *Monarch* and CSS *General Sterling Price* rammed each other head-on with *Price* receiving the worst of it; *Monarch* rammed and sank CSS *Little Rebel*; *Monarch* then dodged a ramming attempt by CSS *General Beauregard* and CSS *General Sterling Price*, who subsequently ran into each other. *Monarch* then turned and rammed *Beauregard*. Two Union wooden ships took out five Confederate ships all in plain sight of Navy ironclads.

Throughout the war, officers with ships not equipped to ram still saw the tactic as a viable option to quickly remove an enemy ship. It was a huge gamble for a captain to ram, as the rammer often suffered as much damage as the ship being

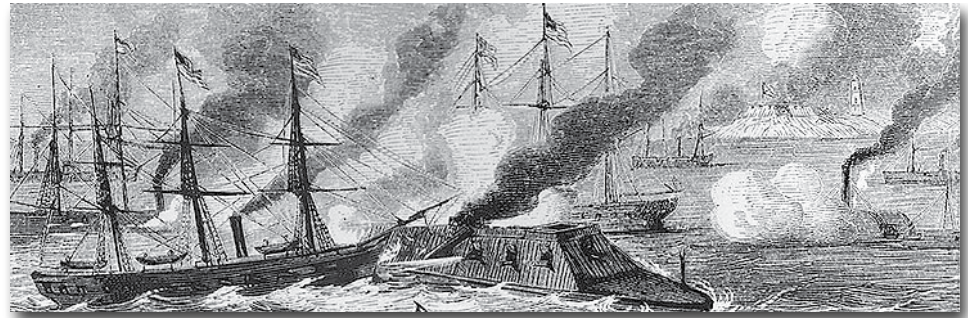


Lacking the firepower to take on CSS *Albemarle*, Union gunboats were ordered to ram the Confederate ironclad. It did more damage to the gunboats than to *Albemarle*. (Naval History and Heritage Command image)

rammed. It also often did not work. But when a more aggressive attack was needed, there was always Newton's First, Second, and Third Law of Motion.

For example, Confederate captains removed two Federal warships this way. In 1862, hopelessly outgunned by Farragut's steam sloops, CSS *Governor Moore* and *Stonewall Jackson* charged and sank the gunboat USS *Varuna*. Later on in the war, local Confederate ships in Galveston, Texas, charged, rammed, and seized the USRC *Harriet Lane*.

In one odd episode, a desperate unarmed Confederate blockade runner, *Ellie & Annie*, made a charge at USS *Niphon* off the coast of Cape Fear. Usually when a blockade runner captain felt that the situation was hopeless, he either ran the ship aground or allowed himself to be captured in the hopes that he would be exchanged as a prisoner of war. When *Niphon* spotted *Ellie & Annie*, *Niphon* fired. Instead of backing off or changing course, the captain ordered *Niphon* to be rammed. At the last



Equipped with an iron prow and a reinforced bow, the steam sloop USS *Lackawanna* rams the ironclad CSS *Tennessee* during the Battle of Mobile Bay. Farragut ordered the prow affixed despite having several ironclads of his own. (Naval History and Heritage Command image)

minute, *Niphon*'s master ordered *Niphon* to put hard astarboard. The two ships barely missed each other. A boarding team then seized *Ellie & Annie*.

Ramming was a favorite option for U.S. Naval commanders when they faced Confederate ironclads. Losing faith in their cannons, commanders resorted to ramming. This was particularly true when trying to cope with the Confederate ironclads *Virginia*, *Albemarle*, and *Tennessee*. While *Monitor* held *Virginia* at bay, the giant 3,000-ton USS *Vanderbilt* steamed into Hampton Roads with the express intention to ram and sink the Confederate ironclad. When *Albemarle* sank USS *Southfield* and threatened to undo all the gains made by Union forces in northeast North Carolina, the Union captains considered ramming the ironclad. Rear Admiral Sydney P. Lee wrote to his local commanders, "The Department seems to prefer ramming...ramming under high speed may drive it in or you may drive her ashore or mount her ends and especially in the sounds with some sea to sink [*Albemarle*]."

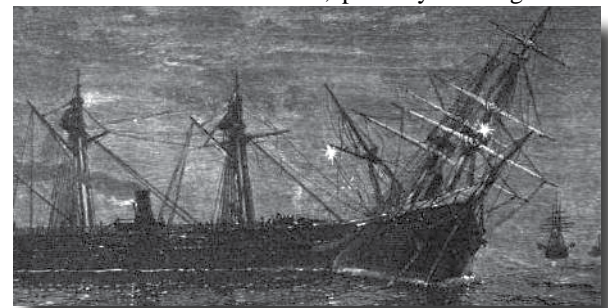
The out-gunned gunboat USS *Sassacus* tried to carry out this advice and rammed *Albemarle*. Unfortunately, *Sassacus* suffered more damage than the ironclad.

Before beginning his famous assault on Mobile Bay in 1864, Rear Admiral David Farragut outfitted two of his wooden steam sloops, USS *Lackawanna* and *Monongahela*, by retrofitting their bows with solid oak timber and an iron prow. Even though he had several monitor-type

ironclads in his squadron, Farragut still wanted the ability to ram *Tennessee*. With Farragut's order to "Get under way and close in upon the Confederate monster and destroy it!", *Lackawanna* charged at *Tennessee* and rammed her. Unfortunately, the iron prow broke off and the ironclad did not sink. Seeing this failure, Farragut ordered his own ship, USS *Hartford*, to ram (which also did not work).

One final act of ramming is worth noting. When the cruiser CSS *Florida* entered Bahia, Brazil, seeking repairs, officers of USS *Wachusett* decided that the best way to take *Florida* out was to ram her in the middle of the night. The U.S. Naval officers believed that in this way, *Florida* could be sunk quickly and quietly, since the two ships were in a neutral port.

Gunfire from two of *Wachusett*'s main guns ended that hope and *Florida* did not sink from the ramming. Once *Florida* arrived in Hampton Roads after being boarded and towed by *Wachusett*, the U.S. Army transport *Alliance* "accidentally" rammed *Florida*, possibly causing her to



In an attempt to sink the cruiser CSS *Florida* quickly and quietly in a neutral port, the steam sloop USS *Wachusett* rammed the Confederate raider. The attempt did not work, though *Florida* did eventually surrender. (HRNM image)

sink.

Ramming became less encouraged after the Civil War since weapons improved in range and lethality. However, ramming was, and still is, an option open to any ship commander. All one needs is some forward momentum and nerves of steel. 