The Man Who Raised the USS MERRIMACK: New Light on John Luke Porter and the CSS VIRGINIA

Edited by Jonathan Dembo[1]

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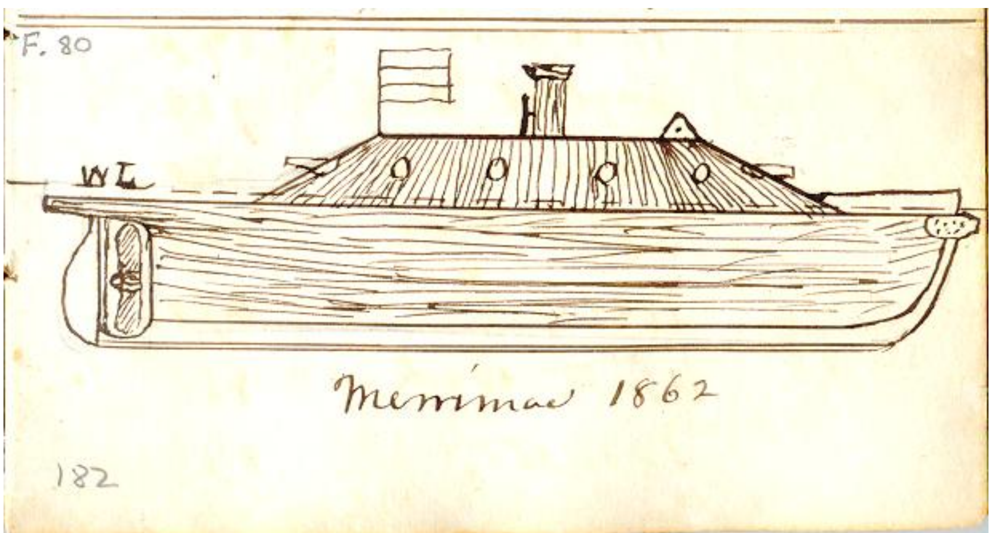

Figure 80: This is a sketch of the CSS Merrimac (1862) by John L. Porter. In *John L. Porter Notebook*, p. 182, John L. Porter Collection #850, Special Collections Department, J. Y. Joyner Library, East Carolina University, Greenville, NC 27858.

DRAFT 22

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Introduction

John L. Porter Papers

Most of the information in this digital exhibit derives from one small 4¼ x 6½" manuscript notebook housed in the John Luke Porter Collection[2] in the Special Collections Department of Joyner Library at East Carolina University. The Porter family loaned the collection to East Carolina University in December 2001. Among the most significant items in the collection is this little manuscript notebook which contains 234 pages closely written in Porter's own hand, done at various times from about 1857 until 1882. It is quite fragile at present. The volume has tears in numerous places. The covers and text block are detached. The primary reason for this digital exhibit is to allow researchers continued access to the notebook while minimizing the risk of further damage from handling. The editor also hopes that this digital exhibit will increase the public's knowledge and understanding of Porter's role in naval history and in some of the most important events of the American Civil War.

USS MONITOR – CSS VIRGINIA Debate

In the years since the Civil War, the *USS MONITOR*[3] has always received a better press than the CSS *VIRGINIA.*[4] The *MONITOR's* story was clear and easy to understand and the essential facts in her case are generally agreed. The U. S. Navy built her from scratch for a specific purpose – to maintain the Union blockade on Confederate ports - and she accomplished that purpose. They gave the construction contract to a single individual, John Ericsson, who designed and built her from the keel up. Ericsson intended her to be an ironclad warship from the beginning. Ericsson faced no limitation on supplies or equipment. He incorporated several other notable innovations in her design, including a screw drive[5] and rotating gun turrets that could fire at any angle. MONITOR also boasted the world's first below-the-waterline flush toilet.[6]

There is general agreement as to *MONITOR's* merits and faults as a warship. Critically, she arrived at the vital spot on the battlefield just in time, and

[2] *John L. Porter Notebook,* John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858.
[3] *Dictionary of America Naval Fighting Ships, Vol. IV* (Washington, DC: Office of the Chief of Naval Operations, 1969), p. 414. See also: http://www.hazegray.org/danfs/monitors/monitor.txt
[4] *Dictionary of American Naval Fighting Ships, Vol. IV* (Washington, DC: Office of the Chief of Naval Operations, Naval History Division, 1969), pp. 337-38. See also: **http://www.Hazegray.Org/Danfs/Frigates/Merrimac.Htm**.
[5] Propellers
[6] *Clash of Iron, b*y Jackson Dykman. Time Magazine (19 Aug. 2002) See: http://www.time.com/time/magazine/article/0,9171,1003076,00.html#ixzz0uEPcYjVo

prevented the *VIRGINIA* from breaking the Union blockade. The fact that the Union won the Civil War has also given the *MONITOR* a public relations advantage over the years. She accomplished her purpose; she was a clear success. Additionally, the *MONITOR* established a pattern for future ironclad warships followed by virtually all later warships. MONITOR's historical significance is undoubted.

On the other hand, very little is clear about the *VIRGINIA's* story. All agree that the Confederate Navy built the *VIRGINIA* from the hulk of the *USS MERRIMACK*, which the U. S. Navy had burned to the waterline when they abandoned the Gosport (Norfolk, Virginia) Navy Yard on 20 April 1861. They found *MERRIMACK* resting on the bottom of the harbor, and lacking her superstructure, but the big ship's lower hull and machinery were intact. During the remainder of 1861 and the first two months of 1862, the Confederate States Navy raised and repaired the *MERRIMACK* and converted her into a casemate ironclad ram, a new warship type that the Confederates hoped would defeat the Union's great superiority in conventional warships.

Commissioned as CSS *VIRGINIA* in mid-February 1862, the ship's iron armor made her virtually invulnerable to most naval guns. VIRGINIA's armament consisted of ten guns, including 7-inch pivot-mounted rifles both fore and aft and a broadside battery of two 6-inch rifles and six 9-inch smoothbores. Attached to her bow was an iron ram, allowing the ship herself to become a deadly weapon.[7] There the clarity ends.

The Confederates had multiple and somewhat conflicting goals for the *VIRGINIA.* They intended to use her to break the Union blockade of southern ports, but they also hoped to use her to control the seas. However, the Confederates had to work hurriedly and faced crippling supply shortages, especially or iron plate, engines, replacement parts, and weapons, which severely limited what they could make the *VIRGINIA* do and forced yet more compromises.

The fact that the Confederates were using the hulk of an existing sailing ship, significantly limited the things they could do to redesign her. While it reduced the initial cost to the Confederacy, it forced the Confederate Navy to accept numerous performance deficiencies in *VIRGINIA*. *MERRIMACK* had auxiliary engines intended mainly for maneuvering in and out of harbors. Initially designed as a sailing ship, *MERRIMACK's* designers had never intended her to use engines for long-distance voyages or rapid, combat

[7] *CSS Virginia Confederate Navy Ship.* http://americancivilwar.com/tcwn/civil_war/Navy_Ships/CSS_Virginia.html

maneuvering. Lacking sails and better engines, *VIRGINIA* had to use these auxiliary engines for all her movements. Thus, *VIRGINIA* was significantly underpowered, slow, and hard to maneuver. Additionally, the weight of her iron armor made *VIRGINIA* heavier than *MERRIMACK* and thus gave her a much deeper draft than *MERRIMACK*. Besides slowing her, this significantly limited where *VIRGINIA* could sail in shallow waters. In other words, the VIRGINIA was too weak and slow to challenge the U. S. Navy on the open ocean but she was too heavy to operate in many shallow, inshore, waters where she might have escaped the Union fleet and gained assistance from shore batteries.

Additionally, most of *MERRIMACK*'s guns lay along the side of the ship as they did in most warships of the day, and could fire only slightly away from right angles to the keel of the ship. Thus, only about half of *MERRIMACK*'s guns could fire at the enemy at any one time. *MERRIMACK* depended on speed to maneuver on the open seas to allow both broadsides to fire at the enemy. In reusing the *MERRIMACK*, the Confederates had to accept the same firing pattern but lacking the speed and maneuverability of the *MERRIMACK*.

VIRGINIA's design was therefore a compromise between old and new construction, between iron and wood, and between blockade-breaker and sea controller. *VIRGINIA's* was imperfectly suited for either of her intended roles. She drew too much water to serve in many of the rivers and coastal shallows of the south; on the other hand, her engines lacked the power and speed to maneuver her on the open seas.

To these liabilities, the Confederates added divided responsibility for the project. Instead of concentrating overall authority in an individual, they appointed a committee of three, including John Luke Porter and Confederate Navy Lieutenant John M. Brooke who surveyed the hull and found the running gear satisfactory to base conversion of the hull to an ironclad ram. Confederate Navy Captain French C. Forrest supervised the construction. Together they raised, repaired and re-equipped the *MERRIMACK* as an ironclad ram. However, the divided responsibilities led to debilitating rivalries and conflicts among the constructors and long survived the war.[8]

In battle, *VIRGINIA* proved highly effective against un-armored warships; but unable to defeat other armored vessels. The first ironclad warship to see action, she easily destroyed or dispersed all the wooden U. S. Navy vessels

[8] *CSS Virginia*. Wikipedia http://en.wikipedia.org/wiki/CSS_Virginia

she faced on the first day of battle off Hampton Roads, Virginia, on 8 March 1862. *VIRGINIA*, however, failed to defeat the *MONITOR* in their historic fight on 9 March 1862 and thus failed to break the Union blockade of the South. This allowed *MONITOR*, while equally unable to damage *VIRGINIA*, to accomplish her sole goal of maintaining the Union blockade of the South. *MONITOR* thus became the model for most modern warships, *VIRGINIA* did not.

In the years since the Civil War, historians have given Ericsson the lion's share of the credit for *MONITOR's* success; the credit for *VIRGINIA* has been in dispute over the years. *VIRGINIA's* very name is in dispute. The Confederates officially renamed her *CSS VIRGINIA* but most northerners and many southerners continued to refer to her as the "*MERRIMACK*," although they sometimes spelled it "*MERRIMAC*." Confederate Naval Constructor John Luke Porter, for instance, uniformly referred to her as the *MERRIMAC*, not *"MERRIMACK*" or *"VIRGINIA"* in his notebook. For sake of historical accuracy, we have designated her CSS *VIRGINIA or VIRGINIA.*

Biographical Sketch of John Luke Porter 1813-1892

John Luke Porter was a Virginian, born in Portsmouth in 1813. He was from a long-established and prominent Portsmouth family that had been successful as merchants and shipbuilders for a number of generations prior to his birth. John's father, Joseph Porter (d. 1831), owned a small but quite advanced shipyard. The Porter yard lay adjacent to the Gosport Naval Shipyard, a large former Royal Navy shipyard that the Navy had purchased after the Revolution. The Gosport Yard continues to exist (2010) as the Portsmouth Naval Shipyard and it remains one of the largest and most important shipyards in the United States. The Porter shipyard built canal boats and sailing ships but also launched steam ships, including the *FREDERICKSBURG*, as early as 1827.[9]

Porter worked in his father's shipyard from an early age and later served as an apprentice to the famous naval constructor Francis Grice. When Joseph Porter died in 1831, the family sold the shipyard. 18-year-old John and his brothers Joseph and Fletcher then sought employment on their own. John and his one-eyed brother Fletcher soon found work as ship carpenters in

[9] *Ironclad Down: USS Merrimack-CSS Virginia from Design to Destruction*, by Carl D. Park, Annapolis, MD: U.S. Naval Institute Press, © 2007, pp. 12-13; *John L. Porter: Naval Constructor of Destiny*, by Alan B. Flanders, White Stone, VA: Brandylane Publishers, Inc., © 2000, pp.1-5

Portsmouth area shipyards. Joseph Porter became a master block and gun carriage maker at the Gosport Shipyard.[10]

In 1834, John married Susan Naylor Buxton, from nearby Nansemond County, Virginia. Their home also became the home of John's widowed mother, his bankrupt uncles, and the four children born to John and Susan Porter. In 1842, Porter moved with his wife and four children to Pittsburgh, Pennsylvania to work on the *USS ALLEGHENY* for the U. S. Navy Department.[11]

In his Record of Iron Ships Built (Notebook p. 209), Porter cites working on the "iron steamer" *WATER WITCH* as early as 1842 when he was stationed at the Washington Navy Yard. However, it was during his stay in Pittsburgh, Pennsylvania, between 1842 and 1847, that Porter first developed the idea of building an ironclad steam-powered warship. He later said that he drew up plans, made a model of the ship, discussed his ideas with his colleagues and then submitted the plans and models to the Navy but got no reply; however, subsequent researchers have not been able to find the plans or models in the Navy's records. Nor did Porter patent the concept or pursue the matter further.[12]

Perhaps feeling that his lack of professional qualifications had counted against him, Porter set about redressing that fault. He began to study to take the U.S. Navy naval constructor's examination. He traveled to the Washington Navy Yard and took the examination in 1847 but did not pass; he eventually passed it in 1857 after an unknown number of failures. The notes Porter compiled during his naval constructor's examination studies take up the bulk of his notebook (pp. 5-159.[13]

Meanwhile, the *USS ALLEGHENY* project also proved to be somewhat of a disappointment. Launched in 1846, *ALLEGHENY*, the iron-hulled, paddle-wheel-powered, steam warship, suffered continuing mechanical problems throughout her career. She spent 1851-1852 under repair and having her paddle wheels replaced with propellers, but this did not improve her

[10] *Ironclad Down: USS Merrimack-CSS Virginia from Design to Destruction*, by Carl D. Park, Annapolis, MD: U.S. Naval Institute Press, © 2007, pp. 15-16; *John L. Porter: Naval Constructor of Destiny*, by Alan B. Flanders, White Stone, VA: Brandylane Publishers, Inc., © 2000, pp.1-3.

[11] *Ironclad Down: USS Merrimack-CSS Virginia from Design to Destruction*, by Carl D. Park, Annapolis, MD: U.S. Naval Institute Press, © 2007, pp. 13-14; *John L. Porter: Naval Constructor of Destiny*, by Alan B. Flanders, White Stone, VA: Brandylane Publishers, Inc., © 2000, pp.7-9.

[12] *Ironclad Down: USS Merrimack-CSS Virginia from Design to Destruction*, by Carl D. Park, Annapolis, MD: U.S. Naval Institute Press, © 2007, pp. 13-14; *John L. Porter: Naval Constructor of Destiny*, by Alan B. Flanders, White Stone, VA: Brandylane Publishers, Inc., © 2000, pp.7-10.

[13] *Ironclad Down: USS Merrimack-CSS Virginia from Design to Destruction*, by Carl D. Park, Annapolis, MD: U.S. Naval Institute Press, © 2007, pp. 13-14; *John L. Porter: Naval Constructor of Destiny*, by Alan B. Flanders, White Stone, VA: Brandylane Publishers, Inc., © 2000, pp.8-9.

fortunes. At one point, in 1852, there was some hope that *ALLEGHENY* might accompany Commodore Matthew C. Perry's expedition to "open" Japan, but she failed her preliminary tests and this hope evaporated. Instead, the Navy struck her from the active service list and put her in "ordinary" at the Washington Navy Yard. She did not see combat service during the Civil War. After some years as the receiving ship in Baltimore, she was against taken out of active service again and sold for scrap at Norfolk in 1869.[14]

Despite this disappointment, Porter returned to Portsmouth, in 1850, and resumed his career as a ship carpenter and his naval constructor studies. He and his brother Joseph became active politically. John also became active in social and civic life and was a leader in the Methodist Church. He won election as the first president of Portsmouth's city council in 1852.[15]

In Portsmouth, Porter served under Samuel Hartt, who was the Gosport Navy Yard's maters shipbuilder. In 1853, Hartt became chief of the Navy's Bureau of Construction, which required him to travel and supervise many projects. This left Porter as acting Naval Constructor at the Gosport Yard, a very senior position for the 40 year old who had not yet passed his naval constructor's examination.[16]

As acting naval constructor Porter's most notable accomplishment prior to the Civil War was salvaging, rebuilding and resurrecting the historic frigate *USS CONSTELLATION*, of War of 1812 fame as a new sloop of war. Built in 1797, the old *CONSTELLATION* was in very poor condition by the 1853.[17] The timber inspector thought that the Navy should send her to "rotten row" and forget about her. Yet Porter succeeded in restoring her and making her fit for active service by 1854. While technically still under Hartt's supervision, Porter was chiefly responsible for the success of the restoration project. He broke up the old CONSTELLATION, saved significant parts of the ship, and then rebuilt her as a virtually new sloop of war, also known as CONSTELLATION.[18] As a result of Porter's work, the new *CONSTELLATION* went on to have a successful career in the anti-slavery patrols off the coast of Africa, as a sloop, and as a picket boat in the Mediterranean and the Caribbean protecting American shipping from

[14] *Ironclad Down: USS Merrimack-CSS Virginia from Design to Destruction*, by Carl D. Park, Annapolis, MD: U.S. Naval Institute Press, © 2007, pp. 15-16; *John L. Porter: Naval Constructor of Destiny*, by Alan B. Flanders, White Stone, VA: Brandylane Publishers, Inc., © 2000, p.9.
[15] *Ironclad Down: USS Merrimack-CSS Virginia from Design to Destruction*, by Carl D. Park, Annapolis, MD: U.S. Naval Institute Press, © 2007, pp. 14.
[16] *Ironclad Down: USS Merrimack-CSS Virginia from Design to Destruction*, by Carl D. Park, Annapolis, MD: U.S. Naval Institute Press, © 2007, pp. 14-15; *John L. Porter: Naval Constructor of Destiny*, by Alan B. Flanders, White Stone, VA: Brandylane Publishers, Inc., © 2000, p.15-18.
[17] *USS CONSTELLATION (1797)* http://www.history.navy.mil/danfs/c13/constellation-i.htm
[18] *USS CONSTELLATION (1854)* http://www.history.navy.mil/danfs/c13/constellation-ii.htm

Confederate raiders. From 1865 to 1933 *CONSTELLATION* served as a receiving and training vessel at Norfolk and other Navy posts. The Navy finally struck her from the active list in 1955 and she became a museum on the Baltimore waterfront.[19]

In 1856, Porter helped work on the frigates *USS COLORADO*[20] and *USS ROANOKE*.[21] In hindsight this proved a stroke of luck for the COLORADO's sister ship was the *USS MERRIMACK*. Later, Porter was able to use his experience in rehabilitating the *CONSTELLATION*[22] and building the *COLORADO*, in raising and converting the *MERRIMACK* into the *CSS VIRGINIA*.[23]

The following year – 1857 - Porter finally passed his naval constructor's examination. This triumph was somewhat diminished by the fact that the Navy obliged U. S. naval constructors to go to whatever post the Navy assigned them. The first of Porter's three such assignments turned out to be at the Pensacola Navy Yard in Pensacola, Florida. By fall 1857, the Porter family and their two slaves Willis and Matilda Hodges had all arrived in Pensacola and settled down to what they probably assumed would be a lengthy stay. They became active in the local Methodist congregation. However, the phase in Porter's life did not prove to be lasting. John's oldest son, George, soon returned to Portsmouth, where he married. His son John and daughters Martha Brent and Alice also left to continue their educations in Virginia and North Carolina. The second daughter, Mary, married the Methodist minister, John S. Moore. Then the Civil War intervened.[24]

The Pensacola Navy Yard was far smaller than Gosport Yard but it gave Porter a fine opportunity to develop his skills. While in charge of the Pensacola Yard, Porter designed and built the *USS SEMINOLE*, a screw sloop, launched in 1859. Unfortunately, Porter became embroiled in a lawsuit alleging that he had used inferior materials in constructing *SEMINOLE*. The case ended satisfactorily as far as Porter was concerned but it must have diminished the pleasure he experienced in completing his first ship as a U. S. naval constructor. *SEMINOLE* later did useful service

[19] *Ironclad Down: USS Merrimack-CSS Virginia from Design to Destruction*, by Carl D. Park, Annapolis, MD: U.S. Naval Institute Press, © 2007, pp. 14-15; *John L. Porter: Naval Constructor of Destiny*, by Alan B. Flanders, White Stone, VA: Brandylane Publishers, Inc., © 2000, p.15-18; *USS CONSTELLATION (1855)* http://www.history.navy.mil/danfs/c13/constellation-ii.htm

[20] *USS COLORADO (1856).* Wikipedia http://en.wikipedia.org/wiki/USS_Colorado_(1856)

[21] *USS ROANOKE (1855)* Wikipedia. http://en.wikipedia.org/wiki/USS_Roanoke_(1855)

[22] *USS CONSTELLATION (1797)* Wikipedia. http://en.wikipedia.org/wiki/USS_Constellation_(1855)

[23] *Ironclad Down: USS Merrimack-CSS Virginia from Design to Destruction*, by Carl D. Park, Annapolis, MD: U.S. Naval Institute Press, © 2007, pp. 14-16.

[24] *Ironclad Down: USS Merrimack-CSS Virginia from Design to Destruction*, by Carl D. Park, Annapolis, MD: U.S. Naval Institute Press, © 2007, pp. 16-17; *John L. Porter: Naval Constructor of Destiny*, by Alan B. Flanders, White Stone, VA: Brandylane Publishers, Inc., © 2000, p.25-26.

during the Civil War capturing three blockade-runners and participating in the *MONITOR-VIRGINIA* battle and the Battle of Mobile Bay.[25]

Porter was still working at Pensacola when Abraham Lincoln won the presidential elections in November 1860 thus precipitating the secession crisis. The Porter family felt the shock very quickly. Before the end of November, the Navy Department stopped paying the salaries of the workers at the Pensacola Yard, causing a great deal of distress among the workers' families. Then, on 10 January 1861, Florida voted to secede from the United States and two days after that local militia forces seized control of the Pensacola Yard in bloodless coup. The militia then told the small U. S. Navy contingent to leave the Yard.[26]

By this time, John's wife Mary had returned to Portsmouth with their daughters, Mary and Alice, and their son, James. Luckily, John quickly received a new assignment, his second, at the Washington Navy Yard in Washington, DC. There he began work outfitting the *USS PAWNEE* and installing machinery in the *USS PENSACOLA*.

While engaged in this work, Porter testified in the court martial of Commodore James Anderson, who had surrendered the Pensacola Navy Yard without a fight. Porter gave a simple factual account of what happened. The court martial found Anderson guilty and suspended him from the service for five years. Luckily for Anderson, however, the initial public indignation at the surrender of the Pensacola Navy Yard to the Confederates passed. Navy then reconsidered the court's decision and allowed Anderson to serve throughout the war. He even returned to command the Pensacola Navy Yard. Apparently, the Navy came to realize that there was little that Anderson could have done to defend the Yard with the few men at his disposal. Porter has left an account of his service in Pensacola in his notebook.[27]

Porter's situation in Washington must have left him seriously conflicted. Professionally, he could have asked for no better assignment for a naval constructor: in the national capitol with the prospect of war looming. Personally, however, the situation was not nearly so advantageous. His assignment in Washington had separated Porter from his wife and family,

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[25] *Ironclad Down: USS Merrimack-CSS Virginia from Design to Destruction*, by Carl D. Park, Annapolis, MD: U.S. Naval Institute Press, © 2007, pp. 16; *John L. Porter: Naval Constructor of Destiny*, by Alan B. Flanders, White Stone, VA: Brandylane Publishers, Inc., © 2000, p.27-29.

[26] *Ironclad Down: USS Merrimack-CSS Virginia from Design to Destruction*, by Carl D. Park, Annapolis, MD: U.S. Naval Institute Press, © 2007, pp. 16; *John L. Porter: Naval Constructor of Destiny*, by Alan B. Flanders, White Stone, VA: Brandylane Publishers, Inc., © 2000, p.29-35.

[27] *John L. Porter Notebook*, pp. 205-207. John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858.

who had returned to the family home in Portsmouth, Virginia. If Virginia were to join the Confederacy, the Porters would find themselves divided by the battle lines for an indefinite period. As the prospect of Virginia's secession grew larger, Porter grew more worried and began to request a transfer to be near his family. The chance of this happening, however, seemed low in view of the short period of time he had spent in Pensacola and his recent arrival Washington.

At this point, fate intervened, in Porter's life. Samuel M. Pook, the chief naval constructor at the Gosport Navy Yard, in Portsmouth, Virginia since 1859, and one of Porter's earliest teachers as a naval constructor, decided to leave the South. A strong Unionist, who had no desire to find himself in the South in the event of war, Pook had requested a transfer to a northern shipyard. The request granted, he moved to St. Louis where he designed and built gunboats for the U. S. Navy. On 1 April 1861, when Porter learned of Pook's transfer, he applied for the vacancy created at Gosport.

Events at this stage were moving with great rapidity. On 12 April, Confederate forces fired on Fort Sumter, in the harbor at Charleston, South Carolina. President Lincoln issued his called 75,000 state militia troops for 90 days service on 15 April. On 17 April, Virginia voted to secede from the Union. Also on 17 April, the Navy Department ordered Porter to report posthaste to the Charles Stewart McCauley, the Commandant of the Gosport Navy Yard to begin his third, last, and shortest assignment for the United States Navy.[28]

When Porter arrived at the Gosport Yard to report to McCauley, he found all in confusion. The workers were all "standing around" idle, some loyal to the Union, others to the Confederacy, but all uncertain about what to do. Porter was probably equally uncertain and immediately headed home to convene a family conference. He was convinced that the South had little or no chance of winning a war against the North but he was a Virginian, first, and more loyal to Virginia than the United States.[29]

Meanwhile, in response to the growing threat from secessionist forces, the Navy Department had been taking steps to increase the strength of its naval forces at the Gosport Navy Yard since the middle of March. By the middle of April McCauley, at age 68, was in the same situation that Commandant Anderson had faced in Pensacola. He was desperately trying to avoid blame

[28] *John L. Porter Notebook*, pp. 207-211. *Ironclad Down: USS Merrimack-CSS Virginia from Design to Destruction*, by Carl D. Park, Annapolis, MD: U.S. Naval Institute Press, © 2007, pp. 17-21; *John L. Porter: Naval Constructor of Destiny*, by Alan B. Flanders, White Stone, VA: Brandylane Publishers, Inc., © 2000, p.37-39.
[29] *Ibid.*

for "losing" the Gosport Yard if the Confederates seized it. McCauley could take no overt act to protect the Yard because the Navy Department had ordered him to do nothing that the Confederates might see as a hostile act, but he did not have sufficient forces to defend the Yard against serious attack. McCauley had at least eight warships available to help defend the Yard, although some, like the *USS MERRIMACK*, were undergoing repairs. His main problem however was that the federal government had written off the whole Portsmouth area as indefensible lacking a major military relief campaign. Neither the Army nor the Navy had sufficient forces to conduct such a campaign. The main federal interest was to force the South to take the first aggressive steps to seize the Gosport Yard.[30]

After Virginia voted to secede, the federal interest changed to trying to save the Navy Yard and ships berthed there. This complicated McCauley's problems because all his junior officers and most of the workers were Southerners. They passed information on McCauley's plans and intentions and they tried to keep him confused about Confederate plans and intentions. Unsurprisingly, McCauley turned to drink and became incapable of effective action. Secretary of the Navy Sumner Welles decided to replace him. Welles sent Commodore Hiram Paulding to succeed McCauley. When Paulding arrived on the *USS PAWNEE*, on 20 April, he found that McCauley had decided that the situation was hopeless and had issued orders to destroy the Navy Yard and the ships in it. After a brief survey of the situation, Paulding agreed with McCauley's assessment and ordered that the destruction to continue. With the help of several hundred U. S. troops from the 3rd Massachusetts Regiment, 100 sailors from the *USS CUMBERLAND*, the Marines stationed at the Yard, Paulding began to destroy everything he could destroy. Prior to his arrival, the Navy personnel had scuttled all the ships in the Yard. He ordered the destruction of the warehouses and equipment. In the case of the *USS MERRIMACK*, however, the fires had the effect of protecting the engines and boilers. When the upper decks burned, the engines and boilers were safe below the waterline. More seriously, the attempt to blow up the dry dock failed when the powder charges failed to ignite. The *PAWNEE* and the tug *YANKEE* managed to tow the *CUMBERLAND* out of the Yard to safety but the U. S. Navy had to abandon all the rest of the ships.[31]

The Navy treated McCauley in much the same way as they had treated Commodore Anderson who had lost Pensacola, except that the Navy forced

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30 *Ibid*.
31 *Ibid.*

McCauley to face a court martial. The Navy allowed McCauley to retire from the Navy in December 1861. The Navy judged that McCauley did the best he could in an impossible situation and perhaps did not want to provide the media an opportunity to review its own contribution to the loss of the Yard. McCauley died shortly after the war in May 1869.[32]

Porter says that he resigned as a U. S. Naval Constructor the same day that he reported for duty at Gosport and immediately reported to Commandant French Forrest, who had assumed command of the yard for the State of Virginia.[33]

Porter immediately began to work for the Confederacy creating a new Navy at the Rocketts Shipyard near Richmond. He made a beginning with equipment and supplies salvaged from the Gosport Yard. At another yard across the James River from Rocketts he began building ships for the new James River Squadron for the Confederate Navy. During the war, Porter also worked with James Mead to design and supervise construction of a series of ironclads based on the *CSS VIRGINIA*. They all had shallow draft and casemates like the *VIRGINIA*'s. However, none of these ironclads proved very successful. While lighter than the *VIRGINIA*, they were too under-powered to venture out to sea and too clumsy to navigate in the confined waters of the James River. They served, essentially, floating gun platforms to protect fixed positions, like cities. In the end the Union only destroyed one of Porter's ironclads: the *CSS ALBEMARLE*. Of the twenty-three others, the Union captured three; the Confederates had to destroy the other twenty to prevent them falling into Union hands.[34]

As the war neared its end, Porter was in Wilmington, North Carolina working on the *CSS ALBEMARLE*. When Fort Fisher fell and, with it, Wilmington, in late February 1865, he helped burn the *ALBEMARLE* and the other permanent Navy yard facilities. Porter then collected his men and movable equipment and retreated to Halifax, North Carolina, hoping to find a place where he could resume work on the ironclads but found himself blocked by Sherman's Army marching north from Georgia. Soon thereafter, he learned that Richmond would soon fall. At this, Porter seemed to lose heart, too. He furloughed his men and tried to head home, living off the unpaid wages of men who had deserted. However, when he arrived in Raleigh, he learned that Richmond had already fallen and that President Davis had retreated to Danville while General Lee had moved to

[32] *Ibid.*
[33] *Ibid.*
[34] *Ironclad Down: USS Merrimack-CSS Virginia from Design to Destruction*, by Carl D. Park, Annapolis, MD: U.S. Naval Institute Press, © 2007, p. 213.

Appomattox Court House and surrendered his remaining forces to Union commander General Ulysses S. Grant. Barred from returning to Portsmouth, Porter moved on to Greensboro, North Carolina, where General Joseph E. Johnston in command of the last large Confederate Army in the East, had his headquarters, and rented a room. Soon the Confederate cabinet arrived in town, including President Davis, and as Porter recalled, "everything for a while seemed in a fog."[35]

Porter remained in Greensboro for about a month. During that time General Joseph E. Johnson determined

> "that the cause was lost, and made arrangements with General Sherman who was then near Raleigh to surrender his forces which was done on the first day of May /64 [ie 65] and we were paroled, and allowed to go to our homes and not to be molested by the U. S. Government so long as we did not violate the terms of the agreement. I went to Richmond found my family had gone to Portsmouth"[36]

When Porter got to Portsmouth, he found that his home on County St. "was confiscated and sold to a man named Husted for $700, by the U. S. Marshall." The community had fallen apart and "every one seemed for himself, no one seemed to sympathise with me for my losses of house, negroes and situation as U. S. N. constructor."

The next few years were very hard on Porter both financially and psychologically. From time to time, he applied for various city government positions but without success. When he had been a constructor in the Navy, he remembered,

> "I had friends a plenty, but after the war I had none, being left poor, and needy, and I often regretted that I ever gave up my situation which offered me a good living for life, instead of roughing it for a living which I had to do afterwards in the ship yards.[37]

In July 1877, George R. Boush, a naval constructor whom Porter had befriended when he had been in charge of the Gosport Yard, hired Porter and put him in charge of the whip sawyers. This, he wrote, "was the first kindness I had received from any one, in these parts, since the close of

[35] *John L. Porter Notebook*, pp. 216-233. John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858; *Ironclad Down: USS Merrimack-CSS Virginia from Design to Destruction*, by Carl D. Park, Annapolis, MD: U.S. Naval Institute Press, © 2007, pp. 214-228.
[36] *John L. Porter Notebook*, pp. pp. 227-228. John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858.
[37] *John L. Porter Notebook*, pp. 233-234. John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858.

the war."[38] He later became superintendent of construction at the Barkley Shipyard.

In his final years, Porter carried on a public debate with John Mercer Brooke and Catesby ap Jones who had denied that he had "invented" the *CSS VIRGINIA.* Together with his son, Porter published the story of how he had designed and built the VIRGINIA and how Brooke and Jones had distorted the truth of the matter. In doing this, Porter has preserved for history both his own role in Confederate ironclad development, and the best remaining images and accounts of the VIRGINIA and her reconstruction.[39]

Towards the very end of his life, Porter managed to achieve a measure of success. In 1883, at the age of seventy, he won election as superintendent of the Norfolk County Ferries. As superintendent, he also designed several ferries. He served until 1888, when he retired. Financially secure once more, he was able to buy his wife's old family home and live comfortably. Porter died at age eighty, on 14 December 1893.[40]

John L. Porter - John M. Brooke Feud

In many instances, the southern version of Civil War history has triumphed over the northern version but this has usually depended on the southerners having a simple and unified point of view. The long-running and bitter *MONITOR – VIRGINIA* feud is an exception to this rule. In this battle, a simple and unified southern point of view has been entirely lacking.

The dispute between Naval Constructor John Luke Porter and Lt. John M. Brooke, who also served on the Confederate committee charged with raising and rebuilding the *Merrimack*, about who deserved credit for designing the *VIRGINIA*, began during the rebuilding process and broke into print almost immediately after the MONITOR - *VIRGINIA* clash in March 1862. The debate continued for more than thirty years until Porter's death in 1893.

Significant evidence supports both sides of the argument. To this day, some historians give the credit to Brooke while others give it to Porter. Both sides have partisans. The evidence in the notebook completely vindicates Porter but it is also completely one-sided. However, it is not the purpose of this

[38] *John L. Porter Notebook*, pp. 234, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858. *John L. Porter: Naval Constructor of Destiny*, by Alan B. Flanders, White Stone, VA: Brandylane Publishers, Inc., © 2000, p. 127-131.
[39] *Ironclad Down: USS Merrimack-CSS Virginia from Design to Destruction*, by Carl D. Park, Annapolis, MD: U.S. Naval Institute Press, © 2007, p. 214-215.
[40] *Norfolk County Ferries Superintendent Election*, in *John L. Porter Notebook*, pp. 3-4, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858.

exhibit to settle the argument; rather its purpose is to present Porter's position as he argued it to himself.[41]

In recent years, with the discovery and recovery of the *MONITOR* from the seabed off North Carolina's Outer Banks attention has focused even more strongly on the *MONITOR* and away from the *VIRGINIA*. Thus, it may be useful to bring, again, to the public's attention some information concerning the history of the *VIRGINIA* and one of her designers and builders, John Luke Porter.

Origin of Porter's Naval Constructor's Notebook

Porter began making entries in this notebook in 1859 while serving at the U. S. Navy Yard in Pensacola, Florida. He intended it as a guide for future naval constructor candidates. In a "Preface" to the notebook, Porter describes that initial purpose:

> This little book contains what is requisite for a candidate to know before he can pass a creditable examination as a constructor in the U. S. Navy. It was completed by myself after my examination as such for a reference, for it will readily be seen after a full perusal of it, that it would be next to impossible for any person to retain it all for any length of time, but if the book is at hand, he could soon refresh himself in case he forgot any part of it. . . . The workings of the displacements, centre of gravity, meta centre, centre of effort of the sails, scale of capacity, &c, &c, have been taken from Steele's works on naval architecture and are the best and plainest now in use . . . .[42]

The initial appraisers of the notebook took Porter at his word and assumed that he had filled the entire volume with this notebook of information required to pass the naval constructors examination. Upon further processing of the collection, however, the curatorial staff realized that this was untrue. They discovered that the *Naval Constructor Candidates Examination Notes* was limited to the first 191 pages of the notebook.[43] Derived from earlier published works, it was a compendium of useful information for passing the U. S. naval constructor's examinations.

Interspersed throughout the notebook, the curatorial staff found a fascinating series of other entries. Inside the front cover, Porter had pasted the

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[41] For more on the Porter-Brooke dispute, see for example: *Ironclad Down: USS Merrimack-CSS Virginia from Design to Destruction*, by Carl D. Park, Annapolis, MD: U.S. Naval Institute Press, 2007, p. 194.

[42] *Preface*, In *John L. Porter Notebook*, pp. 5, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858.

[43] *Naval Constructor Candidates Examination Notes,* In *John L. Porter Notebook* pp. 5-163, 182-191, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858.

Directions for Loading and Handling the [Fixed Fuze] Shell. A printed broadside, it apparently removed it from the munitions' packaging.[44] Between the Title Page and the Preface Porter had inserted an account of his election as Superintendent of the Norfolk County Ferries on 27 December 1882.[45] Later, they discovered copies of several letters and autobiographical accounts of Porter's Civil War experiences, probably written or re-written between 1872 and 1878 in his own hand. Porter wrote some of these accounts on blank pages within the text of his earlier naval constructors' notebook; he wrote others on separate pages and pasted them into the notebook. He also included in the postwar material a draft or copy of a letter he had written to Thomas Oliver Selfridge, a naval officer who had come out of retirement to command the Boston Navy Yard and father of Lt. Thomas Oliver Selfridge, Jr. who had been wounded while serving aboard the USS CUMBERLAND during its battle with CSS VIRGINIA.[46]

The notebook also includes the texts of two autobiographical accounts described below. These autobiographical accounts, entitled *True History of the Iron-Clad Steamer Merrimac 1861 & 2 (1874)*[47] and *A Short History of Myself during the War of 1861 (27 May 1878)*[48] partly overlap with one another and are generally consistent with Porter's wartime testimony and his reports to the Confederate Congress. They are also consistent with his letters to various newspapers disputing Lt. Brooke's claims to have designed the *CSS VIRGINIA*, which have appeared in print elsewhere.[49]

In these accounts, Porter describes his evolution from Union to Confederate Naval Constructor during 1860-1861. He also recounts the Confederate takeover of the Pensacola and Gosport Navy Yards. Besides describing in detail the re-construction of the *VIRGINIA*, Porter assesses the battle damage she suffered and the repairs he made after her first encounters with the Union fleet and the *MONITOR*.

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[44] *Directions for Loading and Handling the [Fixed Fuze] Shell* In *John L. Porter Notebook*, pp. Inside Front Cover. John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858.

[45] *Superintendent of the Norfolk County Ferries,* In *John L. Porter Notebook*, pp. 3-4. John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858.

[46] *John Porter's Letter to Thomas Oliver Selfridge (21 December 1872*) In: *John L. Porter Notebook*, pp. 195-204, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858; See also Biographical Notes.

[47] *True History of the Iron-Clad Steamer Merrimac 1861 & 2,* in: *John L. Porter Notebook,* pp. 164-179, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858.

[48] *A Short History of Myself During the War of 1861 (1878),* in *John L. Porter Notebook*, pp. 205-234, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858.

[49] *C.S.S. Virginia (Merrimack): Story of Her Construction, Battles &c,* by John L. Porter, pp. 1-16, Navy Collection, Misc. Box 2 / Porter, Eleanor Brockenbrough Library, The Museum of the Confederacy, Richmond, VA.

In *A Short History of Myself during the War of 1861 (27 May 1878)*, Porter reviews his wartime experiences as a Confederate naval constructor beginning with the presidential election of 1860 and the spread of the secession movement. He describes the seizure of the Pensacola Navy Yard by a "battalion" of five companies of Alabama volunteers and its surrender by Commodore Anderson. He goes on to discuss his transfer to the Washington Navy Yard, his post from November through mid-April 1861. He then discusses his transfer to the Gosport Navy Yard in Portsmouth, Virginia and his arrival (20 April 1861) in the midst of its destruction and evacuation by the U. S. Navy and its seizure by the State of Virginia. He discusses his subsequent role as naval constructor at the Gosport Navy Yard, including mounting defensive batteries, clearing the wreckage, and the raising and reconstruction of the *CSS VIRGINIA.* He also discusses his appointment by President Jefferson Davis to be a naval constructor for the Confederates States and the shipyards he established and his role in building and repairing ships for the Confederacy. He relates his promotion to Chief Naval Constructor for the Confederate Navy, and his subsequent travels throughout the Confederacy supervising the construction of warships. Especially noteworthy is Porter's account of his experiences from the fall of Fort Fisher, North Carolina in January 1865 to General Joseph E. Johnston's surrender at Greensboro, North Carolina in May 1865. Porter vividly recollects the death of the Confederacy and analyzes the reasons for its defeat.[50]

The copy of the letter from Porter to Thomas O. Selfridge, is dated Portsmouth, Virginia 21 December 1872. Selfridge was a retired naval officer who had commanded the Boston Navy Yard during the Civil War. His son, also a naval officer, had served aboard the *CUMBERLAND* during her battle with the *VIRGINIA*, and had later served aboard the *MONITOR*.[51] The letter includes material also discussed in the *True History of the Iron-Clad Steamer Merrimac 1861 & 2 (1874)* and *A Short History of Myself during the War of 1861 (27 May 1878)* but adds significant additional information, including two sketches showing details of the *VIRGINIA*'s ram and armor.

[50] *A Short History of Myself During the War of 1861 (27 May 1878)*, in: John L. Porter Notebook, pp. 205-234, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858.

[51] *John Porter's Letter to Thomas Oliver Selfridge (21 December 1872),* in: *John L. Porter Notebook,* pp. 195-204, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858; Porter also reproduced the letter in *C.S.S. Virginia (Merrimack): Story of Her Construction, Battles &c*, by John L. Porter, pp. 1-16, Navy Collection, Misc. Box 2 / Porter, Eleanor Brockenbrough Library, The Museum of the Confederacy, Richmond, VA.

The Porter Notebook also includes a copy of an undated letter from Samuel Moore Pook, one of Porter's instructors as a naval constructor, in which Pook proves how "a small size ship of war will carry more cargo than a large one on the same draft of water."[52]

Further, Porter includes a list of all the ironclad ships[53] he had designed and built over the years, the lyrics to a War of 1812-era popular song entitled *Hornet and Peacock*.[54]

Digital Exhibit Project

Between 2001 and 2010, with the assistance of Special Collections Department staff, the editor has transcribed, edited and digitized the entire notebook including both the naval constructors' notebook and the autobiographical materials relating to Porter's Civil War experiences.

In transcribing the notebook the editor has attempted to reproduce accurately both Porter's style and substance. In the interest of readability, the editor has occasionally standardized and corrected Porter's spelling and punctuation. He has also attempted to render in electronic format Porter's mathematical equations. In addition, the editor has provided a glossary of naval, mathematical, nautical, and other terms used by Porter in the text. The editor has also provided directories of most persons, places and ships mentioned in the text, omitting only those too well known or of too little significance to require explanation. Where necessary, the editor has occasionally provided footnotes corroborating or explaining Porter's statements in the manuscript. Where online versions of these citations are available, the editor has included them as links for further reading.

In digitizing the notebook, the editor has also uncovered several, never before published, details. Among the most interesting of these details, now available online for the first time, are two sketches that Porter made, including a horizontal elevation of the *CSS VIRGINIA* dated 1862 and two detail drawings of her armor plating, showing how Porter strengthened her after her battle with the *MONITOR.*

Porter's notebook appears here in print and in its entirety for the first time. The *Hornet and Peacock* lyrics and the Selfridge letter have both appeared

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[52] *Samuel Moore Pook's Letter to John L. Porter (undated),* in: John L. Porter Notebook, pp. 180-182, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858.

[53] *Record of Iron Clads,* in: *John L. Porter Notebook*, p. 192, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858

[54] *Hornet & Peacock,* p. 194, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858; Lyrics & music for the "Hornet & Peacock" is available online at: http://sniff.numachi.com/pages/tiHRNTPEAK;ttHRNTPEAK.html ; & http://back.numachi.com:8000/dtrad/midi/HRNTPEAK.midi

in print on numerous occasions although Porter's version is somewhat different from most others. The Civil War material from Porter's notebook has also appeared in print before although not in the same sequence. Alan B. Flanders' 141-page biography of Porter, entitled *John L. Porter: Naval Constructor of Destiny* (White Stone, VA: Brandylane Publishers, © 2000) includes transcriptions of Porter's Civil War material from the notebook although he does not cite a repository for the collection. Flanders also intersperses his own descriptions of events between passages drawn from the Porter notebook. The transcriptions of the text in the present publication are new and drawn directly from the original notebook, not from the Flanders book. Also entirely new are the, glossary of terms, list of ships and places mentioned in the text, the biographical notes, and the footnotes explicating the text.

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John L. Porter Notebook

Front Cover

John L. Porter
U. S. Naval Constructor

Fixed Fuze. Directions for Loading and Handling the Shell

"FIXED FUZE.[55]"

Directions for Loading and Handling the Shell.[56]

The Shell is not loaded with a bursting charge; but is to be filled with powder, through the charging hole, which must then be carefully plugged with a plug made of beech or of oak, and not of pine. The time of burning of the fuze is marked in seconds on THE LEADEN PATCH which covers the fuze. Before firing REMOVE THE LEADEN PATCH, with the point of the instrument provided for that purpose, or the shell will fail to explode. This must be done after the shell is put into the mouth of the gun, and, and the same time, the surface of the composition much to PRICKED UP so as to raise the fibres of the quick match and thus ensure its taking fire when the gun is discharged.

The manner in which the shell is strapped shows that it is not intended that the fuze shall lie directly in front. If should be placed TOWARD THE MUZZLE, ABOVE THE CENTRE OF THE BORE AND IN THE VERTICAL PLANE which cuts THE AXIS OF THE BORE. The shell being somewhat heavier at the fuze hole than at any other part, by this position of the fuze the greatest regularity of flight, together with the longest range, will be obtained. If, by any accident, the shell should slip in its straps, so that the fuze hole shall be covered or its position deranged, hold the shell firmly and tap the sabot with a mallet or light hammer until the fuze is brought in a direction, which, when the shell is placed in the gun, shall form an angle of about 45 degrees with the axis of the bore.

Instead of ramming the shell, PUSH IT HOME and avoid turning the rammer in this operation for fear of altering the position of the fuze.

In loading, even a grummet is unnecessary, and may hinder the fuze from igniting. The sabot to which the shell is strapped will prevent it from wither rolling or sliding out of place.

Officers are particularly enjoined not to explain the character of these fuzes, and the manner of fitting them, to persons unconnected with the service of the United States.

[1]

[55] Fuze: i.e. fuse.
[56] Printed instructions glued to inside of front cover.

Title Page

John L. Porter
U. S. Naval Constructor 1860
Pensacola Navy Yard

[2]

Norfolk County Ferries Superintendent Election

On the 29th of December 1882 I was elected a Superintendent of the Norfolk County Ferries, the following members of the committee being present Wm. A. McWherter, chairman, Wm H. Peters, R. I. Neely, T. I. Nottingham, Wm H. Douglas & Chas. H. Graham, committee present, and went on duty on the 1st of January 1883. So soon as C. W. Murdaugh, who had been appointed judge of the Hustings Court by the Readjuster Legislature, assumed control, he removed Mssrs. Peters and Neely [?] two of the most efficient members of the committee and appointed in their stead, Ambroso Lindsey and Andrew Hopkins, Readjusters. Mr. Lindsey remained but a short time on the committee and resigned and Mr. John White (Readj.) was appointed in his stead, so the committee now stands on the first day of June:

[3]

Wm. A. McWherter, Chair, Republican
W. N. Douglas Do
T. I. Nottingham Democrat
Chas. H. Graham Readjuster
Andrew Hopkins Do
John White Do

My friends on this committee are the first three named, and to whom I am indebted for my position today, June 9th 1883, but don't know what a day may bring forth in this time.

[4]

Preface

This little book contains what is requisite for a candidate to know before he can pass a creditable examination as a Constructor in the U. S. Navy. It was compiled by myself after my examination as such for a reference, for it will readily be seen after a full perusal of it, that it would be next to [sic] impossible for any person to retain it all for any length of time, but if the book is at hand, he could soon refresh himself in case he forgot any part of it. Everything in the book is made plain and easy to be understood. The workings of the displacements, centre of gravity, meta centre, centre of effort of the sails, scale of capacity, etc. etc. have been taken from Steele's works on Naval Architecture and are the best and plainest now in use, as also the laying down of the lines, bevellings, etc. etc. etc.

John L. Porter
U. S. N. Constructor
1860

[5]

Mathematical Formulae for Naval Constructors

<u>Addition of Vulgar Fractions</u>

Add $\frac{1}{7}$. $\frac{2}{7}$ and $\frac{3}{7}$ together

1 x 7 x 7	=	49
7 x 2 x 7	=	98
7 x 7 x 3	=	<u>147</u>
		294
7 x 7 x 7	=	$49\overline{)343}$

$$\frac{numerators\ 6}{denominators\quad 7\ ans.}$$

Add $\frac{1}{4}$ and $\frac{3}{5}$ together

$\frac{1}{4}$ x $\frac{5}{3}$ = 5
4 x 3 = <u>12</u>
<u>17</u> numerators}
4 x 5 = 20 denominators } = $\frac{17}{20}$ ans.

Add $\frac{1}{8}$ $\frac{3}{10}$ $\frac{4}{12}$ together

$\frac{1}{8}$ x 10 x 12	=	120		
8 x 3 x 12	=	288		
10 x 8 x 4	=	<u>320</u>		
8 x 10 x 12	=	8)<u>728</u>	numerators}	$\frac{91}{120}$ ans.
	=	8)<u>960</u>	denom.}	

Add 5-$\frac{2}{3}$ 6-$\frac{7}{8}$ 4-$\frac{1}{2}$ together

			<u>Integers</u>
2 x 8 x 2 =	32	5	
3 x 7 x 2 =	42	6	
1 x 8 x 3 =	<u>24</u>	4	
3 x 8 x 2 = 48	)<u>98</u> numer.		
	48 denom. 2$\frac{1}{24}$		2 $\frac{1}{24}$
			7.$\frac{1}{24}$ ans.

Addition is reversed.

[6]

Addition of Vulgar Fractions

Add $\frac{5}{6}$ of $\frac{9}{10}$ and $\frac{7}{12}$ of $\frac{4}{5}$ together

$\frac{5}{6} \times \frac{9}{10} = \frac{45}{60}$ $\frac{7}{12} \times \frac{4}{5} = \frac{28}{60}$

Sum $\frac{45}{60} \times \frac{28}{60}$

$\frac{45}{60} \times \frac{60}{28} = \frac{2700}{1680}$

)4380 num.

60 x 60 = 3600   )3600 den   = $1\text{-}\frac{13}{60}$ ans.

Addition of Compound Vulgar Fractions

Add $\frac{7}{9}$ of a £ to $\frac{3}{10}$ of a shilling

1 £ = 20 s.   1 s. = 12 d.

```
      7    s      d               3
9 ) 140 (  15     6 2        10 ) 36 (  3 3
    9               3             30      5
    50                         2 ) 6  | = 3
    45                           )10  |   5
     5  d
    12
9 ) 60   ( 6 d
    54
 3 ) 6 =     2
     9       3
```

$\frac{2}{3}$ and $\frac{3}{5}$

$\frac{2}{3} \times \frac{5}{3} = \frac{10}{5}$

15) 19 num $1\frac{4}{15}$

3 x 5 = 5) 15 den

			s d
Sum	$\frac{7}{9}$ of one £	=	15 - 6 $\frac{2}{3}$
	$\frac{3}{10}$ of one s.	=	- 3 $\frac{3}{5}$
		s.	15.10 $\frac{4}{15}$ ans.

Addition [sic] is reversed

[7]

Subtraction of Vulgar Fractions

From $\frac{4}{5}$ take $\frac{3}{5}$ ans. $\frac{1}{5}$

From $\frac{7}{12}$ take $\frac{4}{12}$ ans. $\frac{3}{12}$ or $\frac{1}{4}$

From $\frac{3}{7}$ take $\frac{2}{5}$

$\frac{3}{7} \times \frac{5}{2} = \frac{15}{14}$

$7 \times 5 = \frac{1}{35}$ ans.

From 8-$\frac{2}{9}$ take 6-$\frac{3}{11}$

8-$\frac{2}{9} = \frac{74}{9}$ 6-$\frac{3}{11} = \frac{69}{11}$

$\frac{74}{9} \times \frac{11}{69}$ = 814

$\underline{621}$

99)$\underline{193\ \text{num.}}$ | = 1 - $\frac{94}{99}$ ans.

11 x 9 = $\underline{99}$ |

$\frac{94}{99}$

From $\frac{1}{2}$ of $\frac{9}{10}$ take $\frac{1}{4}$ of $\frac{4}{9}$

$\frac{1}{2} \times \frac{9}{20} = \frac{9}{20}$ $\underline{1} \times \frac{9}{4} = \frac{4}{9}$ 36

$\frac{9}{24} \times \frac{36}{4}$ = 324

$\underline{80}$

) $\underline{244}$ = $\underline{61}$

36 x 20 = 4) 720 = 180 ans.

Reversed

[8]

Subtraction of Vulgar Fractions

From 6 take $\frac{1}{8}$

$6.\frac{8}{0}$
$\underline{\quad 1}$
$5.\frac{7}{8}$ ans.

From 3 take $\frac{3}{16}$

16
3.0
$\underline{\quad 3}$
$2.\frac{13}{16}$ ans.

From 100 take $99\frac{99}{100}$

100
100 . 00
$\underline{99 . 99}$
$\frac{1}{99}$ ans.

Subtraction of Compound Vulgar Fractions

From $\frac{7}{9}$ of a £ take $\frac{3}{10}$ of a shilling

1 £ = 20 s.
$\underline{\quad 7}$
9)140 (
$\underline{9}$
50
$\underline{45}$
5
$\underline{\quad 12 \text{ d.}}$
9)60 (6
$\underline{54}$
$\frac{6}{9} \mid \frac{2}{3}$

s. d.
15. 6- $\frac{2}{3}$

3- $\frac{3}{5}$

$15.3\frac{1}{15}$ ans.

1 s. = 12 d.
$\underline{\quad 3}$
10) 36(3 $\frac{3}{5}$
$\underline{30}$
2) $\frac{6}{10}$ $\frac{3}{5}$

$\frac{2}{3}$ X $\frac{5}{3}$ = $\frac{10}{9}$

3 X 5 = $\frac{1}{15}$ denom.

Subtraction is reversed.
[9]

Multiplication of Vulgar Fractions

Multiply $\frac{4}{9}$ x $\frac{2}{7}$ = $\frac{8}{63}$ ans.

Multiply $\frac{1}{12}$ x $\frac{3}{8}$ = 3 | $\frac{3}{96}$ | $\frac{1}{32}$ ans

Multiply 12 $\frac{3}{5}$ x 7 $\frac{2}{3}$ 12 $\frac{3}{5}$ = $\frac{63}{5}$. 7 $\frac{2}{3}$ = $\frac{23}{3}$

$\frac{63}{5}$ x $\frac{23}{3}$ = $\frac{1449}{15}$ = 96 $\frac{3}{5}$ ans.

Multiplication not reversed.

Division of Vulgar Fractions

Divide $\frac{4}{9}$ x $\frac{7}{8}$ = $\frac{4}{9}$ x $\frac{8}{7}$ = $\frac{32}{63}$ ans.

Divide $\frac{4}{7}$ x $\frac{2}{3}$ = $\frac{4}{7}$ x $\frac{3}{2}$ = $\frac{12}{14}$ or $\frac{6}{7}$ ans.

Divide 1 $\frac{1}{2}$ x 4 $\frac{8}{10}$ = $\frac{3}{2}$ x $\frac{10}{48}$ = 6 | $\frac{30}{96}$ = $\frac{5}{16}$ ans.

Division is reversed.

[10]

Vulgar Fractions / Decimal Fractions Values

Same Values Vulgar Fractions	Same Values Decimal Fractions
$\frac{1}{8}$	00.1
$\frac{1}{4}$	00.2
$\frac{3}{8}$	00.3
$\frac{1}{2}$	00.4
$\frac{5}{8}$	00.5
$\frac{3}{4}$	00.6
$\frac{7}{8}$	00.7
1	00.8
2	00.17
3	00.25
4	00.33
5	0.42
6	0.50
7	0.58
8	0.66
9	0.75
10	0.83
11	0.92
12	10.00

[11]

Addition of Decimal Fractions

Place tens under tens, hundreds under hundreds, etc**.** Then sum up as in whole numbers, and separate the integers from the decimals by a dot. Example add together

10.257 .. 5.393 .. 4.937 .. 3.873..2.92

10.257
5.393
4.937
3.873
2.92
27.380 sum

Subtraction by Decimal Fractions

Proceed as in the preceding rule then subtract as in whole numbers.

Example

Subtract 10.87686 from 21.59984

21.59984
10.87686
10.72298 ans.

[12]

Multiplication of Decimals

Multiply as in whole numbers and cut off as many figures from the product, proceeding from right to left, for decimals as there are decimal figures in the multiplier and the multiplicand.

Example, multiply 13.59876
by 15.58797

```
        13.59876
        15.58797
         9519132
       12238884
       9519132
     10879008
     6799380
    6799380
   1359876
   211.9770629172
```

To find the Decimal of any vulgar fraction, annex cyphers [ciphers] to the numerator and divide by the denominator.

Example. What is the decimal value of $\frac{3}{4}$ [?]

$$4\,)\,\frac{3.00}{2.8}\,(\;\frac{75}{100}\;\text{ans}$$
$$\frac{2.0}{2.0}$$

[13]

Duodecimals

Feet by feet give feet	Ft.
Feet by primes give primes	‘
Feet by seconds give seconds	“
Primes by primes give seconds	“
Primes by seconds give thirds	“’
Primes by thirds give fourths	“”
Seconds by seconds give fourths	“”
Seconds by thirds give fifths	“”’
Seconds by fourths give sixths	‘’’’’’
Thirds by thirds give sixths	
Thirds by fourths give sevenths	‘’’’’’’
Thirds by fifths give eighths	‘’’’’’’’

How many square feet in a floor 35 feet 4 $\frac{1}{2}$ inches long by 12 feet 3 $\frac{1}{3}$ inches wide [?]

Example

Feet	‘	‘’		‘’’	‘’’’	
35	4	6				
12	3	4				
424	6	0				
8	10	1	-	6		
	11	9	-	6	0	
434	3	11		0	0	ans

[14]

<u>Reduction of Vulgar Fractions</u>

Reduce $\frac{72}{96}$ to its lowest terms

Exam. 12 | $\frac{72}{96}$ 2 | $\frac{6}{8}$ $\frac{3}{4}$ ans.

Reduce $\frac{9}{27}$ to its lowest terms 9 | $\frac{9}{27}$ $\frac{1}{3}$ ans.

Reduce $\frac{3}{4}$. $\frac{4}{5}$. $\frac{5}{6}$ to a common denominator

Example 3 x 5 x 6 = 90 } numerators
4 x 4 x 6 = 96 }
5 x 5 x 4 = 100 }
4 x 5 x 6 = 120 common denominators

Result $\frac{90}{120}$ x $\frac{96}{120}$ x $\frac{100}{120}$ ans.

Reduce 12 $\frac{4}{9}$ to an improper fraction –

Ex.

$$\begin{array}{r} 12 \\ \underline{9} \\ 108 \\ \underline{4}+ \\ \frac{112}{9} \end{array}$$

Reduce $\frac{219}{17}$ to its proper terms

17) 219 (= 12 $\frac{15}{17}$ ans

Reduce $\frac{2}{3}$ of $\frac{3}{4}$ of $\frac{4}{5}$ to a single fraction

Ex. $\frac{2}{3}$ x $\frac{3}{4}$ x $\frac{4}{5}$ = $\frac{24}{60}$ or $\frac{2}{5}$ ans.

Reduce $\frac{5}{6}$ of a penny to the fraction of a £

Ex. $\frac{5}{6}$ x $\frac{1}{12}$ x $\frac{1}{20}$ = $\frac{5}{1440}$ or $\frac{1}{288}$ ans

[15]

<u>Reduction of Vulgar Fractions</u>

Reduce $\frac{1}{1584}$ of a day to the fraction of a minute

Ex. $\frac{1}{1584}$ x $\frac{24}{1}$ x $\frac{60}{1}$ =	1440	180	20	10 ans
	2584	298	22	11

Reduce $\frac{2}{3}$ of a £ to its proper value

Ex. 20 s.
 2 s
3)40 (= 13-$\frac{1}{3}$

Reduce $\frac{9}{10}$ of a year to its proper quantity

Ex. 365
 9
10)3285 (= 328 days 12 hours

Reduce 13 s. 4 d. to the fraction of a £
Ex

s d	d	
13 - 4	= 160	2 ans
£ 1	= 240	3

Reduce 10 s. 6 d. to the fraction of a £

d. 10 s 6 d	= 126	21 ans
£ 1	= 240	40

[16]

Square Root

What is the 4^{th} power of 2

Ex. 2 x 2 x 2 x 2 = 16 ans.

What is the square root of

```
          5499025 (2345 ans
          4____
     4³ )1.49
          1.29
    464 ) 20.90
          18.56
   4685 ) 244.25
          234.25
```

What is the square root of $\frac{7056}{9216}$

```
Ex.  7056 (84          9216 ( 96
     64____            81____
 164) 6.56        186) 1116
      6.56             1116
```

12	84	7 ans
	96	8

If the fraction be a sum that is one whose root cannot be exactly found reduce it to a decimal and then extract the square root.

Ex. What is the square root of $\frac{478}{549}$

```
549 ) 478 (  =    870673  (.9334 ans
                  81____
           183 ) 606
                  549___
          1863 )  57.73
                   55.89_
```

---

[17]

Square Root

What is the square root of $37\frac{36}{49}$ [?]

Ex. $37\text{-}\frac{36}{49} = \overline{\frac{1849}{49}} = \frac{43}{7}$ 7) 43 (6 $\frac{1}{7}$ ans
42
$\frac{1}{7}$

What is the square root of 8-5/7 [?]
Ex. $8\frac{5}{7}$ = 8,7143 (2.954 ans
4
49) 471
441
585) 30.43
29.25

What is the square root of 20736 [?]

[Ex.] 20736 (144 ans
1
24) 1.07
96
284) 11.36
11.36

Figure 1 a Square Root

Proof
100^2 = 10,000
100 x 40 x 2 = 8,000
40^2 = 1,600
4^2 = 16
20,736

The square filled up.

[18]

Cube Root

What is the cube root of 99252847 [?]

99,252,847 (463 ans.
4^3 = 64
4^2 x 3 = 48)352
) 99252
46^3 =) 97336
46^2 x 3 = 6348) 19168
99252847
463^3 = 99252847

Another mode

What is the cube root of
673,373,097,125 (8765 ans [?]
8^3 = 512
161.373

8^2 x 3 = 192.
7^2 annex .49
7 x 3 x 8 =168.8
20929 x 7 = 146.503
14870097

87^2 x 3 = 22707.
6^2 annexed = .36
6 x 3 x 8.7 = 156.6
2286396 x 6 = 13718376

876^2 x 3 = 2302128. 1151721125
5^2 annex = .25
5 x 3 x 876 = 1314.0
22303442.25 x 5 = 1151721125

[19]

Logarithms

Logarithms are a series of numbers or rather roots of numbers calculated in order to facilitate those operations which cannot be performed without extreme labour and delay by common arithmetic.

By means of a table of logarithms multiplication is performed by addition and division by subtraction.

The integer prefixed to a logarithm is called its index. Thus 2. is the index of the logarithm 2.2081725.

The logarithm of 10 is 1, of 100 is 2, of 1,000 is 3, of 10,000 is 4, etc.

When the number for which a logarithm is wanted lies between 1 and 10, 10 and 100, 100 and 1,000, &c,

[20]

Logarithms

. . . a reference must be to a table of logarithms.

The index of the logarithm of any integer or mixed number is always one less than the number of integer places in the natural number. Thus between 100 and 1000, it is 2, and 10,000 it is 3, etc. The index is generally omitted in tables for the sake of brevity.

To find the logarithm of any mixed decimal number.

Rule Find the logarithm as if it were a whole number, and prefix the index of the integer part.

Thus: the logarithm of 259.7 is 4147, to which if the index be prefixed the logarithm is 2.4147.

[21]

Logarithms

To find the logarithm of a vulgar fraction. Rule subtract the logarithm of the denominator from the logarithm of the numerator borrowing 10 in the index, when the denominator is the greatest. The remainder is the logarithm required. What is the logarithm of $\frac{5}{9}$ [?]

Ex. Logarithm of 5 = $\overset{10}{0}$.69897

" of 9 = 0.95424

9.74474

Multiplication by Logarithm

Rule Add together the logarithms of the multiplier and the multiplicand. The sum is the logarithm of the answer required.

Multiply 9 by 253.

Ex. Logarithm of 9 = 0.95424

" of 253 = 2.40312

3.35736

3.35736 is the logarithm of 2277 ans

[22]

Logarithms

Division [by logarithm]
Subtract the logarithm of the divisor from the logarithm of the dividend. The difference is the logarithm of the quotient.

Divide 477 by 3

Ex. Logarithm of 477	=	2.67852
“ “ 3	=	0.47712
		2.20140

Logarithm of 2.20140 is 159 ans

Involution by Logarithm

Rule Multiply the logarithm of the root by the index of the power to which it is to be raised. The product is the logarithm of the answer.

Required the 5th power of 11.

Ex. Logarithm of 11	=	1.04139
	x	5
		5.20695

5.20695 is the logarithm of 161051 the answer.

[23]

Logarithms

Evolution [by Logarithm]

Divide the logarithm of the given number, by the index of the power. The quotient is the logarithm of the root. Example.

What is the cube root of 15625 [?]
Logarithm of .15625 = 4.19382.
419382 divided by 3 = 1.39794.
139794 = logarithm of 25 ans.

Rule of Three by Logarithms

Add together the logarithms of the 2nd and 3rd terms, and from their sum deduct the logarithm of the first term. The difference will be the logarithm of the answer.

Example.

If 110 gives 19 what will 94 give [?]

	100	:	19	: :	94	
Log -	204139	:	197313	: :	127875	
					197313	
					3.25188	2nd & 3rd terms
				deduct	2.04139	1st term
					1.21049	

1.21048 logarithm of 16.24 ans.

[24]

Algebra

+ into + produces +
- into + produces -
+ into - produces -
- into - produces -

This is for multiplication.

In division the same rule is to be observed respecting the signs as in multiplication. That is: If the divisor & dividend are both positive, or both negative, the quotient must be positive. If one is positive and the other negative the quotient must be negative.

[Algebra] Addition

Add	- 3bc	- ax	- 2ab	my
to	- bc	-3ax	- ab	- 3my
	- 5bc	-2ax	- 7ab	- 8my
	- 9bc	-6ax	-10ab	-12my

Add	+ 6b	+4b	+5bc	- 2 hm	- dy	+ 6 m
to	- 4b	-6b	- 7bc	- 9 hm	- 4 dy	-__ m
	+ 2b	-2b	- 2bc	- 7 hm	- 3 dy	+ 5 m

[25]

Algebra

[Algebra] Subtraction

From	+28	16 b	14 da	-28	- 16 b	- 14 da
Subtract	+16	+12 b	+ 6 da	-12	- 4 b	- 6 da
	+12	+ 8 b	+ 8 da	-16	- 12 b	- 8 da

This case is the same as in arithmetic. The two next examples do not occur in common arithmetic.

From	+16 b	12 b	6 da	-16	- 12 b
Subtract	+28 b	16 b	14 da	-28	-16 b
Div.	-12 b	- 4 b	- 8 da	+12	4 b

From	+ 28	+ 16 b	+ 14 da	- 28	- 16 b
Subtract	- 16	- 12 b	- 6 da	+ 16	+ 12 b
Div.	+ 44	28 b	20 da	- 44	- 28 b

From	2 xy - 1	h + 3 bx	hy - ah
Subtract	- xy + 7	3h – 9 bx	5 hy – 6 ah
Div.	3 xy – 8	2h + 12 bx	- 4 hy + 5 ah

From	3 abm	h + 3 bx	-17 + 4 ax
Subtract	- 7 abm	3h – 9 bx	-20 - ax
Div.	10 abm	- 2h + 12 bx	+ 3 + 5 ax

[26]

Algebra Multiplication

Multiplication in whole numbers is taking the multiplicand as many times as there are units in the multiplier.

Mul.	9 ab	12 hy	3 dh	2 ad	7 bdh
Into	3 xy	2 rx	ny	13 hmy	x
	27 abxy	24 hyrx	3 dhny	26 adhny	7 bdhx

Multiply	d + 2 xy	2 h + m	3 hl + 1	2 hm
Into	3 b	6 dy	ny	4 b
Prod.	3 db	12 hdy + m	3 hlny + ny	4 my

Mult.	b + a	b + c + 2
Into	b + a	b + c + 3
	bb + ab	bb + bc + 2b
	+ ab + aa	bc + cc + 2c
Prod.	bb + 2ab + aa	+ 3b + 3c + b
		bb + 2bc + 5b + cc + 5c b

If the signs of the factors are alike the signs of the product will be affirmative, but if the signs of the factors are unlike the signs of the product will be negative.

Mul	b – 3a	2a – m	h – 3d – 4
Into	6y	3h + x	2y
	6y – 18ay	6ah · 3hm	2hy – 6dy – 8y

2ax mx

6ab . 3hm 2ax mx

[27]

Algebra Division

When the divisor is found as a factor in the dividend, the division is performed by canceling this factor.

Divide	ex	dh	drx	hmy	dhxy	abcd
By	$\frac{e}{x}$	$\frac{d}{h}$	$\frac{dr}{x}$	$\frac{hm}{y}$	$\frac{dy}{hx}$	$\frac{b}{acd}$

If a letter is repeated in the dividend care must be taken that the factor rejected by only equal to the divisor.

Div.	aab	bbc	aadddx	aammyy
by	$\frac{a}{ab}$	$\frac{b}{bx}$	$\frac{ad}{addx}$	$\frac{amy}{amy}$

In division the same Rule is to be observed respecting the signs as in multiplication. That is if the divisor and dividend are both positive or both negative, the quotient must be positive. If one is positive and the other is negative, the quotient must be negative.

[28]

Algebra Continued

Find the number which being added to itself shall give a sum equal to 30.

$$x + x = 30$$
$$2x = 30$$

Hence $x \; \frac{30}{2} = 15 = x$

A cask which held 143 gallons was filled with a mixture of brandy and water, and there was ten times as much brandy as water. How much was there of each [?]

Let x = the gallons of water
Let 10 x = the gallons of brandy

Therefore $x + 10x = 143$ gallons
Or $11x = 143$ gallons

Hence $x \; \frac{143}{11} = 13$ the answer

[29]

Algebra

Divide 1000 dollars between A B & C so that A shall have $72 dollars more than B and C $100 more than A.

Let x = B's share of the 1000
Then x = + 72 = A's share
And x + 172 = C's share

Their sum is 3 x + 244 = $1000

By transposing 244 we have

$$3x = 1000 - 244 = 756$$

and $x = \frac{756}{3} = 252$ = B's share

Hence x + 72 = 252 + 72 = $324 = A's share
And x + 172 = 252 + 172 = $424 = C's share

Verification 252 + 324 + 424 = 1000

The product of a, c, and c, divided by the difference of c and d is equal to the sum of b and c added to 15 times h.

Ans. $\frac{abc}{c-d} = b + c + 15h$

[30]

<u>Algebra</u>

A mast 100 feet high broke off at such a distance from its base that the top struck the ground at the distance of 50 feet from it. At what height did it brake [sic] [?]

<u>Example</u>

Figure 1 b Algebra

Let $x = A, C$

$100 = x = DC$ or $C B$

$(100 - x^2) = (x^2) \quad (50^2)$

$1000 - 200x + x^2 = x^2 + 2500$

$-200x + x^2 - x^2 = 2500 - 10{,}000$

$-200x = 7500$

$2 \quad x = 75$

$2 \quad x = 37\frac{1}{2}$

$100 - 37\frac{1}{2} = 62\frac{1}{2} = BC$ or CD

Proof $50^2 \quad = 2500$

1406.25

$37\frac{1}{2}^2 = 2\ \sqrt[2]{\frac{3906.25}{36}}$

122) 306

<u>244</u>

62.25

[31]

Mechanical Powers

Lever

The power multiplied by its distance from the fulcrum, is equal to the weight multiplied by its distance from the fulcrum.

Ex. A weight of 1600 lbs. is to be raised by a force of 80 lbs. required the length of the longest arm, the shortest being one foot.

$\frac{1600}{80} = 20$ ans Proof $1600 \times 1 = 1600$

$80 \times 20 = 1600$

A weight of 400 lbs is placed 15 inches from the fulcrum of a lever. What force will raise it, the length of the other arm being 10 feet [?]

Ex: $\frac{400 \times 15}{120} = 50$ ans

[32]

Mechanical Powers - Lever

When the fulcrum is at one extremity and the weight at the other. Rule, as the distance between the power or weight and the fulcrum is to the distance between the weight and the fulcrum, so is the effect to the power.

Example

What power will raise 1500 lbs the weight being 5 feet from it and 2 feet from the fulcrum [?]

Figure 2 Levers' Power to Raise Weights

5 + 2 = 7 : 2 :: 1500

$$\begin{array}{l} \underline{\quad 1500} \\ 7)\ 3000\ \ (\ 428 - \frac{4}{7}\ \text{ans.} \\ \quad \underline{28} \\ \quad 20 \\ \quad \underline{14} \\ \quad\ \ 60 \\ \quad\ \ \underline{56} \\ \quad\quad \frac{4}{7} \end{array}$$

[33]

Mechanical Powers - Lever

What is the weight in each support of a beam that is 30 feet long supported at both ends and bearing a weight of 6000 10 feet from one end

Figure 3 Levers' Weight Capacity

30 : 20 : :: 6000 = 4000
30 : 10 : :: 6000 = 2000

If on a lever 6 feet long 45 lbs be placed on one end and 20 lbs on the other at what point will they balance [?]

Figure 4 Levers' Balancing Point

[34]

Mechanical Powers - [Cranes]

To find the power of cranes divide the product of the driven teeth by the product of the drivers and the quotient is the relative velocity, which multiplied by the length of the winch, and the force in pounds, and divide by the radius of the barrel, will give the weight that can be raised.

Example.

The force of 18 lbs is applied to the winch of a crane, the length being 8 inches, the pinion having 6 and the wheel 72 teeth, and the barrel 6 inches in diameter, what weight can be raised [?]

Figure 5 Cranes

```
         6)72
           12 relative velocity
            8 length of winch
           96
           18 lbs applied
          768
           96
rad  3) 1728
          576 ans
```

[35]

Mechanical Powers - [Inclined Plane]

Inclined Plane

As the length of the plane is to its height so is the weight to the power.

Example

Required the power necessary to raise 100 lbs up an inclined plane 6 feet long and 4 feet high.

As 6 : 4 : : 1000
1000
6) 4000
666 $\frac{2}{3}$ ans

Two bodies on two inclined planes sustain each other by the aid of a cord over a pulley. Their weights are directly as the length of their planes.

Figure 6 Inclined Planes

[36]

Mechanical Powers - Screw

The screw is an inclined plane wound round a cylinder. Its length is found by taking the square of the circumference of the screw, and adding the pitch, which is the height between the threads, and finding the square root of that sum.

Then as the length of the plane is to the height so is the weight to the power.

If a lever or bar be added, the radius described from the centre is the length of the plane.

Then as the radius described is to the radius of the screw, so is the weight to the power or the power to the weight.

[37]

Mechanical Powers - Screw

What power is requisite to raise a weight of 8000 lbs by a screw 12 inches in circumference and 1 inch pitch [?]

Ex. $\frac{12 + 1}{12}$

$\sqrt[2]{1.45}$ (12.04116 : 1 : : 8000

1	8000
22) 45	12.0416) 8000) 664.36 ans
44	722496
2404) 1.0000	775040
9616	722496
24081) 38400	525440
24081	481664
240826) 1431900	437760
1444956	361248
	765120
	722496

If a lever of 30 inches be added 3.1416) 12,0000 (3819 ÷ 2 = 1.9095430 = 31.9095 : 1.9095 : : 664.36 = 39.75 ans

Figure 7 Screws

[38]

Mechanical Powers - Pulley

Divide the weight to be raised by the number of parts ingaged [sic] in supporting the lever or moveable block.

Example

What power is required to raise 600 lbs when the lower block contains six shives[57], and the end of the rope is fastened to the upper shive.

6 shives
2 parts
12 parts) 600 (50 ans
60
0

And what power when fastened to the lower block [?]

6 shives
2 + 1
13) 600 (46.15 ans

[Mechanical Powers] - Wedge

As the length of the wedge is to half it back so is the resistance to the force.

[39]

[57] Shives: pulleys

Specific Gravities

To find the specific gravity of a body heavier than water.

Rule[:] Weigh it both in an out of water and take the difference. Then as the weight lost in water is to the whole weight, so is 1000 to the specific gravity of the body.

Example.

What is the specific gravity of a stone which weighs 15 pounds but is water only 10 lbs [?]

15 — 10 = 5
5 : 15 :: 1000
1000
5) 15000
3000 ans

If it is lighter than water weigh it and multiply the weight by 16 for the specific gravity of a cubic foot [of water].

[40]

Gravitation of Bodies

To find the velocity of a fallen body will acquire in any given time.

Rule. Multiply the time in seconds by 32.166.

Example

Required the velocity in 12 seconds

12 x 32.166 = 386 feet. ans

To find the velocity a body will acquire by falling from any given height.

Rule. Multiply the space in feet by 64.333, and the square root of the product will give the velocity[.]

To find the space through which a body will fall in any given time[:]

Rule. Multiply the square of the time in seconds by 16.083[.] It will give the space[.]

[41]

[Geometry Theorems]

Geometry Theorem I [Angles]

Figure 8 Right Angles

When a right [straight] line as A,B stands upon another right line as C, D they form two angles D,A,B, and B,A,C which together are equal to two right angles.

Demonstration

If A,B were perpendicular to C,D each of the angles would be a right angle, but as E, A, B is the excess of B,A,C, above a right angle, and D,A,B is less than a right angle by the same quantity, the angles D,A,B and B,A,C, must be equal to two right angles.

If ever so many right lines stand thus on one point A, on the same side of the right line C,D, the sum of all the angles are equal to two right angles or 180 degrees.

[42]

Geometry Theorem II [Intersection of Right Lines]

If two right lines intersect each other the opposite angles are equal.

Figure 9 Intersection of Right Lines

Demonstration

By theorem 1st B.E.D and D.E.A are equal to two right angles, for the same reason the angle A.B.C and A.E.D are also equal to two right angles and by subtracting the common angle A.E.D the remaining angles will be equal. That is the angle D.E.B. is equal to the angle A.E.C. and the angle A.E.D to B.E.C.

[Geometry] Theorem III [Intersection of Parallel Lines]

Figure 10 Intersection of Parallel Lines

If a straight line A.B.C intersect two parallel [sic] straight lines C.D.E.F the alternate or opposite angles will be equal, and the outward angle A, will be equal to the inward or opposite angle C.

[43]

Geometry Theorem III [<u>Intersection of Parralel Lines</u>]

<u>Demonstration</u>

If we suppose the space between CD and EF to be a line, the outer opposite angles are equal to the last theorem by the same reason the angle A is equal to the angle E, and the angle C to the angle D.

<u>Geometry Theorem IIII [Right Angled Triangles]</u>

Figure 11 Right Angled Triangles

In any right lined triangle the sum of the three angles is equal to 180 degrees or two right angles, and if one side of the triangle as B.C.A continued or produced, the outward angle A.C.D will be equal to the sum of the inward and opposite angles A & B.

<u>Demonstration</u>

Through the point A draw a right line EF parallel [sic] to B.D. then by

[44]

Geometry Theorem IV [Right Angled Triangles] (continued)

theorem III, the angle E.A.B is equal to the angle A.B.C and F.A.C to A.C.B "hence the three angles included in the semi-circle, are equal to the three angles of the triangle. Again the three angles of the semi circle are equal to two right angles or 180 degrees, and the three angles of the triangle are also equal to two right angles. The two angles DCA & ACB are likewise equal to two right angles, as before shown, and use of course equal to three angles of the triangle subtracting therefrom the common angle A.C.B the angle C.A.B and A.B.C. Hence the sum of any two angles of a triangle subtracted from 180 degrees, gives the third angle.

[45]

Geometry Theorem V [Parallelograms]

Figure 12 Parallelograms

Parallelograms [sic] standing on the same base, or equal bases, and between the same parallels [sic] are equal.

Demonstration

As A.B is equal to C.D so must A.a be equal to B.b. B.a being common to both and because A.C equals B.D. as the angle A equals the angle C, the triangle A.C.a is equal to the triangle B.D.b and if from both these triangles, the common triangle B.e.a be taken there will remain the tripazoid [sic] A.B.c.C equal to the tripazoid [sic] a.b.c.D. Now the tripazoid [sic] A.B.c.C added to the triangle D.c.C is equal to the parallelogram [sic] A.B.C.D. and the tripazoid [sic] a.b.c.D added to the triangle C.c.D is equal to the parallelogram [sic] a.b.C.D.

[46]

Geometry Theorem V [Parallelograms] (continued)

Consequently the parallelogram [sic] A.B.C.D. is equal to the parallelogram [sic] a.b.C.D. Hence all triangles standing on the same base, or when equal bases, and between the same parallels, are equal, for all triangles are but the halves of their corresponding parallelograms [sic], and if the whole be equal, the halves must also be equal.

Geometry Theorem VI [Right Angled Triangles]

In any right angled triangle the square of the hypotenuse or side opposite to the right angles, is equal to both the squares of the side containing it.

[47]

Geometry Theorem VI [Right Angled Triangles] (continued)

Figure 13 Right Angled Triangles

Let the triangle A.B.C have a right angle at B. The will the square of A.C. be equal to the squares of AB and B.C.

Demonstration

Upon A.B. BC. CA, describe the squares AE. BF. BI. Draw likewise BK parallel [sic] to CA. and join BD. BE. AI and C.F. Now the angle DAC, is equal to the angle F.A.B each being right angles & by adding the triangle A.B.C common to both, the angle B.A.D is equal to the angle F.A.C. also because AB is equal to A.F. and AD to A.C. By construction the triangle B.A.D is equal to the triangle F.A.C. The parallelogram [sic] A.K is equal to twice the triangle B.A.D. and the square A.a is equal to twice the triangle A.F.C. Consequently the

[48]

Geometry Theorem VI [Right Angled Triangles] (continued)

parallelogram [sic] A.K is equal to the square A.A.

In like manner it may be shown that the parallelogram [sic] C.K is equal to the square C.H.

The triangle E.C.B is equal to the triangle A.C.I. The parallelogram [sic] C.K is equal to twice the triangle E.C.B and the square C.H is equal to twice the triangle A.C.I. Consequently the parallelogram [sic] C.K is equal to the square C.H. The square A.E is equal to the parallelogram [sic] AK and CK and the square A.E is also equal to the squares AG and CH. Hence from two sides of a triangle right angled given the third may be easily found. The hypotenuse by adding the square of the two legs and extracting the sq [uare] root, the others by subtracting the squares & finding the square root.

[49]

Geometry Practical

To divide a given right line into two equal parts.

Figure 14 Dividing a Line in Equal Parts

From a given point in or near the middle of a given line, to draw a perpendicular to the given line.

Figure 15 Drawing a Perpendicular from the Middle of a Line

From a given point near the end of a given line, to draw a perpendicular to the given line.

Figure 16 Drawing a Perpendicular from the End of a Line

[50]

Practical Geometry

From a given point let fall a perpendicular to a given line when the point is nearly over the middle of the line.

Figure 17 Dropping a Perpendicular to the Middle of a Line

From a given point nearly at the end of a given line to raise a perpendicular.

Figure 18 Raising a Perpendicular from the End of a Line

To divide a given angle into two equal parts.

Figure 19 Dividing an Angle into Two Equal Parts

[51]

Practical Geometry

To divide a right angle into three equal parts.

Figure 20 Dividing an Angle into Three Equal Parts

To find the centre of a circle.

Figure 21 Finding the Center of a Circle

To describe a circle that will pass through any three given points not situated in a right line.

Figure 22 Describing a Circle that will pass through Three Given Points

[52]

Practical Geometry

To construct an elipse [sic].

Figure 23 [Constructing an Ellipse]

Make C.C equal to A.G and Cb to Bg then drive a nail at c and f and put on a string which shall reach C and proceed to draw the elipse [ellipse].

Pentagon

Figure 24 [Constructing a Pentagon]

Hexagon

Figure 25 [Constructing an Hexagon]

Octagon

Figure 26 [Constructing an Octagon]

[53]

Practical Geometry

One triangle that will equal two triangles.

Figure 27 One Triangle that will Equal Two Triangles

One square that will equal two squares.

Figure 28 One Square that [will] Equal Two Squares

Figure 29 a Isosceles Triangle: 2 Sides Equal

Figure 29 b Right Angle Triangle / Hypothenuse [sic]

Figure 29 c A Quadrilateral or square all sides equal angles right.

Figure 30 Parallellohedron [sic]: a solid

Figure 31 Prismoid

Figure 32 Rectangle

Figure 33 Prism

[54]

Practical Geometry

A Parallellogram [sic] or Rhomboid: Opposite sides parallel [sic], but not right angles.

Figure 34 Parallellogram [sic] or Rhomboid

A Rhombus: All side equal but angles not right.

Figure 35 Rhombus

To Expand a Quarter Circle

Figure 36 To Expand a Quarter Circle

[55]

Practical Geometry

[Geometry of a Circle]

Figure 37 Geometry of a Circle

To lay off a Mast Hole, Octagon

Figure 38 To lay off a Mast Hole, Octagon

[56]

Practical Geometry

A parabola is a figure formed by cutting a section from a cone by a plane parallel [sic] to its sides.

To Construct a Parabola

Figure 39 To Construct a Parabola

[57]

Practical Geometry

[Forming a Hyperbola]

A Hyperbola is a figure formed by cutting a section from a cone by a plane not parallel [sic] to its axis, or sides

To Construct a Hyperbola

Figure 40 To Construct a Hyperbola

[58]

Mensuration of Surfaces

To find the area of a circle.

Rule – Square the diameter and multiply this sum by .7854.

To find the circumference. Multiply the diameter by 3.1416

Figure 41 To find the Circumference of a Circle

To find the area of an Ellipse. Multiply the two diameters together and the product by .7854.

To find the circumference square the two diameters and multiply the square root of half their sum by 3.1416.

Figure 42 To find the Area of an Ellipse

[59]

Mensuration of Surfaces

To find the Area of the Segment of a Circle. Multiply the chord by the versed sine; divide the product by 3 and multiply the remainder by 2.

Figure 43 To find the Area of the Segment of a Circle

To find the Area of a Cycloid. Multiply the area of the generating circle a.b.e by 3, and the product is the area.

Figure 44 To find the Area of a Cycloid

[60]

Mensuration of Surfaces

Figure 45 To find the Area of a Lune [Lunette]

To find the area of a Lune [Lunette] find the area of each segment of the circle from which the Lune [Lunette] is formed, and subtract one from the other, and the difference will be the area required.

Figure 46 To find the Area of a Convex Surface

To find the [area of] the convex surface multiply the diameter of the sphere by its circumference and the produce is the surface.

[61]

Mensuration of Surfaces

To find the Area of a Trepezoid [Trapezoid]

Figure 47 To find the Area of a Trepazoid [Trapezoid]

Multiply the sum of the parallel [sic] sides by the perpendicular a.b. between them. One half this sum is the area.

To find the Area of a Trepezium [Trapezium]

Figure 48 To find the Area of a Trapezium

Multiply the diagonal a.c by the perpendicular falling upon it from the opposite angles. Half the product is the area.

To find the Area of a Triangle

Figure 49 To find the Area of a Triangle

Multiply the sides A.B by the perpendicular falling upon it. Half the product is the area.

[62]

Mensuration of Surfaces

Circular Arc Sector Area

Figure 50 To Find the Circular Arc Sector

To find the area multiply the length of the arc by half the radius of the circle of which it is a part.

Figure 51 To Find the Length of the Arc

To find the Length of the Arc

From 8 times the chord of half the arc A.B. subtract the chord of the whole arc A.C. One third the remainder will be the length.

[63]

Mensuration of Surfaces

[Diameter of a Circle]

When the chord and versed sine of an arc is given to find the diameter of the circle.

Rule. Divide the square of half the chord by the versed sine and to the quotient add the versed sine.

The apothine and cord [sic] of a circular sector being given to find the radius of the circle.

Rule. To the square of the apothine, add the square of half the cord [sic], and extract the square root of the sum of the squares.

The versed sine and cord [sic] of an arc being given to find the cord [sic] of half the arc.

Rule. To the sqr [square] of the versed sine, add the square of half the cord [sic], and extract the square root of the sum.

[64]

Mensuration of Surfaces

Figure 52 To Find the Area of a Right Angled Triangle

To find the area of a right angled triangle multiply the base A.B by the height B.C. Half the product is the area.

To find the length of the hypotenuse, add together the squares of the other legs A.B and B.C and extract the square root of that sum.

To find the length of the other leg when the hypotenuse and one leg is given subtract the square of the leg given from the square of the hypotenuse & extract the square root of the remainder. The square of the hypotenuse A.C. is equal to the squares of the other two sides A.B and B.C.

[65]

Mensuration of Surfaces

Figure 53 To Find the Area of a Parabola

To find the area of a right angled triangle multiply the base a.b by the height c.d. Two thirds the product will give the answer.

Figure 54 To Find the Area of an Hyperbola

To find the area of an hyperbola. To the product of the transverse and abscissa a.b. add 5/7 of the square of the abscissa, and multiply the square root of the sum by 21. Add 4 times the square root of the product of transverse and abscissa to the product last found and divide the sum by .75.

[66]

Mensuration of Surfaces

Figure 55 To Measure Irregular Figures

To measure any irregular figures lay it of [sic] in any number of ordinates required taking the half of the first and last. Add them together and multiply them by the distances between them, and the product will be the area required.

[To find the area of a Regular Polygon]

To find the area of any regular polygon multiply [the length of the sides] by the number of sides in the figure and the and the product by the perpendicular falling upon it. One half the product will be the answer.

[67]

Mensuration of Surfaces

Table 1 Area of a Regular Polygon

To find the area of any regular polygon multiply the square of the side of the polygon by the number opposite the name of the polygon in this table.

	Sides	Number for Area	Angle
Trigon	3	0.433012	60”
Tetragon	4	1.000000	90”
Pentagon	5	1.720477	108”
Hexagon	6	2.598076	120”
Heptagon	7	3.633912	128”
Octagon	8	4.828429	135”
Nonagon	9	6.181824	140
Deckagon	10	7.694208	144”
Undeckagon	11	9.365640	147
Dodecagon	12	11.196152	150

[68]

Mensuration of Solids

To find the solidity of a sphere cube the diameter and multiply the product by .5236.]

Figure 56 To find the Solidity of a Sphere

To find the Solidity of Spherical Segment. To three times the square of the radius of the base a.b add the square of the height b.c Then multiply the sum by the height and the product by .5236.

Figure 57 To find the Solidity of a Spherical Segment

To find the Solidity of a Cone. Multiply the area of the base by the height. One third the product will be the answer.

Figure 58 To find the Solidity of a Spherical Segment

[69]

Mensuration of Solids

To find the Solidity of the Frustrum of a Cone

To find the solidity of the frustrum of a cone add together the end areas A.B and take the mean. Multiply this sum by the height and the product will be the solidity.

Figure 59 To find the Solidity of the Frustrum of a Cone

To find the Solidity of a Pyramid A and Frustrum B

A. Multiply the base by the height. 1/3 the product will give the solidity.

Figure 60 To find the Solidity of Pyramid A

B. Add together the areas of the two ends and take the mean. Multiply this sum by the height and the product will give the solidity.

Figure 61 To find the Solidity of Frustrum B

[70]

Mensuration of Solids

To find the Solidity of a Spheroid

To find the solidity of a spheroid multiply the square of the revolving axis C.D. by the fixed axis A.B. and the product again by 5236.

Figure 62 To find the Solidity of a Spheroid

Figure 63 To find the Solidity of a Frustrum of a Spheroid

To find the solidity of the frustrum of a spheroid. To twice the square of the middle diameter add the square of the end diameter. Multiply this sum by the length of the frustrum and the product again by 2618 for the solidity.

[71]

Mensuration of Solids

Figure 64 To find the Solidity of a Parabolic Conoid

To find the solidity of a parabolic conoid multiply the area of the base by half the altitude and the product will be the solidity. To find the solidity of the frustrum of a parabolic conoid A.B.C.D. multiply the sum of the squares of the diameters of the two ends by the height of the frustrum and the product again by 3927.

Figure 65 To find the Solidity of an Ellipse

To find the solidity of an Ellipse add the two diameters together and multiply the cube of one half that sum by 5236.

[72]

Mensuration of Solids

Figure 66 To find the Solidity of a Hyperboloid

To find the solidity of a hyperboloid. To the square of the radius of the base, add the square of the middle diameter, between the base and vertex. Multiply this by the height, and the product by 5236.

Figure 67 To find the Solidity of a Frustrum

To find the solidity of a frustrum add the squares of the greatest and least semi diameters together, and the square of the square of the middle diameter. This sum multiplied by the height and the product by 5236 will give the solidity.

[73]

Centres of Gravity

To find the centre of gravity of a semi circle, multiply the radius by 4 and divide by 3, multiply by 3.1416.

Figure 68 [To find the Centre of Gravity of a Semi Circle]

To find the centre of gravity of a trapezium, lay it off into four triangles and find the centre of gravity of each and join the four points, the intersection will give the centre of the figure.

Figure 69 [To find the Centre of Gravity of a Trapezium]

To find the centre of gravity of a trepazoid draw a line as A.B. joining the middle of the two parallel [sic] sides, then lay it off into two triangles, and from the centre of gravity of each, join these two centres and where the line intersects the line A.B. will be the centre of gravity.

Figure 70 [To find the Centre of Gravity of a Trepazoid] [sic]

[74]

<u>Centres of Gravity</u>

Figure 71 [To find the Centre of Gravity of a Triangle]

To find the centre of gravity of a triangle draw a line from any angle to the middle of the opposite side two thirds the distance on the line will give the ans.

Figure 72 [To find the Centre of Gravity of a Sector of a Circle]

To find the centre of gravity of a sector of a circle multiply 2 by the chord of the arc, and the radium of the circle and divide by 3 multiplied by the length of the arc, will equal the distance from the centre of the circle.

Figure 73 [To find the Centre of Gravity of a Segment of a Circle]

To find the centre of gravity of a segment of a circle, cube the chord of the segment and divide it by 12, multiplied by the area of the segment.

[75]

Centres of Gravity

Of a Sphere, Spherical Segment, or Zone, at the middle of the height.

Of a cylinder, cone, frustrum of a cone, pyramid, frustrum of a pyramid, or ungula, the centre of gravity is at the same distance from the base as that of the parallelogram, triangle, or trapezoid which is a right section of either of the above figures.

Of Solids

Sphere, cylinder, cube, regular polygon, spheroid, ellipsoid, cylindrical ring, or any spindle, the geometrical centre of these figures is their centre of gravity.

[76]

Cask [Gauging]

Casks are usually divided into four varieties. The first variety is the middle frustrum of a spheroid. Second The middle frustrum of a parabolic spindle. Third The two equal frustrums of a paraboloid united at their bases. Fourth Two equal conic frustrums united at their bases.

When casks are much curved they are considered to belong to the first variety. When less curved to the second variety. When still less to the third, and when straight to the fourth.

To find the contents of a cask of the first variety, to twice the square of the bung diameter A.B. add the square of the head diameter C.D. multiply this sum by the length of the cask, and divide the product by 882.354 for wine gallons, by 1077.15 for ale gallons, by 1054.11 for imperial gallons. That is divide by the divisors for conical vessels and the quotient is the answer.

Figure 74 [To find the Contents of a Cask of the First Variety]

[77]

Figure 75 [To find the Contents of a Cask of the Second Variety]

To find the contents of a cask of the 2nd variety, to twice the square of the bung diameter E.F. add the sqr. Of the head diameter and from the sum subtract $4/10^2$ of the square of the difference of these diameters. Multiply the remainder by the length and divide

by 882.354 for wine gallons
1077.15 for ale gallons
& 1059.11 for imperial gallons.

For those of the 3d variety

Figure 76 [To find the Contents of a Cask of the Third Variety]

Add the square of the bung diameter I.J. to the head diameter. Multiply by the length and divide

By 588.236 for wine gallons
" 718.106 for ale gallons
" 706.0724 for imperial gallons.

[78]

To find the contents of casks of the 4th kind

Figure 77 [To find the Contents of a Cask of the Fourth Variety]

Add the head and bung diameters and their squares together. Multiply by the length, and divide the product by

882.354 for wine gallons
1077.15 for ale gallons
1059.11 for imperial gallons

[79]

<u>Arithmetical Progression</u>

Arithmetical progression is the augmentation or diminution of any series of numbers by the addition or subtraction of an equal difference. Thus 2. 4. 6. 8. 10 are numbers in arithmetical progression increasing by 2, and 100, 96. 92. 88. 84 are in arithmetical progression decreasing by 4.

Proposition 1st

To find the sum of the series, multiply the sum of the extemes by half the number of terms, the product will be the answer.

<u>Example</u>. The sum of a number of terms increasing by 3 the extremes being 1. and 25.

[80]

Arithmetical Progression

Here it is evident that as the difference between 1 and 25 is 24 and the common difference 3, and as 24 ÷ 3 = 8 the number of terms must be equal to 8 + the first term (1) i.e. the number of terms equals 9.

Sum of 1 + 25 = 26 x 4 ½ = 117 ans.

Example 2. What is the sum of the number of times that a clock strikes between the hours of two & twelve.

The first term equals 3. The last term equals 12. The common difference 1. The number of terms = 10

3 + 12 = 15 15 x 5 = 75 the answer.

----

[81]

Arithmetical Progression

Proposition II

Given one of the extremes, the common difference and the number of terms, to find the other extreme. Rule. Multiply the common difference by on less than the number of terms, then add the product to the first term. To find the greatest extreme, or deduct from it the largest extreme, to find the least.

The largest extreme is required of a number whose other extremes is 5. the number of terms 10, and the common difference is 2.

2 x 9 – 18. 18 + 5 = 23 ans.

The smallest extreme is required of a number whose greatest term is 103, the common difference 4, the number of terms, 25.

4 x 24 = 06 103-96 = 7 the ans.

[82]

<u>Arithmetical Progression</u>

Proposition III

Given the extemes and common difference to find the number of terms. Deduct the less extreme from the greater. Divide by the common difference, add 1 to the quotient. The sum is the answer.

Extremes 48 and 152, common difference 4, required the number of terms.

152 – 48 = 104 ÷ 4 = 26 = 1 = 27 ans.

Proposition 4

Given the extremes and number of terms to find the common difference.

Deduct the lesser extreme from the greater. Divide the difference by the number of terms – 1. The quotient is the common difference.

Example. The two extremes 589 and 1093, the number of terms = 127, required the common difference.

1093 – 589 = 504 ÷ 126 = 4 the common difference.

[83]

Geometrical Progression

A geometrical progression is a series of numbers increasing or decreasing by a given proportion that each term divided by its preceding one will produce the same quotient that is given by the division of a number to which the aforementioned term is the divisor, and the next adjacent increasing or decreasing term the dividend. Thus 2 : 4 :: 8 : 16 :: 32 : 64 :: 128 &c.

8 ÷ 4 produces the same quotient or common ratio, as 16 ÷ 8 &c &c.

Proposition I

To find the series or the sum of the series, divide the difference of the extremes by the ratio less 1. Add to the quotient the greatest extreme. The sum is the sum of the series.

Example over.

[84]

Geometrical Progression

The lesser extreme being 2, the larger, 256, the ratio 2, required the sum of the series.

2 : 4 :: 8 : 16 :: 32 : 64 :: 128 : 256 :: number of terms = 8. Difference of extremes = 254 ÷ 1 = 254 + 256 = 510 ans.

Proposition II

To find the greatest extreme, given the ratio, one extreme, and the number of terms.

Rule. Multiply the ratio into itself a number of times, less by 1, than the number of terms. Divide the greater extreme by the product to find the least term and multiply the inferior extreme by it, to find the greatest term.

Example. The smallest term being one, the ratio 3, and the number of terms 8, required the greatest extreme. 3 multiplied 7 times = 2187 x 1 = 2187 the answer.

[85]

<u>Geometrical Progression</u>

Proposition III

Given the extremes and ration to find the number of terms.

Rule. Divide the greatest extreme by the least term, divide the quotient by the ratio til it is equal to it, add 2 to the number of times that the aforesaid quotient has been divided. The sum will be the number of terms.

Example.

Extremes 3 and 2187 ratio 3, required the number of terms.

2187 ÷ 3 = 729 ÷ 5 five times = 3 five times added to 2 = 7 the ans.

[86]

Miscellaneous

[Melting Temperatures]

Copper melts at		1996 degrees	
Gold	" "	2200	"
Brass	" "	1869	"
Cast iron	" "	2786	"
Water boils	"	212	"
Water freezes	"	32	"
Zero the starting point		0	"

[Conversion tables]

One cubic foot will hold one fathom of chain cable 1-11/16 diam.
231 cubic inches in one gallon.

4-$\frac{1}{2}$ cubic feet of bread in a barrel.

$\frac{5}{8}$ of a pound of nails to fasten one sheet of sheathing copper.

A cubic foot of salt water	64 lbs.
" " " " fresh water	62-$\frac{1}{2}$ lbs.
" " " " Cumberland coal	50 lbs.
" " " " anthracite coal	55-$\frac{1}{2}$ lbs.

Space to store a ton of anthr.	40 feet
A bushel of bituminous	80 lbs.
To store a ton	40-$\frac{1}{2}$ lbs.

40 feet of round timber or 50 feet of hewn timber make one tone
One square foot of $\frac{1}{4}$ iron plate 10 lbs.

One square foot of $\frac{3}{4}$ iron plate 30 lbs.
[87]

Miscellaneous

[Calculating Weights of Round Objects]

To find the weight of an iron ball by its diameter, multiply the cube of the diameter in inches by 1365 and the sum is the weight. And divide the weight in pounds by 1365 and the cube root of the product is the diameter.

To find the weight of a leaden ball, multiply the cube of the diameter in inches by 2147 and the sum is the weight. And divide the product in pounds by 2147 and the cube root of the product is the diameter.

To find the weight of a shell multiply the difference of the cube of the extreme and interior diameter in inches by 1365

[88]

Miscellaneous

[Calculating Holding Capacities]

To find how much powder will fill a shell, multiply the cube of the interior diameter in inches by .01744.

	In.	In.
Boats ammunition boxes	19 sqr.	12 deep
150 lbs. powder tanks	17 “	23 “
100 “ “ “	13 “	21 “
50 “ “ “	11 “	18 “
200 “ “ “	__ “	__ “

[Distance Conversions]

30-$\frac{1}{4}$ yards make 1 rod
40 square rods 1 rood
4 square roods (160 rods) one acre
640 acres one square mile.

[Contents of Plank Stock]

To find the cubical contents of a plank stock, multiply the length in feet by the depth and breadth in inches and divide the product by 144.

Ex. 50 x 12 x 12 ÷ 144 = 50 feet ans.

[89]

Miscellaneous

Piling Bales

What is the number of bales in a pile, each side of the base containing 30 bales[?] This is for a triangle 30 x 31 x 32 ÷ 6 = 4960 ans.

How many bales are there in a square pile of 30 rows [?]
30 x 31 x 61 ÷ 6 = 9455 ans.

How many bales are there in an oblong pile, the number in the base rows being 16 and 7[?]
16 x 3 -7 – 1 x 7 x 7 + 1 ÷ 6 = 392 ans.

Chain Cable Lockers

230 cubic feet will hold 165 fath. of 2 in.
85 " " " " 120 " " 1-$\frac{1}{16}$ "
150 " " " " 150 " " 1-$\frac{11}{16}$"

[90]

[Spars and Rigging]

Tops, Trussel [sic] Trees, &c

For the breadth of main top beam x 43

For the length multiply the breadth x 67

For length and breadth of for tops multiply the main top by 92

For the length and breadth of mizzen top multiply main by 75

Fore, main and mizzen trusseltrees in depth equal to their respective topmasts in the caps.

Topmast trusseltrees to be equal in depth to the diameter of respective topgallant masts.

Thickness of trusseltrees half their depth.

Length of after topmast cross trees one half their respective tops.

[91]

Rules for Sparing [sic] a Ship

Length main mast multiply beam by 2.35
“ fore mast multiply main by .92
Mizen [Mizzen] mast $\frac{1}{3}$ mast head above main top
Mast heads 4/23rd of their length
“ Main topmast multiply main mast by .60
“ Fore topmast multiply main mast by .60
“ Mizen topmast multiply mizzen mast by .60
Topmast heads 4/25ths of their length
“ Topgallant masts multiply topmast by .50
“ Royal mast multiply topgallant mast by .68
“ Poles multiply royal masts by .50
“ Main yard length of foremast
“ Fore yard multiply main yard by .92
“ Mizen yard multiply lower yard by .70
“ Topsail yard multiply lower yard by .75
“ Topgallant yards multiply topsail yards by .66
“ Bowsprits out board multiply the ships length by 22. This is for sailing ships. Steamers do not require so much length as this gives

[92]

Rules for Sparing [sic] (continued)

Jib boom multiply bowsprit by .80

Flying jib multiply jib boom by .80

Spanker book over taffrail 10 feet

Spanker gaff multiply beam by .80

Fore gaff multiply beam by .70

Main gaff multiply beam by .55

For the diameter of fore and main masts multiply the length by .32

For the diameter of mizzen mast multiply the length by .25

For diameter of yards multiply the length by .25

Diameter of studdingsail booms multiply their length by .20

Length of studdingsail booms one half of their yards. They go on length of stud. yards 4/7 their booms.

For diameter of topmasts multiply their length by .31

For topgallant masts multiply by.31

Bow Sprit diam. of main mast.

[93]

Iron Work on Spars

Boom irons on fore and main lower and topsail yards.

Quarter irons on main and fore yd.

Iron jack straps on all the yds. Except cross jack, and rope jack stays on fore & main yard in addition to the iron for reefing these starts require to be from 16 to 20 inches apart and rods of iron of $\frac{7}{16}$ to $\frac{3}{4}$ diameter according to the size of the ship.

On the lower yards, fore and main two truss bands, two sling bands & stretcher, and two bands for Ir. Blocks

On the topsail yards, two bands for ties, and ir. Bocks.

On the cross jack two bands for slings & stretcher and two bands for trusses.

Royal yards & topgallant yds. One sling band, and a small eye bolt in each end.

[94]

To Cut Rigging by Drafts

It is necessary to have a draft giving the breadth of beam, and width of channels abreast of each mast, also the breadth of each top, and the length of the cross trees, also a draft from the foremast to knight heads, showing the bow sprit, jib and flying jib booms. A fore and aft draft of the ship entire showing the position of the masts and channels, rakes &c, and distances of dead eyes on the channels and in the tops.

To get the lengths for cutting the lower shrouds, place a mark on the beam draft above the bolster of one and a half the circumference of each respective mast head as required. Then take the distance from it to the upper

[95]

Cutting Standing Rigging

edge of the channel with your dividers. Transfer it to the fore and aft draft by placing one point of your dividers on the channel at the forward dead eye, and the other point on the mast head and mark it. Then measure for the forward leg of no. 1 pair of shrouds from the mark on the mast head to the upper edge of the channel in the wake of its own dead eye, and add to it, once the diameter of the rope, then place a mark for the centre of the eye. Measure for the after leg from mark on the mast head to upper edge of channel in the wake of its own dead eye. Add the diameter of the rope, and the length of no. 1 pair of shrouds will be found.

[96]

Cutting Standing Rigging

Measure for forward leg of no. 2 pair of shrouds from mark on mast head to channel in the wake of its own dead eye and add to it two diameters of the rope then place a mark to the centre of the eye for the after leg, and measure from that mark to channel in the wake of its own dead eye, and add to the same as the forward leg. Continue to measure for each successive pair in the same way, and add to each leg of no. 3, three diameters, to no. 4, four &c &c.

Fore Topmast Rigging. Back strap, Top gallant rigging &c let the same rules be observed. The diameters of the rigging is to be taken with the [service ?] on and the circumference of mast head to be taken just above the bolsters where the rigging is intended to be placed.

[97]

Rigging from the Bow Sprit

Two or three bob stays to cut water
Fore stays sets up to bowsprit
Fore topmast stays sets up through bees and to bulls eyes in the bow
Bow sprit shrouds one or two pair of chain and sets up to hearts on bow, in line with the bow sprit.
Jib and flying jib jib guys of rope and sets up to bulls eyes
Martingale stays of chain and sets up with hearts and lanyards
Jib and flying jib stays comes in through the martingale and sets up to rolling [thimber ?] from a iron rod secured to the bow
Eye bolts are required for bumpkin braces for fore tack, also for a jumper for whiskies, and to haul the cut block fwd of the hawse holes.

[98]

Centre of Effort, Sails

Make a sheer draft of the ship and draw each sail to it s size on a proper scale. Draw also the water or load line to measure the heights from, and erect a perpendicular just forward of the main mast extending as high as the centre of gravity of the highest sail to be takin into the calculation, to measure then fore and after distances on or from.

Then foreward to find the area in square feet of each sail and mark it on that sail when found. Then find the centre of gravity of each sail and mark that also upon each sail. Then measure the height of the centre of gravity of each sail

[99]

<u>Centre of Effort, Sails</u>

from the water or load line and multiply it into the area of said sail for the [msrments ?] After the [msrments ?] for each sail has been found and added together, divide them by the areas of all the sails added together and the height of the centre of effort of all the sails will be found.

To find its position from the perpendicular line erected just forward of the foremast or at the middle of the length on the load water line, proceed to measure the distance of the centre of gravity of each sail that is forward of it and multiply it into the area of each for the [msrments ?] and add them all to gether as the - over

[100]

Centre of Effort, Sails

[msrments ?] before the middle line. Then proceed to measure the distances of the centres abaft the middle line, and multiply each separately into its own area as those fwd for the [msrments ?] abaft the middle line. When if the difference of the two sums of the [msrments ?] be divided by the sum of the areas it will give the place of the centre of effort either before or abaft the middle perpendicular according to which of the [msrments] has the escess.

In calculating the centre of effort of all the sails,   the flying jib and royals are omitted as they are only carried in pleasant weather and do not effect the steering of the ship materially.

[101]

Centre of Effort, Sails

It is a matter of great importance to have the centre of effort of the sails in the proper place, or it would be almost impossible to carry all sail at the same time, and make the ship steer.

This centre should always be forward of the middle of the load water line and between the main and foremast. It frequently occurs that ships gripe forward, or carrys [sic] a lee helm. In all such cases the centre of effort of the sails is not in the right place and the mast should be moved or the sails on one increased, and the others diminished. Sometimes the altering of the rake of the mast will answer the purpose. In the above directions it is presumed the centre of the load water line is the centre of gravity of that line for it is from this point the distances are to be taken.

[102]

Meta Center

The meta center of a ship is at that point above which the center of gravity must in no wise be placed, for if it were, the ship would overset.

This center has also been called a shifting center for it varies it [sic] position with the inclination of the ship. Its vertical position is always to be frwrd [sic] in a line through the center of the ship from the keel upwards.

Whenever the ship is at rest on t he water and in perfect equilibrium the height of the meta center above the center of gravity of the displacement is found by taking the cubes of the ordinates of the load water line from the center of the ship, and multiply them by the distances between

[103]

Meta Center

them for the msrmnts. Two thirds of this sum divided by the whole displacement will give the point of the height of the meta center above the center of gravity of the displacement.

But when the ship is healed [sic] from her upright position as is shown in the figure [78] below, the position of the center of displacement is changed, as also the meta center for the center of displacement

Figure 78 [Calculating the Meta Center]

[104]

Meta Center

which was at G when the figure was in an upright position, has been carried out to H, and the meta center carried up to E on the center line, and out side of the center of gravity D, on a vertical line. Hence E becomes the point of stability or meta center and the power or force which is at C, multiplied into its distance to E, is equal to the weight of D multiplied into its distance D.E. The meta center should always be of a proper distance above the center of stability to insure stability.

Definitions and Explanatory remarks on the motion of vessels

[105]

Centre of Gravity

The centre of gravity of a ship is at that point by which it may be suspended and the parts remain in perfect equilibrium. It is also the centre of all the forces or movements which presses it vertically or directly downward towards the centre of the earth.

Centre of Cavity [or Displacement]

Or displacement is the centre [of] gravity of the hollow, or of that part of a ship's body which is immersed in the water, and also the centre of all the vertical force that the water exerts to support the vessel, or to raise it directly upward. As this centre depends upon the shape of the body immersed, it of course varies with every inclination of the ship.

[106]

Meta Center

Is that point above which the centre of gravity must in no wise be placed, because if it were, the ship would overset.

This centre which has likewise been called a shifting center depends upon the situation of the centre of cavity, for it is that point where a vertical line drawn from the centre of cavity, cuts a line passing through the centre of gravity and being perpendicular to the keel.

Centre of Motion

The centre of motion is at that point upon which a vessel oscillates or rolls when put in motion. This centre is always in a line with the waters edge. When the centre of gravity is even with or below the surface of the water. But whenever the centre of gravity is above

[107]

the waters surface, the centre of gravity is then the centre of motion.

This must be understood of bodies not perfectly circular, for it circular and homogeneous, the centre of motion will be the centre of the circle.

[Line of Support]

The line of support is the vertical or perpendicular line supposed to pass through the centre of cavity, and intersecting a line drawn perpendicularly to the keel of the vessel, through the point called the meta center

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[Longitudinal Axis]

The longitudinal axis of a vessel is an imaginary line which passes her longitudinally from head to stearn [sic] through the centre of gravity.

[108]

[Vertical Axis]

The vertical axis is an imaginary perpendicular line drawn through the centre of gravity when the vessel is in equilibrium.

[Transverse Axis]

The transverse axis is an imaginary horizontal line passing breadth wise from side to side through the centre of gravity. It is about these axes that ever vessel in motion may be supposed to turn.

In rolling she may be supposed to oscillate on the longitudinal axis, in pitching on the transverse axis, and in working &c to turn on her vertical axis.

[109]

To Lay off a Ships Cants

The cants of a vessel may be laid off at any distance apart which the builder may wish, so as to fill up the space between the first sqr frame frwrd and the knight heads or hawse timbers, and the last square frame aft and the fashion timber.

They work on the same principle as a door hung on it hinges and lie square against the dead wood from the base line similar and parallel [sic] to the square frames. They only alter their cant by the joint being swung further forward [sic] or aft as the case may be. In taking the measurements off the cant in the half breadth plan it must always be taken in the direction of the cant line, and transferred to the horizontal lines corresponding in the body plane.

[110]

Ships Cants

Great care must be taken in laying off the cut for the keels against the deadwoods, for as the cant increases, so does the distance of the cut from the side line.

Lay off in the body plan the height of the heel of the cant to be laid in on the line representing the centre of the keel, stem &c. Then level out thisheight, and take the distance of the cant in the half breath plan from the centre to the side of the stem or keel line, and on theline of the cant, and mark its distance from the centre line in the body plan, on the line already leveled out and mark it. This mark squared up and parallel [sic] to the side line will give the cut against the dead wood.

[111]

Bevelling Cants

Dress out a beveling board of the same width that the cant is to be in its siding. Then on the mould loft floor lay off from the joint of the cant on the half breadth plan the siding sizes of the cant forward and aft of the joint and strike the line from the rail to the centre or ram line. At the intersection of the joint with the centre or ram line, nail a short batten or straight edge down square with the joint extending as long as the siding line at least, and proceed to take off the measurements the same as for the moulding edge of the cant, and lay in the beveling edges frwd and aft of it. Then take the distance with a pair of compasses

[112]

Bevelling Cants

From the moulding edge to the beveling edge as shown in the body plan already laid down at each beveling sort, and transfer it to the beveling board from a square line across the board and mark the spot. Draw this across the board and the cut for the board will be indicated.   This mark is what the cant bevels form a square and as the beveling edge has been laid down from a bottom at the heel square from the joint there can be no variation.

These bevels should all be appear square on the timber. If to be more particular moulds can be made to both edges of cants.

[113]

<u>Bevelling Cants, Heels, &c</u>

The joint of the cant as shown on the dead wood being square from the base line, to obtain the cut of the fore and aft line at the bearding, place the stock of the bevel on the joint and let the tongue teach forward for the cut before the joint, and aft for the cut across the joint keeping it at the same time on the bearding line as far as the siding of the cant shown.

To get the fore and aft cut against the dead wood. Apply the bevel stock against the side line, and let the tongue teach towards the rail on the joint of the cant and in the same direction varying as each cant varies.

[114]

Horizontal Transoms

Horizontal transoms are the same as parallel [sic] water lines laid in at the same heights, and my be put in a vessel just as near together as the builder may wish filling up the space between the main transom and the heel of the fashion timber.

The beveling of all transoms is taken from the bearding line on which they seat, and the buttock or section lines which cross them. Let both edges of the transoms be laid down on the half breadth as well as the sheer plane. Make a mould to be edges and bevel them over by taking the difference from a square, and counter mould them. The line of the

[115]

Horizontal Transoms

fashion timber as shown on the half breadth plan will give the cut off, as it [f-ys?] against the transoms, the up and down cut being always square.

Transoms may be beveled by taking the bevels of the different section lines which cross them, by applying the bevel stock in the top of the transom and letting the tongue [teach ?] in the direction of the buttock line downwards and marking also the station of these buttock lines parallel [sic] from the side line. The stock of the bevel however must be kept exactly on the line as drawn across the top of the transom and square also from it face so as to prevent the tongue of the bevel from canting with way.

[116]

Canted Transoms

The mould of a canted transom is obtained by the buttock lines or sections in the same manner as horizontal transoms, and the beveling or counter mould may be obtained in the same manner also, but to cut off the end of a canted transom so as to [f-y ?] against the fashion timber proceed as follows[:] Lay off the position of the after side of the fashion timber in the half breadth plan. Take the distance on the centre line and transfer it to the sheer plan at the base line, and square it up, as high as the transoms required. Then lay in all the transoms in the sheer plan, and where they intersect the buttock

[117]

Canted Transoms (continued)

lines square them down in the half breadth plan on the corresponding section or buttock lines[.] To obtain the shape of the moulding edge[:] Let them extend far enough to cut off when the proper length is obtained. Then take the length of each canted transom separately on the sheer plan, and in the direction of the cant line, from the after perpendicular to the squared up line of the after fashion piece, and transfer it back to the centre line in the half breadth plan, and draw a line parallel [sic] to the line of the after side of the after fashion piece, as far out as the end of the transom which will be the length to cut off by.

[118]

Canted Transoms (continued)

To counter mould a canted transom continue the line of the top of the transom from the end of the bearding where it cuts off, to the after perpendicular, and where it intersects the after perpendicular, square it down to the thickness of the lower edge of said transom. And the intersection of these squared down lines with the bottom line, is the point to set off the distances from (similar to those on the upper edge) to obtain the cutting off length on the lower side.

The direction of the section or buttock lines will give the mould similar to a horizontal transom. If squared down in the half breadth plan to their corresponding lines, which are parallell [sic] to the side line.

[119]

Parallell [sic] Hawse Pieces

Parallell [sic] hawse timbers may be laid off in any siding size desired parallel [sic] to the side line or apron in the half breadth plan and cutting off against the fore side of the forward [sic] cant.

Where they intersect the various lines in the half breadth plan let them be squared up to the sheer plan on the corresponding lines and the spots will give the moulding edge of each piece. They cut off square against the heel of the forward [sic] cant, and the cut is found by squaring up the moulding edge where it intersects the frwd cant on the half breadth plan. Counter mould by taking the difference of the moulding edge from a square.

[120]

Parallell [sic] Hawse Timbers which are Tapered but not Canted

Lay off the hawse timbers in the half breadth plan of the size and taper desired commencing at the side of the apron, and cutting off the heels against the fore side of the forward [sic] cant. Where they intersect the various lines in the half breadth plan, square them up to the sheer plan on the corresponding lines, and the spots will indicate the shape of the moulding edge of each piece. They cut off square against the cant, and the cut is found by squaring up its intersection at the moulding edge, with the fore side of the cant. The bevel or counter mould, take the difference from a square ata each water line &c.

[121]

Parallell [sic] Hawse Timbers which are Tapered but not Canted

In beveling or counter moulding these timbers great care must be taken & from the fact that the tapered line on the half breadth plan only represents the sizes on the moulding or outer edge, and not on the moulding size. To get the difference then from a square, a line must be drawn parallel [sic] at the intersection of the tapered line with each water line &c and the difference taken on the parallel [sic] line from the centre and not on the tapered linen.

The distances taken for the counter mould or bevellings from a square must be taken in the direction of the water lines, so that the counter moulding may be done exactly.

[122]

Hawse Timbers that are Canted and Tapered at the Heels

Lay off the canted and tapered hawse timbers in the half breadth plan as desired, cutting off their heels against the forward [sic] side of the forward [sic] cant. To lay off the moulding edges, erect a perpendicular in some convenient place, draw a base line, and draw in the heights of all the water lines, sheer lines &c. As the tapered line is not parallel [sic] to the side line, nor square from the base line the cants, it will be necessary to expand the water lines and sheer lines to get their heights correctly. The bearding line on the apron will give the moulding edge of the first piece. For the mould of all the other pieces take a batten and place it on

[123]

Tapered and Canted Hawse Timbers

the line of the taper putting one end against the cant, and mark the intersection of all the water lines and sheer lines. Transfer these marks to the corresponding lines in the body plan, keeping the end of the batten against the perpendicular. Mark the spots which are on the batten and the moulding edge will be indicated. Proceed in a similar manner for each piece taking care to expand the water lines &c for the heights, as they will vary on ever hawse timber, the cant being more on every one. "To cut off the heel." As the perpendicular from which the measurements are set off represents the cant timber, of course it will be the line to off the heels.

[124]

To Bevel or Counter Mould Hawse Timbers which are Tapered & Canted

The siding and beveling of these timbers are very difficult and great care will be required as the fronts of the pieces are larger than the insides. It will then be necessary to side the timber on one side first, and mould it.

Hew the moulding edge down square from the face, then side it by the sizes taken from the floor in the firstion of the taper. Then [appy ?] the mould of the next piece, keeping it back from the squared edge whatever the difference is from a square in the half breadth plan, as taken from the floor. A sliding mould made with the tapered lines will be of great service in siding these pieces.

[125]

[Calculating Ship Displacements]

Sam Pook: For Approximating to the Displacement of a Ship's Bottom Immersed

From 90 degrees deduct the angle of the floor. Multiply this by .0075. The quotient is the decimal of capacity. Multiply this sum by the length on the load water line, then by the beam & the depth to the rabbet of the keel, and divide the whole sum by 35.[58]

To Find the Tonnage

Take the whole length on deck and deduct from it 3/5th of the beam. Multiply the remainder by the beam, and again by half the beam for the depth, and divide the whole sum by .95.

In the case of a single deck vessel where the depth is less than half the beam, multiply by the whole depth, and divide by .95.

[126]

[58] Samuel Moore Pook, U. S. Naval Constructor. See Biographical Notes.

Displacement of Ship

The displacement of a ship is the solid, or cubical contents of that part of the bottom below the load water line. After the solid has been brought into cubic feet, multiply this product by 64 the number of lbs in a cubic foot of water, and divide by 2240, or divide the product of cubic feet by .35 which will give the displacement in tons.

It the weight of the whole mass is desired, including outfits, guns, stores, anchors, cables &c &c, take the draft of water when the ship is ready for sea, and calculate the displacement below that line, as in the first case, and the whole weight will be obtained.

[127]

To Find the Displacement

Proceed to calculate the area of the first horizontal plane or water line (taking the measurements of the fowd [sic] and after body separate) on the ordinates or square frames put in for this purpose. These ordinates and the horizontal planes should be sufficiently near that the curves of the different sections should be as near a straight line as possible from one to the other. As the measurements are to be taken on all the ordinates in each body, the forward [sic], and aft, only the half of the first and last must be taken which will mak [sic] a medium or mean of the two ordinates.

Draw a column on a sheet of paper for each water line, or horizontal plane, and sufficiently

[128]

To Find the Displacement

long to accommodate all the ordinates, which are to be marked in the left of the first column, so that the measurements on the same ordinate for the different water lines may be set down in order as they are taken off the water lines or horizontal planes. After the measurements have [been] taken off the first plane and placed in the column headed 1st W Line, proceed to take of [sic] all the rest in the order which the [sic] come as 2nd 3d, 4th &c &c taking but the half of the first and last ordinate in every case.

After all the measurements have been taken and placed in their respective columns, add them up separately and set down the products of each.

[129]

To Find the Displacement

After the measurements in the fowd [sic] body have been taken, proceed to measure the water line in the after body in the same manner beginning with the 1st water line and taking them in order 2nd 3d 4th &c &c and set them down in their proper columns & opposite their proper names. Then add them all up separately and set the product of each under its own column or water line. Add next the products of the different water lines of the fowd [sic] and after body's [sic] together, keeping each water line separate, when the lengths of the ordinates of all the water lines, or horizontal planes will be obtained.

[130]

To Find the Displacement

The lengths of the ordinates of the different water lines having been obtained, we next place them in order, to to [sic] find the solid of the displacement, as follows.

Take half of the sum of the ordinates of the 1st w line, all of the 2nd , 3d, 4th &c and half of the last, and add them together. Multiply this sum by the distance between the water lines, and the product by the distance between the ordinates and the solid of half the bottom between the first and last or load water line will be found. Next add on the solid contained in the space from this 1st ordinate foward [[sic] and the stern to the load water line, and the

[131]

Displacement continued

solid contained in the space from the last ordinate aft and the sternpost, to the load water line. Next add in half of the solid of the keel in the fore body, and half of the solid of the keel in the after body. Then half the cubical contents in feet contained between the first water line and the rabbet of the keel and one half of the solid in cub [sic] feet below the load water line will be obtained. Multiply this sum by two and the product is the whole displacement, which divide by 35 and the displacement in tons will be obtained.

P. S. The whole operation is merely a sum in mensuration of surfaces and solids, the dimensions being given.

[132]

The Centre of Cavity or Displacement

The centre of cavity or displacement is at that point, if from which the model was suspended, it would hang in perfect equilibrium.

The find the position of the centre of gravity on the horizontal lines, or planes, separately proceed as follows,

Take the plane at the load line and measure all the ordinates separately as for the displacement, and set them down in a table opposite their names commencing with the first ordinate foward [sic], and containuing to the last ordinate aft taking the foward [sic] and after body together taking only the half of the first and last ordinate.

[133]

Centre of Cavity or Displacement

Opposite each ordinate and measurement which have been taken and set down, commence with the number, beginning at the second ordinate as 1 . 2 . 4 . 4 . 5 . 6 . including the whole liest. Multiply the lengths of the ordinates by their number for the msrmnts [sic] which place in another column to the right, and add up the ordinates and also the msrmnts [sic] then multiply the msrmnts [sic] by the distance between the ordinates & divide this sum by the ordinates and it will give the distance of the centre of gravity of the plane from the last ordinate.

[134]

Centre of Gravity continued

Continue to measure all the planes in the same way and find the distance of the centre of gravity in each from the last ordinate, also the msrmnts [sic] &c. After all the planes have been gone through in the same way including the keel place them in a table in order so as to get the mean centre of the different planes. Draw a column for the numbers of the planes as 1 . 2 . 3 . 4 . 5 . &c including keel. Next draw a column to the right and set down the product of the length of the ordinates of each plane opposite their number. Multiply these by the distance between the ordinates, for the whole areas

[135]

Centre of Gravity (continued)

taking but the half of the first & last and set down the sums in another column to the right as the whole areas. Multiply these whole areas by the distances of the different centres of gravity as all ready found and the msrment [sic] will be obtained. Divide these msrments [sic] by the whole areas and the distance of the centre of gravity from the last ordinate of the whole bottom will be obtained.

To find the height [of the center of gravity]

Place the areas in column again commencing with the keel and going up to the first plane taken, taking but half of the 1st and last. Multiply these planes by their numbers omitting the first and beginning with 1 . 2 . 3 . 4 . 5 . &c to the end, revering their order

[136]

Centre of Gravity continued

Multiply the areas of the planes into their numbers for the msrments [sic]. Divide these msrment [sic][by the sum of the areas, and multiply the remainder or quotient by the distance between the planes and the height of the centre of gravity above the lower edge of the rabbet of the keel will be found.

[Calculations for a sloop of War of 22 Guns as Described]

The following will show the calculations for a sloop of war of 22 guns as described

	feet
Length between Perp.	150.
Beam Extreme	37.6
Depth to lower edge rabbet	18.6
Tons	$909 \frac{80}{95}$

[137]

[Displacement Tables]

Table 2 Displacement Calculations (Forward Body)

For the Displacement							
Ord.	1 W. L.	2 W. L.	3 W. L.	4 W. L.	5 W. L.	6 W. L.	7 W. L.
$\frac{1}{2}$ j	.4	.4	.4	.5	.6	.7	.8
h	.9	1.2	1.3	1.6	1.10	2.4	3.0
f	1.4	2.1	2.10	3.9	4.9	5.11	7.1
d	1.9	2.9	3.9	5.2	6.5	7.11	9.4
b	2.2	3.6	4.6	6.7	8.1	9.9	11.4
z	2.7	4.3	5.10	7.10	9.7	11.4	12.11
X	3.0	5.1	6.8	9.2	11.11	12.5	14.3
V	3.4	5.8	7.8	10.4	12.2	13.10	15.3
T	3.9	6.5	8.8	11.5	13.4	14.11	16.1
R	4.1	7.0	9.4	12.3	14.3	15.8	16.9
P	4.5	7.6	10.0	13.0	15.0	16.4	17.4
N	4.7	7.11	10.7	13.8	15.7	16.10	17.9
L	4.19	8.4	11.1	14.2	16.2	17.3	18 -
I	5.1	8.9	11.8	14.8	16.6	17.8	18.2
H	5.2	9.0	11.9	15.0	16.9	17.10	18.4
F	5.3	9.2	11.10	15.3	16.11	18.0	18.6
D	5.4	9.4	12.0	15.6	17 -	18.1	18.6
B	5.4	9.4	6.0	15.6	17 -	18.2	18.6
$\frac{1}{2}\Omega$	2.8	4.8	9.4	7.9	8.6	9.1	9.3
	65.5	111.3	154.5	193.2	221.3	243.11	261
Forward Body Measurements							

[138]

Table 3 Displacement Calculations (After Body)

For the Displacement							
Ord.	1 W. L.	2 W. L.	3 W. L.	4 W. L.	5 W. L.	6 W. L.	7 W. L.
$\frac{1}{2}\Omega$	2.8	4.7	6.4	7.9	8.7	9.1	9.3
2	5.4	9.2	12.9	15.6	17.2	18.2	18.6
4	5.4	9.2	12.7	15.4	17.2	18.2	18.6
6	5.2	8.11	12.4	15.2	16.11	18.0	18.6
8	5.0	8.8	12 -	14.10	16.10	17.10	18.5
10	4.10	8.4	11.7	14.6	16.7	17.9	18.4
12	4.8	7.11	11.1	14.0	16.4	17.7	18.2
14	4.5	7.6	10.7	13.5	15.11	17.5	18 -
16	4.1	7.0	9.11	12.9	15.6	17.2	17.10
18	3.9	6.5	9.2	11.11	14.9	16.9	17.8
20	3.5	5.11	8.4	11.0	133.11	16.4	17.4
22	3.1	5.4	7.6	10 -	12.11	15.7	16.11
24	2.10	4.9	6.7	8.10	11.9	14.9	16.5
26	2.5	4.1	5.8	7.9	10.5	13.2	15.7
28	2.1	3.6	4.10	6.7	9.0	11.9	14.6
30	1.8	2.10	4.0	5.5	7.5	10.2	13.0
32	1.4	2.2	3.1	4.3	5.9	8.1	11.0
34	1.1	1.8	2.3	3.0	4.0	5.8	8.2
36	.5	.7	.9	.11	1.4	1.9	2.4
	63.7	108.6	151.4	192.11	232.3	265.2	288.5
After Body Measurements							

[139]

Table 4 Sum of the Calculations for Displacement Calculations

Sum of the Calculations for Displacement							
Ord.	1 W. L.	2 W. L.	3 W. L.	4 W. L.	5 W. L.	6 W. L.	7 W. L.
After Body	63.7	108.6	151.4	192.11	232.3	265.2	288.5
Fowd Body	65.5	111.3	154.5	193.2	221.3	243.11	261.0
	129	219.3	305.9	386.1	453.6	509.1	549.5

$\frac{1}{2}$ of 1st W Line	64.6
whole 2nd W. L	219.9
" 3rd W.L.	305.9
" 4th W.L.	386.1
" 5th W.L.	453.6
" 6th W.L.	509.1
$\frac{1}{2}$ of 7th W.L.	274.8
	2213.4
X distance between W Lines	2 ft.
	4426.8
X distance between ordinates	4 ft
	17706.8
Cubic feet from ord. 36 aft	96.0
Cubic feet from j foward [sic]	48.0
Cubic feet $\frac{1}{2}$ keel fore body	108 –
Cubic feet $\frac{1}{2}$ keel after body	114.4

(over)

[140]

Table 4 Sum of the Calculations for Displacement continued

Sum of the Calculations for Displacement

amt [sic] Brot [sic] over	18073.0
Cubic feet from 1st W Line to the larboard beam	605.00
One half the displacement	18678.
X 2	2
Whole displacet [sic] in cub. Feet	37356

divided by 35) 37356 (1067- $\frac{11}{35}$ tons

```
 35
 235
 210
  256
  245
   11
   35
```

The whole displacement therefore of the ships bottom to her 7th W. Line including keel &c is 1067- $\frac{11}{35}$ tons.

[141]

Table 5 Calculation of Center of Gravity on 7 W.L. (from Ordinate 36)

For Finding the Center of Gravity on 7 W. L. (from ordinate 36)							
Ord.	Length	Num.	Msrmnts	Ord.	Length	Num.	Msrmnts
$\frac{1}{2}$ j	.8	0		2	18.6	19	351.6
h	3.0	1	3.0	44	18.6	20	370.6
f	7.2	2	14.4	6	18.6	21	388.6
d	9.4	3	28.0	8	18.5	22	405.6
b	11.4	4	45.4	10	18.4	23	421.8
z	12.11	5	64.7	12	18.2	24	436 -
X	14.3	6	85.6	14	18.0	25	450 -
V	15.3	7	106.9	16	17.10	26	463 -
T	16.1	8	128.8	18	17.8	27	477 -
R	16.9	9	145.9	20	17.11	28	501 -
P	17.4	10	173.4	22	17.4	29	502 -
N	17.9	11	195.3	24	16.5	30	492.6
L	18.0	12	216 -	26	15.7	31	483.1
I	18.2	13	236 -	28	14.6	32	464 -
H	18.4	14	257.6	30	13.0	33	429 -
F	18.6	15	277.6	32	11.0	34	374 -
D	18.6	16	296 -	34	8.2	35	285.5
B	18.6	17	314.6	½ 36	2.4	36	80 -
$\frac{1}{2}$ Ω	18.6	18	233 -				
	270.4		2921.		279.2		7291.6

[142]

Table 6 Calculation of Center of Gravity on 6 W.L.

For Finding the Center of Gravity on 6 W. L.							
Ord.	Length	Num.	Msrmnts	Ord.	Length	Num.	Msrmnts
$\frac{1}{2}$ j	.7	0		2	18.2	19	345.2
H	2.4	1	2.4	44	18.2	20	363.4
F	5.11	2	11.10	6	18 -	21	378 -
D	7.11	3	16.9	8	17.10	22	392.4
B	9.9	4	39.0	10	17.9	23	408.3
Z	11.4	5	56.8	12	17.7	24	422.0
X	12.5	6	75.6	14	17.5	25	435.5
V	13.10	7	96.10	16	17.2	26	446.4
T	14.11	8	119.4	18	16.9	27	452.3
R	15.8	9	141.10	20	16.4	28	457.4
P	16.4	10	163.4	22	15.7	29	452 -
N	16.10	11	185.2	24	14.9	30	442.6
L	17.3	12	208 -	26	13.2	31	408.2
I	17.8	13	229.8	28	11.9	32	376 -
H	17.10	14	249.8	30	10.2	33	335.6
F	18.0	15	270 -	32	8.1	34	274.10
D	18.1	16	289.4	34	5.8	35	198.4
B	18.2	17	308.10	½ 36	1.9	36	63 -
$\frac{1}{2}$ Ω	9.1	18	329.0.				
	233		2690.3		256		6650.9

[143]

Table 7 Calculation of Center of Gravity on 5th W.L.

For Vinding the enter of Gravity on 5th W. L.							
Ord.	Length	Num.	Msrmnts	Ord.	Length	Num.	Msrmnts
$\frac{1}{2}$ j	.6	0		2	17.2	19	326.2
H	1.10	1	1.10	44	17.2	20	343.4
F	4.9	2	9.6	6	16.11	21	355.3
D	6.5	3	19.3	8	16.10	22	370.4
B	8.1	4	32.4	10	16.7	23	381.5
Z	9.7	5	47.11	12	16.4	24	392 -
X	11.11	6	65.6	14	15.11	25	397.11
V	12.2	7	85.2	16	15.6	26	403 -
T	13.4	8	106.8	18	14.9	27	398.3
R	14.3	9	128.3	20	13.11	28	389.8
P	15.0	10	150 -	22	12.11	29	374.7
N	15.7	11	171.5	24	11.9	30	352.6
L	16.2	12	194.6	26	10.5	31	322.11
I	16.6	13	214.6	28	9.0	32	288 -
H	16.9	14	234.6	30	7.5	33	244.9
F	16.11	15	253.9	32	5.9	34	195.2
D	17 -	16	272.0	34	4.0	35	140 -
B	17 -	17	289 -	½ 36	1.4	36	48.0
$\frac{1}{2}$ Ω	8.6	18	306 -				
	221.3		2582.7		232.5		5740.3

[144]

Table 8 Calculation of Center of Gravity on 4 W.L.

For Finding the Center of Gravity on 4 W. L.							
Ord.	Length	Num.	Msrmnts	Ord.	Length	Num.	Msrmnts
$\frac{1}{2}$ j	.5	0		2	15.6	19	294.6
H	1.6	1	1.6	44	15.4	20	306.8
F	3.9	2	7.6	6	15.2	21	313.6
D	5.2	3	15.6	8	14.10	22	326.4
B	6.7	4	26.4	10	14.6	23	333.6
Z	7.10	5	39.2	12	14.0	24	336.
X	9.2	6	55.0	14	13.5	25	335.5
V	10.4	7	72.4	16	12.9	26	331.6
T	11.5	8	91.4	18	11.11	27	321.9
R	12.3	9	110.3	20	11.0	28	308 -
P	13.0	10	130.0	22	10 -	29	290 –
N	13.8	11	150.4	24	8.10	30	265 -
L	14.2	12	170 -	26	7.9	31	240.3
I	14.8	13	190.8	28	6.7	32	210.8
H	15.0	14	210 -	30	5.5	33	178.9
F	15.3	15	228.9	32	4.3	34	144.6
D	15.6	16	248 -	34	3.0	35	105 -
B	15.6	17	263.6	$\frac{1}{2}$ 36	.11	36	33 -
$\frac{1}{2}$ Ω	7.9	18	279 -				
	193.2		2289.2		192.11		4679.4

[145]

Table 9 Calculation of Center of Gravity on 2d W.L.

For Finding the Center of Gravity on 2d W. L.							
Ord.	Length	Num.	Msrmnts	Ord.	Length	Num.	Msrmnts
$\frac{1}{2}$ j		0		2	9.4	19	117.4
H	1.2	1	1.2	44	9.2	20	183.4
F	2.1	2	4.2	6	8.11	21	187.3
D	2.9	3	8.3	8	8.8	22	190.8
B	3.6	4	14 -	10	8.4	23	191.8
Z	4.3	5	21.3	12	7.11	24	190 -
X	5.1	6	30.6	14	7.6	25	187.6
V	5.8	7	39.8	16	7.0	26	182 -
T	6.5	8	51.4	18	6.5	27	173.3
R	7.0	9	63.0	20	5.11	28	165.8
P	7.6	10	75	22	5.4	29	154.8
N	7.11	11	87.1	24	4.9	30	142.6
L	8.4	12	100.	26	4.1	31	126.7
I	8.9	13	133.9	28	3.6	32	112 -
H	9.0	14	126.0	30	2.10	33	93.6
F	9.2	15	137.6	32	2.2	34	73.8
D	9.4	16	149.4	34	1.8	35	58.4
B	9.4	17	158.8	$\frac{1}{2}$ 36	.7	36	21 -
$\frac{1}{2}$ Ω	4.8	18	168.0				
	111.3		1348.8				2580.11

[146]

Table 10 Calculation of Center of Gravity on 3d W.L.

For Finding the Center of Gravity on 3d W. L.							
Ord.	Length	Num.	Msrmnts	Ord.	Length	Num.	Msrmnts
$\frac{1}{2}$ j	.4	0		2	12.8	19	242.3
H	1.3	1	1.3	44	12.7	20	251.8
F	2.10	2	5.8	6	12.4	21	249 -
D	3.9	3	11.3	8	12 -	22	264 -
B	4.6	4	18.0	10	11.7	23	268.5
Z	5.10	5	29.2	12	11.1	24	266 -
X	6.8	6	40 -	14	10.7	25	264.7
V	7.8	7	53.8	16	9.11	26	257.10
T	8.8	8	69.4	18	9.2	27	247.6
R	9.4	9	84 -	20	8.4	28	233.4
P	10.0	10	100.	22	7.6	29	217.6
N	10.7	11	115 -	24	6.7	30	197.6
L	11.1	12	133 -	26	5.8	31	175.8
I	11.8	13	151.8	28	4.10	32	154.8
H	11.9	14	164.6	30	4.0	33	132 -
F	11.10	15	181.3	32	3.1	34	104.10
D	12.0	16	196 -	34	2.3	35	78.9
B	6.0	17	212.6	36	.9	36	27 -
$\frac{1}{2}$ Ω	9.4	18	228 -				
	154.5		1794.8		151.4		3629.6

[147]

Table 11 Calculation of Center of Gravity on 1st W.L.

For Finding the Center of Gravity on 1st W. L.							
Ord.	Length	Num.	Msrmnts	Ord.	Length	Num.	Msrmnts
$\frac{1}{2}$ j	.4	0		2	5.4	19	101.4
H	.9	1	.9	44	5.4	20	106.8
F	1.4	2	2.8	6	5.2	21	108.6
D	1.9	3	5.3	8	5.0	22	111 -
B	2.2	4	8.8	10	4.10	23	111.2
Z	2.7	5	12.11	12	4.8	24	112 -
X	3.0	6	18.0	14	4.5	25	110.5
V	3.4	7	23.4	16	4.1	26	106.2
T	3.9	8	30 -	18	3.9	27	101.3
R	4.1	9	36.9	20	3.5	28	95.3
P	4.5	10	43.9	22	3.1	29	89.5
N	4.7	11	50/5	24	2.10	30	85.0
L	4.19	12	58.0	26	2.5	31	74.11
I	5.1	13	66.1	28	2.1	32	66.8
H	5.2	14	72.4	30	1.8	33	55 -
F	5.3	15	78.9	32	1.4	34	45.4
D	5.4	16	85.4	34	1.1	35	37.11
B	5.4	17	90.8	36	.5	36	15.
Ω	5.4	18	96 -				
	65.5		779.8		63.7		1533.5

[148]

Center of Gravity on 7th W.Line

Length ord.	270.4	Msrmnts	2921.0
“ “	279.2	“	7291.6
	549.6		10212.6
by distance between the ord.			4 ft.
			40850.

```
549.50)40850.00   (74 feet
       384650
        238500
         219800
          18700
             12
549.50) 224400    (4 in.
        219800
```

The centre of gravity on the 7th water line is 74 feet 4 inches from ordinate 36 -.

[149]

Center of Gravity on 6th W.Line

Length of ord.	253 -	Msrmnts	2690.3
" "	256	"	6650.9
	509		9341.
by distance between the ord.			4 ft.
			37364.

```
509)37364.00    (73 feet
     3563
      1734
      1527
        207
         12
509 )2484    (4 in.
     2036
      448   =  7 eights
```

The centre of gravity on the 6th water line from ordinate 36 is 73 feet 4 inches – $\frac{7}{8}$ -

[150]

Center of Gravity on 5th W.L.

		Msrmnts
Length of ord.	221.3-	2582.7
" "	232-5	5740.3
	453.8	8322.10
by distance between the ordinates		4 ft.
		33291.4

```
453.66) 33291-33  (73.
        31756.2
        153513
        136098
            17415
               12
453.66 )  208980  (4 in.
          181464
           27516
```

The centre of gravity the 5th water line from ord 36 is 74 [73] feet 4 inches

[151]

Center of Gravity on 4th W.Line

		Msrmnts
Length of ord.	193.3-	2289.2
" "	192.11	4679.4
	386.2	6968.6
by distance between the ordinates		4 ft.
		27874

386) 27874 (72. feet
2702
854
772
82

12
386)984 (2 $\frac{1}{2}$ "
272
212

The centre of gravity in the 4th W Line is 72 feet 2 $\frac{1}{2}$ in. from ordinate .36

[152]

Center of Gravity on 3d W. Line

		Msrmnts
Length of ord.	154.5-	1794.8
" "	151.4	3629.6
	305.9	5424.2
by distance between the ordinates		4 ft.
		21696.8

305.75) 21696.66 (70
214025
29416
12
305.75) 333992 (11 in.
30575
28242

The centre of gravity in the 3d W Line from ordinate 36 is 70. feet 11. inches.

[153]

Center of Gravity on 2nd W. Line

		Msrmnts
Length of ord.	111.3	1348.8
“ “	108.6	2580.11
	219.9	3729.7
		4.
		15718.4

219.75) 15718.33 (71. 6 in
15382.5
33583
219.75
219.75)11608.0 (52.
10987.5
6205.0
4395.0

The centre of gravity in the 2nd W Line from ordinate 36 is 71. feet 6 inches -

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Center of Gravity on 1st W Line

		Msrmnts
Length of ord.	65.5-	779.8
“ “	63.7	1533.5
	129 -	2313.1
by distance between the ordinates		4 ft.
		9252.4

129) 9252.4(71 feet
903
222
129
93
12
129) 1116 (8 in. $\frac{1}{2}$
1032
84

The centre of gravity in the 1st Water Line from ord 36 is 71 feet 8 in $\frac{1}{2}$ inches.

over to other page

[155]

P. S.

These calculations have been made from the drawings of a sloop of war made by myself while on duty at the Pensacola Navy Yard in 1860. The workings are in accordance with Steele's works on Naval Architecture, and are plain and correct, and easily understood.

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[Center of Gravity of the Whole Bottom of the Ship from Ordinate 36]

Table 12a Center of Gravity of the Whole Bottom of the Ship

The centres of gravity of each plane having been found, the center of gravity of the whole bottom of the shim from ordinate 36 may be obtained as follows:

	Planes	Lengths of Ordinates	Distances between	Whole area of the planes
Half of	1st	274.8 x	4 =	1097
Whole of	2nd	509.1 x	4 =	2036
"	3	453.6 x	4 =	1814
"	4	386.1 x	4 =	1544
"	5	305.9 x	4 =	1223
"	6	219.9 x	4 =	879
"	7	129 x	4 =	516
Half of	Keel		=	94
				9155

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[Center of Gravity of the Whole Bottom of the Ship from Ordinate 36 continued]

Table 12b Center of Gravity of the Whole Bottom of the Ship

	Distances of Centres of Gravity	Whole msrments
Multiplied by the distances of the Centres of gravity of each plane for the sum of the msrmnts	74.4 "	81692.4
	73.4 $\frac{7}{8}$	149307.2
	73.4	133.480.6
	72.2 $\frac{1}{2}$	109.753.0
	70.11	86.823.0
	71.6	62.848.0
	71 8 $\frac{5}{8}$	37 023.0
		3888.0
		689.815

Now 689.815 divided by 9155 gives 75 feet 4 inches which is the distance the Centre of Gravity is from Ord. 36.

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Height of the Center of Gravity

Table 13 Height of the Centre of Gravity

		Area of the Planes		Msrment
Half	8 Keel	94	X 0	
Whole	7	516	X 1	516
“	6	879	X 2	1758
“	5	1223	X 3	3669
“	4	1544	X 4	6176
“	3	1814	X 5	9070
“	2	2036	X 6	12216
Half	1	1049	X 7	7343
		9155		40748

Now 4078 divided by 9155 gives 4 feet 5 $\frac{3}{8}$ inches which being multiplied by 2 feet the distance between the water lines gives 8 feet 10 $\frac{3}{4}$ inches the height of the Centre of Gravity from the lower edge of the rabbet of the keel.

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Iron Plated Ships &c to Resist Solid Shot. Enhancements

If a projectile strikes a plain surface perpendicularly, its whole living force (rotary velocity not being considered, as it is not very great in balls from smooth bore guns) is available at the point of impact, either in penetrating or breaking through the surface. If it impinges obliquely its velocity, AB, may be considered as discomposed into two components, AC, and BC, the first of which only is available in rupturing the plane. If the angle, BAC, were 45^0 (about the angle of incidence

Figure 79 Iron Plated Ships Resistance to Iron Shot

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for the proposed inclined sides of ships of war) the living force or power of doing the work of smashing or penetrating due to the component AC, is just half of that due to the entire velocity of the projectile AB. Thus; by this simple arrangement, the projectile is at once disarmed of half its destructive powers. But is not all; the projectile will not concentrate all the effect due to the component AC, at the point A. as it would if AC. Were the only velocity with which it arrived. By the component BC, it will be carried along toward D, simultaneously with the action of AC, upon the plane. For want of concentration upon a single point, the pene-

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-trating power of the component AC. May be considered as within certain limits wholly lost; the entire living force due it is, nevertheless wholly expended upon the bulwark EC provided it does not escape at the point D before the reflection is complete; but it is likely that the smashing power (i.e., of breaking down the bulwark) is much diminished owing to its distribution over considerable space.

In short, with an angle of incidence of 45^0 the power of penetration of the ball would be wholly lost; that of smaching the bulward reduced to considerable [sic] below one half. If therefore we throw at these inclined sides, a projectile of such magnitude that

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its living force is considerably more than double – say four times – that which experience shows sufficient to break down a vertical bulwark, we may expect to accomplish the object. At any rate we can do it without going beyond the limits of practical magnitude in projectiles.

Experiments at Metz, in 1834, showed that masonry walls could be breached at an angle of 25^0 or 30^0 with, (I suppose) ordinary breaching artillery, viz. 18 or 24 pounders.

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[Autobiographical Accounts]

True History of the Iron Clad Steamer Merrimac 1861 & 62[59]

Shortly after the beginning of the war between the north and the south in 1861, having resigned my position as a constructor in the U.S. Navy and accepted a similar position in the C.S. Navy and seeing the great advantage which the U.S. had in consequence of their large Navy over the confederacy, I made a model for an iron clad bomb proof vessel similar to one I made for the same purpose in 1847 at Pittsburgh, PA[60] and presented to Hon. S. R. Mallory, Secy. of the C.S. Navy at Richmond. The whole matter was referred to a commission composed of Chief Engineer W.P. Williamson, CSN, Lt. J. M. Brooke and myself and resulted in putting my shield on the old burned Steamer Merrimac.[61]

[164]

[59] "True History of the Iron-Clad Steamer Merrimac 1861 & 2, (1874)" John L. Porter Notebook, pp. 164-179, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858.

[60] Probably the USS Hunter; possibly USS Alleghany.

[61] On May 30 1861, also, the Confederates raised the scuttled Merrimac. http://www.navyhistory.com/cwnavalhistory/May1861.html.

Merrimac Continued

As we had not the time, nor conveniences for building steam engines at the time, I had intended to make the armor only three inches, but after some experiments made by Lt. Brooke with heavy ordnance at Richmond on this thickness (which did not prove satisfactory), we (the commission) concluded to increase it to four inches as I informed them she had capacity enough in the way of displacement to carry this weight. The secretary of the Navy approved of our report, and the work was commenced by his order July 11th 1861, Chief Engineer Williamson attending to the machinery & Lt. Brooke to the ordnance and armor.

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Merrimac Continued

Having put the hulk of the burned Steamer Merrimac in the dry dock I commenced by cutting her down on a straight line from forward to aft 19 feet on the stem, and 20 feet on the sternpost. I had intended to cut her down to 19 feet aft also, but it came in contact with the propellers, and not wishing to reduce that, the line was raised to 20 feet, which gave me too much displacement as I had to submerge her hull two feet under water for protection, the shield[62] only being bomb proof, this surplus of displacement had to be overcome by pig iron as ballast. The shield was 150 feet[63] in length and put on at an angle of 35 degrees. It was 24 feet on the -

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[62] *Shield*: That is the iron plating.

[63] "180" is written in pencil nearby on page.

Merrimac Continued

inclination from the knuckle to the shield deck. The shield was joined to the sides of the ship by means of oak knees running down between the old frames and bolted to them. The rafters, which were of yellow pine, were bolted to these knees also and to each other making this work solid. They moulded 16 inches. Across this a course of yellow pine planks 5 inches thick was placed running fore and aft and bolted to the rafters with 3/4 iron bolts. This having been calked [sic] and pitched another course of white oak 4 inches thick was placed on vertically, and bolted, and calked [sic] also, before the armor was put on.

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Merrimac Continued

The upper or shield deck was strongly framed with pine beams. Between these beams at their ends pieces of oak timber were dovetailed so as to support the ends of the rafters. An oak capping or plank sheer was placed on top of the rafter and on the beams also which served as a bed for the iron gratings which covered the entire deck made of two inch square bars and crossed, being riveted together, the meshes being 2 1/2 inches. A large pilot house of cast iron was placed on the forward end of the shield deck but it was never used for that purpose, the captain & pilots choosing

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Merrimac Continued

rather to stand on a small peak form in a hatch way over the steering wheel, and partially exposed to the enemy's shot, and notwithstanding the smoke stack was literally riddled in her engagements, none of them were hurt while in this position. The interior arrangements were not different from other men of war only they were all submerged. The orlop deck being used for berth decks forward & aft. The same magazines and shell rooms were used without material alteration.

Forward and aft the shield, the deck beams were solid and bolted together. On this an oak deck four inches thick was

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Merrimac Continued

laid. These deck ends were submerged two feet under water. They were plated with iron armor one inch thick and then covered with pig iron five inches thick for ballast in order to get the ship down. I had also to put a large quantity in the hold for the same purpose in all about 300 tons.

The same rudder was used. The post [of the rudder] was connected to the hull by a string piece of oak timber. A yoke was placed on the rudder head formerly belonging to the Steamer USS Pensacola, the chains leading through pipes under the shield to the wheel and all under water. A large fan tail was built out to prevent

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Merrimac Continued

vessels from running into the rudder and propeller.

The armor was placed in the first course fore and aft of two inches thickness and eight inches wide. The second course [was] vertical (crossing the first) of two inches thickness and eight inches width, this was bolted on with 1 $^{1/4}$ inch bolts passing through both courses and sitting up with nuts on the inside making the whole armor of four inches and about eight hundred tons in weight.

Below the knuckle, which was intended to be two feet under water and on the side of the ship, a course of iron one inch thick was

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Merrimac Continued

placed running horizontally. After her action with the ships in Hampton Roads, another course of two inches thickness was put on this vertically, the upper ends lapping on the shield iron, which made it very safe. The latter course was not fully completed for want of time and iron as her presence was urgent in Hampton Roads a second time.

The idea of a ram was a new one, and had not been talked of much by any one until the steamer was nearing completion. For my part I did not rely on it much, but to please all I concluded to do so, and for the want of means I had to put on a cast iron

Over)

[172]

Merrimac Continued

one and had the Cumberland been struck a blow at right angles it would have stood very well but the Merrimac struck her a glancing blow, and although it broke her through, it also broke off. Whether it remained in the Cumberland or not, I have no means of knowing. After her engagements in the Roads and return to the yard I made a new ram of wrought iron entirely having got the material from the Tredegar Iron Works for that purpose strengthening the bow as far as 14 feet and putting a wrought ram steel pointed on that forged under the steam hammer as the Gosport Navy Yard

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Merrimac Continued

and fitting so snugly to the bow as to prevent its being broken off. I am of the opinion that projections of any kind beyond a ship's bow will not stand as a ram, but that the bow should form the ram.

The ship mounted 8 nine inch shell guns in the broad side and two rifled 7 inch pivot guns in the bow and stern making a battery of ten guns. Four of the quarter ports had no guns in them being made for shifting ports and were closed by shutters, four inches thick, of wrought iron made at Richmond. These were not opened during her fights and her pivots were never shifted.

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Merrimac Continued

Every thing being in readiness on Saturday the 8th day of March 1862 Capt Franklin Buchanan in command cast off the Gosport Navy Yard and steamed for Hampton Roads. The U.S. frigates Congress and Cumberland were at anchor off New Port News at the time Capt. Buchanan steamed up between both of them and received their broad side which made no impression on the Merrimac the balls all glancing off as soon as they hit her, passing above the ships. Capt B. turned his ship around and came down on the Cumberland and striking her on the bow with

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his ram knocked her bow in and she sunk in a very short time. The Congress surrendered, and was burned, by hot shot from Merrimac.

The next day [March 9] the Merrimac and Monitor were engaged for a long time and many shots exchanged. Their effects were more severe than those from the other ships, being of larger caliber, and at much closer range. The effects of this fight broke several of the plates on the shield of the Merrimac and started the wood work in several places but not seriously as it was soon easily and

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Merrimac Continued

quickly repaired when she returned to the Navy Yard. Lt. Catesby ap Roger Jones commanded in the fights with the Monitor, Capt. Buchanan having been wounded by a minnie ball the day before fired from the shore.

A small but insignificant leak was caused in the stem of the Merrimac after the ram was knocked off but [it was] nothing worth noting as is would not make a barrel of water in 24 hours.

Upon examination, it was found that over one hundred shot had struck the Merrimac, not one of which penetrated. Those from the Congress and Cumberland

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Merrimac Continued

only making a dent, but those from the Monitor breaking the plates in several places and shoving some little signs of starting inside in a few places, <u>where four shot struck together</u>. What the effect of the Merrimac shots on the Monitor were, I do not know. She succeeded in beating her off, to retreat.

The Merrimac had nothing but cast iron shells on board. But when she went down a second time [on March 9] under Capt. Josiah Tatnall, Jr., she had wrought iron slugs steel pointed and solid shot and was in every respect greatly improved, had more iron armor, all her port shutters completed

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Merrimac Continued

etc. but the Monitor could not be induced to make a second attack, and never again would she come near her. On the Thursday [May 8] before the evacuation of the Navy Yard by the Confederates the whole U.S. fleet attacked Sewell's Point after having learned of its partial evacuation. The Merrimac went to its relief when the whole fleet cut out for Old Point in double quick without waiting for her to fire a gun Monitor and all. There is no doubt of their perfect dread of her.[64]

After the evacuation [of Norfolk, VA] by the C.S., Capt. Tatnall destroyed her from necessity (as he thought) in the Elizabeth as she drew to much water for the James [River].[65]

J. L. Porter C. S. N.

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[64] On May 8, 1862, the Merrimac went to the relief of the Confederate batteries on Sewell's Point which were under attack from the Monitor and the rest of the US fleet. The Merrimac did not advance far enough to be rammed by the US ships so they retreated down the river. U. S. Naval War Records Office. *Official records of the Union and Confederate Navies in the War of the Rebellion. Series I - Vol. 7: North Atlantic Blockading Squadron (March 8, 1862 - September 4, 1862)* (Washington, DC: Govt. Printing Office, 1898), pp. 333-338 http://cdl.library.cornell.edu/cgi-bin/moa/pageviewer?frames=1&cite=http%3A%2F%2Fcdl.library.cornell.edu%2Fcgi-bin%2Fmoa%2Fmoa-cgi%3Fnotisid%3DANU4547-0007&coll=moa&view=50&root=%2Fmoa%2Fofre%2Fofre0007%2F&tif=00365.TIF&pagenum=333; See also: "Naval Chronology of the Civil War" at civilwar.com website: http://www.navyhistory.com/cwnavalhistory/May1862.html.

[65] On May 11, 1862, Tatnall ran the Merrimac aground near the entrance to the Elizabeth River and set fire to her to prevent her falling into the hands of advancing US troops. U. S. Naval War Records Office. *Official records of the Union and Confederate Navies in the War of the Rebellion. Series I - Vol. 7: North Atlantic Blockading Squadron (March 8, 1862 - September 4, 1862)* (Washington, DC: Govt. Printing Office, 1898), pp. 333-338, 787-799; http://cdl.library.cornell.edu/cgi-bin/moa/pageviewer?frames=1&cite=http%3A%2F%2Fcdl.library.cornell.edu%2Fcgi-bin%2Fmoa%2Fmoa-cgi%3Fnotisid%3DANU4547-0007&coll=moa&view=50&root=%2Fmoa%2Fofre%2Fofre0007%2F&tif=00008.TIF&pagenum=335

[Copy of Letter] From S. M. Pook, U. S. N. Constructor (Undated) [66]

A small size ship of war will carry more cargo than a large one in the same draft of water. Example

The displacement of a ship when loaded is equal to one and one half the tonnage. 1000 tons ship has a displacement = to 1500 tons, a 2000 tons ship has a displacement equal to 3000 tons. The load draft should be 2/5 the beam. The length = to 6 times the beam. Suppose the ship

of 1000 tons be 30 ft. beam x 6 = 180 long.

2000 tons be 44 ft " x 6 = 264 long.

Draft of water of 1000 ton ship is 12 feet

" " " " 2000 " " " 17 $\frac{3}{5}$ "

4/5 the weight which go to make up the total displacement are included in the hull, spars, rigging

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[66] Samuel Moore Pook, U. S. Naval Constructor. See Biographical Notes.

Continued

Sails, cables & anchors, machinery & fuel, leaving only 1/5 available for cargo, which consists of guns, powder, shell & shot, men provisions and water.

1000 ton ship = 1500 dis. – 4/5 = 1200

2000 ton ship = 3000 " - 4/5 = 2400

1500 – (4/5 = 1200) = (cargo) 300

3000 – (4/5 = 2400) = (cargo) 600

Then the 1000 ton ship carries 300 tons of cargo at 12 feet draft but the 2000 ton ship carries only 600 tons cargo at 17 $\frac{3}{5}$ feet draft/

12 feet draft

difference of draft 5 $\frac{3}{5}$ feet "

calculated

at tons 125 per foot

tons 700 to which

add 300 tons (cargo)

Making 1000 tons which the small vessel would carry

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as cargo at a draft of water at $17\frac{3}{5}$ feet, while the 2000 ton ship would only carry 600 tons cargo at the same draft.

So that the only question arises is there room to carry this additional quantity of men, provisions &c in the small ship.

Cost of Ships

Table 14 Cost of Ships Complete for Sea in 1800

Cost of Ships Complete for Sea in 1800	
44 gun ship	$295,000
36 " "	$235,000
24 " "	$78,926
Brigs & schooners $30 per ton for hulls.	

Sketch of Merrimac 1862[67]

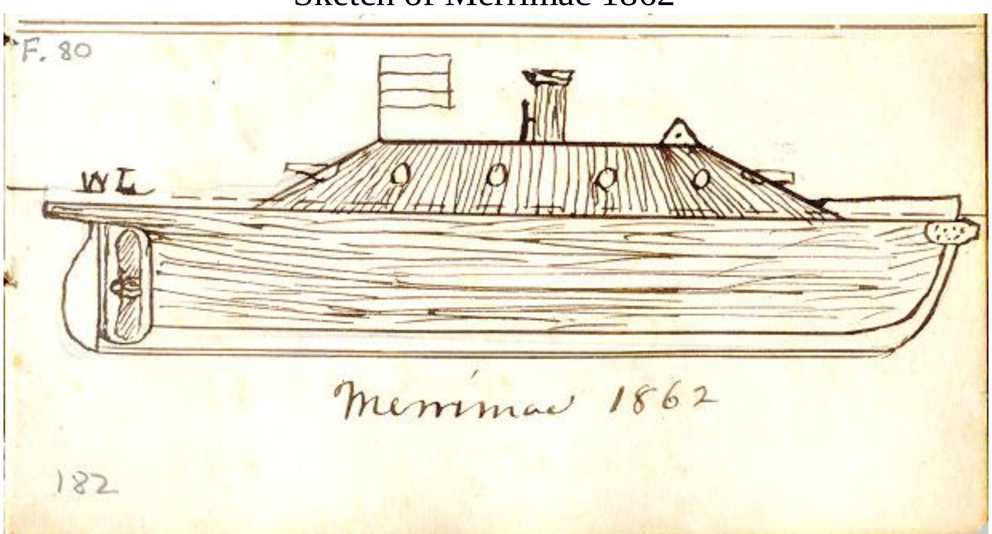

Figure 80: Sketch of the Merrimac (1862) by John L. Porter
[182]

67 *Figure 80: Sketch of the Merrimac (1862) by John L. Porter:* In *John L. Porter Notebook*, p. 182, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27834.

[Specific Gravities and Weights of Materials]

Table 15 Dry Specific Gravities

Dry Specific Gravities of Wood		
For the weight of a cubic foot divide the specific gravity by 16.	Water =	1000
	Ash	845
	Beech	852
	Cherry	715
	Cork	240
	Cypress	644
	Ebony	1331
	Elm	672
	Hacmatac[68]	592
	Lignum vitae	1333
	Live Oak	1120
	Mahogany	1063
	Mulberry	897
	English Oak	932
	Yellow Pine	660
	White Pine	554
	Walnut	671
	White Oak	850
	Locust	846

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[68] Hackmatack, from the Algonquin Indian meaning "snowshoe wood" refers to any of several species of trees including the common juniper and poplar.

Table 16 Weight of a Cubic Foot of Wood

<table>
<tr><td colspan="3">Weight of a Cubic Foot of</td><td></td></tr>
<tr><td rowspan="17">For the weight of a cubic foot divide the specific gravity by 16.</td><td></td><td>Well Seasoned</td><td>Dry</td></tr>
<tr><td>Ash</td><td>45</td><td>53</td></tr>
<tr><td>Beech</td><td>39</td><td>53</td></tr>
<tr><td>Cherry</td><td>38</td><td>45</td></tr>
<tr><td>Cypress</td><td>28</td><td>40</td></tr>
<tr><td>Hickory</td><td>532</td><td>55</td></tr>
<tr><td>Mahogany</td><td>45</td><td>66</td></tr>
<tr><td>White Oak</td><td>47</td><td>54</td></tr>
<tr><td>Yellow Pine</td><td>34</td><td>41</td></tr>
<tr><td>White Pine</td><td>30</td><td>35</td></tr>
<tr><td>Poplar</td><td>28</td><td>35</td></tr>
<tr><td>Cork</td><td>15</td><td>-</td></tr>
<tr><td>English Oak</td><td>47</td><td>58</td></tr>
<tr><td>Cedar</td><td>36</td><td>42</td></tr>
<tr><td>Walnut</td><td></td><td>42</td></tr>
<tr><td>Live Oak</td><td></td><td>70</td></tr>
<tr><td>Locust</td><td>39</td><td>53</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

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Table 17 Cohesive Fore of Materials

Cohesive force of materials. Weight or force necessary to tear one square inch asunder in pounds

Ash	16,000	Copper cast	22,500
Cedar	11,400	" wire	61,200
Elm	13,400	Cast iron	18-50,000
Lancewood	23,000	Iron wire	10,300
Lignum Vitae	11,800	Best bar	75,000
Locust	20,500	Brass	45,000
Mahogany	21,000	Copper 10 to 1	32,000
White Oak	11,500	" 8 to 1	35,000
English Oak	13,600	" 4 to 1	36,000
Yellow Pine	13,000	Silver 5 cop 1	48,000
Poplar	7,000	" 4 tin 1	41,000
Walnut	7,800	Tin 10 zinc 1	12,914
Beech	11,500	" 10 lead 1	6,800
Box	20,000	Led cast	880
Span. Mahog.	12,000	Lead milled	3,300
Tickwood	14,000	Platinum wire	53,000
		Silver cast	40,000
		Steel soft	120,000
		Rayzor steel	150,000
		Block tin cast	5,000
		Zinc cast	2,600
		Zinc sheet	16,000
		Gold cast	20,000
		" wire	30,000

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Table 18 Weight of a Cubic Foot of Various Substances

Cast iron	450.55
Wrought iron	486.65
Steele	489.8
Copper	555
Lead	708.75
Brass	537.75
Tin	456
Salt Water	64.3
Fresh Water	62.5
Air	.07529
Steam	.0350
Sand	95
Clay	135
Cork	15
Tallow	59
Brick	125
Common Soil	124

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Table 19 Weight of a Foot of Square Rolled Iron

$\frac{1}{16}$	.013	$2.\frac{1}{4}$	17.112
$\frac{1}{8}$	.053	$2.\frac{3}{8}$	19.066
$\frac{3}{10}$	.118	$2.\frac{1}{2}$	21.120
$\frac{1}{4}$	.211	$2.\frac{5}{8}$	23.292
$\frac{3}{8}$	.475	$2.\frac{3}{4}$	25.560
$\frac{1}{2}$	.845	$2.\frac{7}{8}$	27.939
$\frac{5}{8}$	1.320	3.	30.416
$\frac{3}{4}$	1.901	$3.\frac{1}{8}$	33.010
$\frac{7}{8}$	2.588	$3.\frac{1}{4}$	35.704
1.	3.380	$3.\frac{3}{8}$	38.503
$1.\frac{1}{8}$	4.278	$3.\frac{1}{2}$	41.408
$1.\frac{1}{4}$	5.280	$3.\frac{5}{8}$	44.418
$1.\frac{3}{8}$	6.390	$3.\frac{3}{4}$	47.534
$1.\frac{1}{2}$	7.604	$3.\frac{7}{8}$	50.756
$1.\frac{1}{5}$	8.926	4.	54.084
$1.\frac{3}{4}$	10.352	5.	84.517
$1.\frac{7}{8}$	11.883	6.	121.664
2.	13.520	7.	165.632
$2.\frac{1}{8}$	15.263	8.	216.336

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Table 19 Weight of a Foot of Round Rolled Iron (Continued)

$\frac{1}{16}$	.010	$2.\frac{1}{4}$	13.440
$\frac{1}{8}$	.041	$2.\frac{3}{8}$	14.975
$\frac{3}{16}$	.119	$2.\frac{1}{2}$	16.688
$\frac{1}{4}$	.165	$2.\frac{4}{8}$	18.293
$\frac{3}{8}$	.373	$2.\frac{3}{4}$	20.076
$\frac{1}{2}$	.663	$2.\frac{7}{8}$	21.944
$\frac{5}{8}$	1.043	3.	23.888
$\frac{3}{4}$	1.493	$3.\frac{1}{8}$	25.926
$\frac{7}{8}$	2.032	$3.\frac{1}{4}$	28.040
1.	2.654	$3.\frac{3}{8}$	30.240
$1.\frac{1}{8}$	3.360	$3.\frac{1}{2}$	32.512
$1.\frac{1}{4}$	4.172	$3.\frac{5}{8}$	34.886
$1.\frac{3}{8}$	5.019	$3.\frac{3}{4}$	37.332
$1.\frac{1}{2}$	5.972	$3.\frac{7}{8}$	39.864
$1.\frac{1}{5}$	7.010	4.	42.464
$1.\frac{3}{4}$	8.128	5.	66.752
$1.\frac{7}{8}$	9.333	6.	95.552
2.	10.616	7.	130.048
$2.\frac{1}{8}$	11.988	8.	169.856

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Table 20 Different Size and Lengths of Iron Rivets

Table showing the different sizes and lengths of iron rivets used for different thicknesses of iron, hot & cold.

Thickness of Iron	Diameter of Rivets	Lengths of Hot Riverts	Lengts of Cold Rivets	Distance from C to C.
		Boilers		
$\frac{1}{16}$	$\frac{1}{4}$		$\frac{9}{16}$	1. $\frac{1}{4}$
$\frac{1}{8}$	$\frac{5}{16}$		$\frac{5}{8}$	1. $\frac{3}{8}$
$\frac{3}{16}$	$\frac{9}{16}$	1. $\frac{3}{8}$	1	1. $\frac{3}{4}$
$\frac{1}{4}$	$\frac{5}{8}$	1 .$\frac{1}{2}$	1. $\frac{1}{8}$	1.$\frac{7}{8}$
$\frac{5}{16}$	$\frac{5}{8}$	1.$\frac{5}{8}$	1 .$\frac{1}{4}$	1.$\frac{7}{8}$
$\frac{3}{8}$	$\frac{11}{16}$	1. $\frac{3}{4}$	1. $\frac{3}{8}$	2
$\frac{7}{16}$	$\frac{3}{4}$	1.$\frac{7}{8}$		2.$\frac{1}{8}$
$\frac{1}{2}$	$\frac{7}{16}$	2.$\frac{1}{8}$		2.$\frac{1}{4}$
		Ships		
$\frac{1}{4}$	$\frac{5}{8}$	$\frac{7}{16}$		1.$\frac{3}{4}$
$\frac{5}{16}$	$\frac{3}{4}$	1		1.$\frac{7}{8}$
$\frac{3}{8}$	$\frac{3}{4}$	1.$\frac{1}{8}$		2
$\frac{7}{16}$	$\frac{3}{4}$	1.$\frac{1}{4}$		2.$\frac{1}{8}$
$\frac{4}{8}$	$\frac{3}{4}$	1.$\frac{3}{8}$		2.$\frac{1}{4}$

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[Cost of Ships of Navy, 1801]

Table 21 Cost (Including Ord. Stores) of Ships of Navy 1801

	Tonnage	Guns	Cost
Unites States	1,444	44	$229,336.56
Constitution	1,444	44	$302,718.84
Constellation	1,268	36	$314,242.81
President	1,444	44	$220,900.08
Congress	1,268	36	$197,246.81
Chesapeake	1,044	44	$220,677.80
Philadelphia	1,040	44	$$179,549.00
Essex	.850	32	$139,362.58
John Adams	.544	24	$113,505.72
Adams	.530	24	$76,622.27
George Washington	.624	24	$69,024.92
Genl. Greene	/645	24	$105,492.52
Richmond (Brig.)	.163	18	$27,896.37
Norfolk (Brig.)	.172	18	$18,720.55
Enterprise (Schooner)	.135	12	$15,046.30

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[Miscellaneous Conversions]

A box 12 $\frac{7}{8}$ inches square will contain one bushel of grain.

An acre of land is nearly 209 feet each way, or 43,560 [square] feet

231 cubic inches in a gallon.

35 cubic feet in a ton

40 cubic feet of anthracite [=] one ton.

44 bushels bituminous in a ton.

A cubic foot of salt water [=] 64.3 lbs.

A cubic foot of fresh water [=] 62.5 lbs.

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Record of Iron Vessels [built by John L. Porter].[69]

In 1842 I built the iron steamer Water Witch at the Washington Naval Shipyard.

In 1845 & 7 I built the US Str. Alleghany of 1000 tons of iron at Pittsburgh, Pa.

In 1866 I built three iron tugs of rate for the State of Virginia, William T. Taylor, Iroquois [?], & Virginia to collect oyster tax.

In 1868 I built the iron tug Astoria at the Atlantic Works.

In 1869 I built the iron steam boat Cygnet at the Atlantic Works.

In 1846 I built the iron steamer Hunter at Pittsburgh, Pa.

Had the entire control of the building and arranging of these vessels.

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[69] John L. Porter Notebook, pp. 192, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858

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Hornet and Peacock [Lyrics]

1 Ye Brittens attend and Fede[erals, too]
I’ll sing you a song, you all know [is true]
It is of the Peacock a ship in full [sail]
And ‘tis of the Hornet which lowered [her sail]
Chorus
    Sing beeboro, duboro, granny O [Wale][70]
    Our Hornets can tickle a british [bird’s tail]
    Our stings are all sharp and pierce [without fail]
    Success to our navy says ‘Granny O [Wale]
2 This Peacock was bread in the land of …[Page torn]
His feathers very fine and his tail very long
He spread forth his wings like a ship in full [sail]
And prided himself from the size of his [tail].
    Sing beeboro, duboro, granny O [Wale]
3 King George says my bird to America go
Each hornet & wasp, make a british birds [foe]
Cheer up my brave bird and sure you don’t [fail]
Make them honour Kings birds & respect them …[Page torn]
    Sing beeboro, duboro, granny O [Wale]
4 Away flew the bird at the word of command
With his course directed to freedom’s own land
Till the Hornet discovered her wings like a sail
And quickly determined to lower her tail.
    Sing beeboro, duboro, granny O [Wale]
5 The Hornet & Peacock together did cling
The Hornet still working close under her wing
Till the stings of the Hornet which never did fail
Soon rumpled her feathers and lowered her tail.
    Sing beeboro, duboro, granny O [Wale]
6 Here is health to brave Lawrence who well knows
When Hornets & Wasps are just in the
To sting British birds who spread out their sails
And pride themselves from the size of their tails.
    Sing beeboro, duboro, granny O [Wale]

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[70] Granny O’Wale may be a transliteration of the Irish “Granuaille” or Old Woman.

[Autobiographical Accounts Continued]

Merrimac

John L. Porter's Letter to Thomas Oliver Selfridge (1874)[71]

Portsmouth, VA, Dec. 21, 1874

Thos. O. Selfridge, Commander, U.S.N., Boston Navy Yard.

Sir. Mr. G. R. [George R.] Boush, assistant naval constructor of this yard has called on me, and presented your letter, of the 14th inst. asking for certain information in regard to the Merrimac, Monitor, etc., etc., etc., which I cheerfully give from he fact that you state as a matter of history you want the facts to set the history straight.

There is no matter that I know of in which so many erroneous statements have been made from time to time, and in fact I must say that I have yet to see the first correct one published. Having constructed the Merrimac as an iron clad, docked her after the actions in Hampton Roads, and refitted her in the dock at the Gosport Navy Yard, noting every particular of the conditions of the ship, and the effect from the shot from the

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71 "John Porter's Letter to Thomas Oliver Selfridge (1874), John L. Porter Notebook, pp. 195-204, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858

various ships with which she was engaged, and also being fully acquainted with the particulars of those engagements, I am fully capable of giving you the desired information, and also other interesting facts in connection with her history which you do not ask but which I think will interest you, and which no other person has, all of which are strictly true, and which I would qualify to.

The Merrimac was armed with eight 9" shell guns in her broadside (of her original battery) and one 7" rifle gun in each end of the shield mounted on a pivot carriage. As we did not expect to encounter any iron clads she was only provided with shells for all the guns rifled and smooth bore. She left the Navy Yard[72] at one o'clock on Saturday 8th of March 1862 and steamed for Newport News where the Congress, and Cumberland, were lying at anchor. The Congress on the starboard side and nearest received the first fire. A shell from the bow gun

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[72] i.e. Gosport Navy Yard

entered her stern port on the spar deck, and killed Lt. Joseph B. Smith, U.S.N. She very soon came abreast of the Congress and received her broadside which made no impression whatsoever that could be noticed inside the case mate. She continued on and very soon came abreast he Cumberland on her port side which also opened her broad side and with no better effect. She then continued on until she came abreast of the land battery and opened fire upon it for some time. She then turned and made for the Cumberland, and striking her a glancing blow with her ram she broke her side in, and also broke off the ram, which was of cast iron and projected the stem two feet, and was made thus:

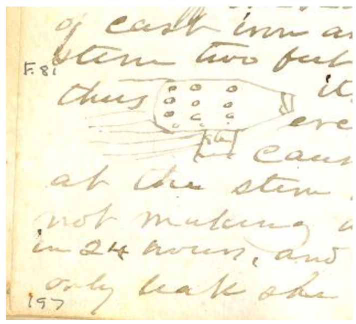

Figure 81: Sketch of the Merrimac's Iron Ram [73]

Its weight did not exceed a ton. This caused a small leak at the stem hardly perceptible not making a barrel of water in 24 hours, and which was the only leak she ever had.

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[73] *Figure 81: Sketch of the Merrimac's iron ram, by John L. Porter*: In: John L. Porter Notebook, pp. 197, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858.

The Cumberland soon went down, bow foremost, firing her after pivot gun while her bow was under water and sinking rapidly. The Congress had struck her colors and was on fire. Capt. Buchannan was stationed in a small hatch with the pilot, his head and shoulders being exposed all the time but did not receive the least injury from the fire of the Cumberland, Congress, or shore battery, but in nearing the shore some of the sharp shooters fired into the ports killing one or two of his men and from his position he could see them & called for a musket which he used but not having room, he very unfortunately got on top of the shield and was wounded by one of them. No shot or shell penetrated her shield in any of the actions and the only men who were killed were those mentioned above.

Lt. Robert Minor was flag lieutenant and after the firing from the ships had ceased had ceased, made an examination all around and reported to Capt. Buchannan that they had not fazed her (to use his own words). This he related to me afterwards. She then passed down towards the Minnesota. The Roanoke, Jamestown, & Jensen which had been fitted out at Richmond came out of this port early in the action and fought throughout on the first day, but not with the Monitor.

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So soon as the firing began the Minnesota which was lying off Fortress Monroe got under way and attempted to go up to Newport News by the "inside" channel and grounded. She was in this condition when the Merrimac came down the out side channel Hampton bar being between them. The Merrimac neared her until she grounded both ships firing rapidly as possible at each other. The shot from the Merrimac doing great damage, while those from the Minnesota did none whatsoever. This continued until night came on and put a stop to the fight for the 1st day, the 8th of March. On that very evening the Monitor was towed into Hampton Roads and on Sunday morning the 9th of March she came out to engage the Merrimac. Up to this time she had sustained no injury except the breaking off of the ram and the shooting off the muzzle of one of the broad side guns but which did not prevent its use. The action lasted several hours. The vessels at times touching each other and with no seeming advantage to either until a shell struck the look out on the Monitor immediately in front of Lt.

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[John Lorimer] Worden, who was directing the fight, and knocked him senseless from the concussion. So soon as this occurred, the Monitor [went] out for Old Point, and Lt. Jones, who then commanded the Merrimac, made signal for all the vessels to go up to the Navy Yard. This course of Lt. Jones was not generally sustained. Capt. Buchannan said to me afterwards that Lt. Jones had made a great mistake in not going for the Minnesota. The only good reason I could see for his coming up was that his vessel had been lightened so much from the burning of her coals, and the discharges of shells & powder as to bring her vulnerable parts near the surface forward, but aft, she was more secure, as her propeller & steering gear were submerged deeper, the ship having tipped by the stern. I saw the assistant surgeon of the Minnesota in Baltimore afterwards[74], who informed me that the officers & crew of the ship all left her on Saturday night and held a consultation at Old Point and concluded if the Merrimac renewed the attack next day to set her in fire, and a small party was sent on board for that purpose, but after the Merrimac left the Roads, the crew went aboard again, got up steam, and got her off. This I witnessed myself. The next day I put the ship in the dock and made a thorough examination, and found no

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[74] *Assistant Surgeon of the Minnesota*: A possible reference to Samuel L. Jones, who served in that position as late as April 15, 1863.

serious damage anywhere. I put a piece in the stem, and put in a better] ram of wrought iron, and steel, extending about 14 feet on the bow. I found 8 & 10 plates broken in the shield by the shot from the Monitor but none knocked off. I could tell these from the shot of the other ships because she fired two at a time and being at close range they invariably struck the shield together, and low down, both being 10" solid. The effect of the two I considered far more destructive than one would have been. These plates I soon replaced, and without the least difficulty. I examined her shield. Out side ninety impressions made by the shots from the other ships were visible but merely made an indent without doing any injury. The Monitor's (20) only making any impression. What detained the ship so long in dock was we were putting on more armor, so as to protect her better near the waters edge. Thus, we bent more iron 2 inches thick as at A

Figure 82: Vertical Section View of the Merrimac's Armor[75]

and bolted it on the ends of the inclined plates for better protection in case she was lightened, and, were also making wrought iron slugs

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[75] *Figure 82: Vertical section view of the Merrimac's hull, by John L. Porter:* Sketch shows added armor below the water line. In: *John L. Porter Notebook*, p. 201, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858.

with steel points for all her guns with which she was fully supplied when she went down to meet the Monitor the second time. We also improved her steering gear, and she was a much better ship. Capt. Tatnall commanded her then. He went to Hampton Roads for the express purpose of meeting the Monitor and waited for her to come out but she failed to do so. There were several small vessels with stores for the U. S. Government lying out there. Capt. Tatnall sent one or two small gunboats and captured them right under her guns, and brought them to the Navy Yard, but she still remained under the guns of Old Point, and never afterwards did she come within the range of the Merrimac's guns. Furthermore, when afterwards, we were preparing to evacuate this place, and were removing all the guns from Sewell's Point battery, a man in our service in charge of a tug deserted and carried the news to Gen. John Ellis Wool, U. S. A. at Fortress Monroe. The whole Federal fleet got under way and commenced a rapid fire on it, including the Monitor, but we had no men there to reply, but the Merrimac was sent down from the Yard to meet the whole fleet, Monitor and all, but just as

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soon as she rounded Pinners Point, and hove in sight, they all, the whole fleet, Monitor and all, cut out for Fortress Monroe and didn't let the Merrimac get within two miles of them.

I heard afterwards that her commander had orders from the Navy Department to avoid another fight with the Merrimac if possible on account of the great stakes at issue, for it was plain that if either of them were out of the way, the other would have the control of these waters, and I never for a moment supposed her officers were not brave, but at any rate it does not look much like she was destroyed by the Monitor as I understand Admiral Worden is claiming prize money. The cause of her destruction was the advance of Genl. McLellan [sic] on Richmond; this place had to be evacuated to get the troops, and so we could not get her in the James [River] on account of her draft

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of water. She would have been in the Federal lines, and cut off from supplies, and would have been compelled to surrender very soon, and Capt. Tatnall thought his only chance was to destroy her, although at the time he thought of taking her to Port Royal, and I actually had a strong set of Port breakers I had made for that purpose, but he changed his mind. When destroyed she was in fighting trim, and vastly superior to that in her two days fight.

John L. Porter,

N. Con.

P. S.

After the Congress had stuck her colors to the Merrimac, Capt. Frank Buchannan, C.S.N. commanding, sent Lt. Rob. Minor in a small tug, to take possession of her. As he neared the ship he was fired into by the sharp shooters who were concealed behind the sand hills, and wounded slightly. Capt. Buchannan then ordered two shot to be heated and fired into her, which set her on fire. This was the cause of her being burned.

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A Short History of Myself During the War of 1861, by John L. Porter (1878).[76]

During the presidential canvass for 1860, I was stationed as Naval Constructor in the Navy Yard at Pensacola, FL. So soon as it was known that Lincoln was elected[77] the secessionists began their work of breaking up the union, and declared they would not live under a government that would not allow them to carry their slaves into any of the U.S. territories and protect them. A convention of the state was soon called and a majority elected who soon passed the ordinance of secession.[78]

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[76] "A Short History of Myself During the War of 1861 (1878)," John L. Porter Notebook, pp. 205-234, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858

[77] Lincoln was elected president in November 1860. American Civil War. Com. Civil War Timeline., 1861 – 1865, http://www.americancivilwar.com/tl/tl1861.html.

[78] Florida seceded from the Union on 0 January 1861. American Civil War. Com. Civil War Timeline., 1861 – 1865, http://www.americancivilwar.com/tl/tl1861.html.

So soon as this was done, a battalion of volunteers, consisting of fire companies, came from the interior of the state of Alabama to the navy yard and Commodore James Armstrong delivered the yard up to them, without an effort on his part at defense.[79] He was afterwards court martialled for it and suspended for five years.[80] Two or three days after the surrender, I received orders to report for duty at the Washington Navy Yard, where the U.S. Ship Pensacola, which I had lately built, was receiving her machinery. I found there the Steamer Pawnee and was ordered to fit her out, which I did in March 1861.

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[79] The Pensacola Navy Yard fell to the Confederates on 12 January 1861. *Pensacola's Navy Yard, 1825-1911 (Part IV: The Navy Yard, The Forts, & The Civil War),* p. 19, in : eHistory. http://www.ehistory.com/local/gulfcoast/escambia/books/navyyard/0020.cfm.

[80] *Pensacola's Navy Yard, 1825-1911 (Part IV: The Navy Yard, The Forts, & The Civil War),* p. 20, in : eHistory. http://www.ehistory.com/local/gulfcoast/escambia/books/navyyard/0020.cfm.

Early in April, I learned that Samuel Pook[81] the naval constructor at the Gosport Navy Yard was anxious to be relieved from duty at that Yard. I applied to Mr. Gideon Welles the secretary of the navy to be sent there, and was ordered to do so, and reported to Commodore Charles S. McCauley on the 17 day of April 1861.

Every thing at that time was disorder and confusion the men were standing in groups about the yard and no one could work. At one o'clock [on 20 April] the gates of the yard were closed to the workmen and the destruction of the yard began by the US

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[81] Samuel Moore Pook, U. S. Naval Constructor. See Biographical Notes below.

officers & men. They sunk the Germantown at the wharf, cut down the masting spars, which fell across her, and made her a total wreck. They next went on board of the Merrimac and broke all her small machinery opened all her cocks and sunk her. The sloop of war Plymouth, the Columbus, and Delaware, 74s,[82] were also sunk by them. Then commenced the destruction of stores, small arms, &, & until night came on when the Pawnee came. S. R. Spalding came up to the Yard with a regiment of Massachusetts volunteers[83] who were nearly all night

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[82] *74s*: i.e. The Navy rated them as having no less than 74 guns each.

[83] *Massachusetts volunteers*: The 3rd Regiment Massachusetts Volunteer Infantry (3 months Militia) arrived aboard the steamship *S. R. SPAULDING* and the sloop of war *USS PAWNEE*. The 3rd Regiment had left Boston for Fort Monroe on the *S. R. SPAULDING* on April 17, 1861. They arrived at Fort Monroe on April 20. They went on board the *USS PAWNEE*. Both ships moved to Norfolk on April 20, where they destroyed the Navy yard. The Confederates occupied it the next day April 21. *The Civil War Archive: Union Regimental Histories: Massachusetts*, website: http://www.civilwararchive.com/Unreghst/unmainf1.htm#3rd3mo.

firing the yard and destroying property and by day light they had burned the Germantown [and] Merrimac, both of the ship houses, the building near the gate, marine barracks, ships Pennsylvania, Brandywine, Potomac, brig Porpoise & all the vessels in ordinary and evacuated the Yard, the Pawnee taking the Cumberland, Capt. Jesse Garrett Pendergrast, in tow. It seemed that the old ship United States escaped burning from both sides as neither the Federals nor Confederates burnt her. Thus in the short space of four months I had been attached to three navy yards, two of which had been given up without any defense whatever.[84]

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[84] *Watching The "Merrimac,"* by R. E. Colston, Brigadier-General, C. S. A., in Battles and Leaders of the Civil War, cited in : eHistory.com. http://www.ehistory.com/uscw/library/books/battles/vol1/712.cfm.

In my opinion the Gosport Yard could have been defended had Com. McCauley chosen to have done so, but he was not called to account for his conduct while Com. Armstrong, who had but little means of defense was court martialled, and suspended.

So soon as the yard was evacuated[85] the Confederates took possession of it, and commenced sending supplies in all directions from the vast amount of stores & materials found in the Navy Yard. The guns were sent to the Potomac, Richmond, New Orleans, Mississippi River & & &.

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[85] 21 April 1861.

I then resigned my appointment as constructor in the U. S. service, and reported for duty to Commodore French C. Forrest who had assumed the command of the yard in the name of the State of Virginia. I took charge of the yard as naval constructor on the part of the State of Virginia, April 19th, 1861[86]. The most [i.e. bulk] of the work being done was to mount guns, and fit up the various batteries erected in the harbor and down the river to prevent the return of the Federals and clear up the wreck all on account of the State of Virginia, which had not

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[86] *April 19, 1861*: Porter seems to have lost track of time here, since the Yard did not fall to the Confederacy until April 21.

as yet joined the Confederacy but she soon did this[87] and invited the Government to move from Montgomery to Richmond[88] which it did when work began in earnest in the Yard at Gosport.

We took the hulk of the Merrimac which the Federals had burned to the water's edge . . . ,[89] [we] built two gunboats called the Nansemond and Elizabeth, also the iron clad steamer Richmond which was finished in Richmond after the Confederates evacuated the Yard which was soon after the action of the Merrimac

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[87] Virginia seceded from the Union on April 17th. On 6 May 1861, the Confederate Congress passed a declaration of war against the United States. See History Place.com, http://www.historyplace.com/civilwar/. and The History Place - US Civil War 1861-1865, http://www.navyhistory.com/cwnavalhistory/May1861.html.

[88] Jefferson Davis and the government of the Confederacy arrived in Richmond on 30 May 1861. *Arrival of President Davis*, Richmond Dispatch, 5/30/1861, cited in: http://www.mdgorman.com/Dispatch/richmond_dispatch_5301861.htm.

[89] "A Short History of Myself During the War of 1861 (1878)," John L. Porter Notebook, pp. 205-234, John L. Porter Collection #850, Special Collections Department, Joyner Library, East Carolina University, Greenville, NC 27858

in Hampton Roads in which she destroyed the frigates Cumberland and Congress and defeated the Monitor. We built also a number of small boats for operating in the rivers and fitted out several gunboats for the waters of North Carolina, made and shipped large numbers of gun carriages in all directions, and did much for the camps around this section, supplied anchors and chains for obstructing, tanks and casks for water & ropes & tackle, ordnance stores & with which the yard was well supplied; made models and moulds

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and sent them to Wilmington, Charleston, and other places, and sent plans of gunboats in all directions over the Confederacy.

When the Confederates left[90] they burned nearly every thing the Federals had left, except the officers' quarters, and the old frigate United States. Shortly after the Confederate government moved to Richmond, I was appointed a constructor in the Navy of the Confederate States of America by President Jefferson Davis, S. R. Mallory being secretary of the Navy.[91]

In the lower part of Richmond, I established a navy ship yard and placed Mr. James Meads in charge. Here we built two iron clads, the Texas and

[214]

[90] The Confederate forces abandoned Norfolk on May 9, 1862. See: R. L. Curry's *Civil War in Miniature: Chronology of the Civil War*. Website: http://civilwarmini.com/dates.htm.

[91] Porter, who had been serving as an unofficial naval constructor for the Confederacy since resigning his commission in the U.S. Navy in May 1861; after the move to Richmond, in June 1862, Porter received an official appointment as a naval constructor for the Confederacy, and was named chief naval constructor in January 1864 and served in that capacity until the end of the war. See: "C.S.S. Virginia (Merrimack) Story of her construction, battles &C," by John L. Porter, Naval Constructor, in: Navy Collection, Misc. Box 2/Porter, Eleanor Brockenbrough Library, The Museum of the Confederacy, Richmond, Virginia; *Official records of the Union and Confederate Navies in the War of the Rebellion. Series II – Vol. 1: Statistical Data of Union and Confederate Ships; Muster Rolls of Confederate Government Vessels; Letters of Marque and Reprisals; Confederate Department Investigations,* (Washington, DC: Govt. Printing Offices, 1921), pp. 802-803. See also: http://cdl.library.cornell.edu/cgi-bin/moa/pageviewer?frames=1&cite=http%3A%2F%2Fcdl.library.cornell.edu%2Fcgi-bin%2Fmoa%2Fsgml%2Fmoa-idx%3Fnotisid%3DANU4547-2001&coll=moa&view=50&root=%2Fmoa%2Fofre%2Fofre2001%2F&tif=00001.TIF&pagenum=802. See also: "Chief Naval Constructor John L. Porter, Confederate States Navy, (1813-1893)," *Naval Historical Center Online Library of Selected Images*. http://www.history.navy.mil/photos/pers-us/uspers-p/jl-portr.htm.

Fredericksburg and finished the Richmond which we had built at the Gosport Navy Yard, an iron clad of 4 heavy guns. I established also an office in connection with the Navy Department and was appointed Chief Naval Constructor, C. S. N.[92]

During the war I visited all parts of the country on business connected with the Navy Department where we were building gunboats. I visited Mobile, Selma, Montgomery, Columbus, Ga., Charleston, Wilmington, Savannah, Kinston, Raleigh, Jackson, Yazoo City &, at all of which places we were building gunboats except Jackson which was an inland

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[92] *Chief Naval Constructor*: Porter was officially made chief naval constructor for the Confederacy in January 1864, a position he had lobbied to create. See: Official records of the Union and Confederate Navies in the War of the Rebellion. / Series II - Vol. 2: Navy Department Correspondence 1861-1865, with Agents Abroad (Washington, DC: U.S. Govt. Printing Office, 1921), p. 272; See also: "Chief Naval Constructor John L. Porter, Confederate States Navy, (1813-1893)," *Naval Historical Center Online Library of Selected Images*. http://www.history.navy.mil/photos/pers-us/uspers-p/jl-portr.htm.

city. While waiting there for the cars I had my trunk and all my clothes stolen from me.

The last gunboat we began was at Wilmington an iron clad.[93] She was well advanced. The caulkers were at work on her but after Fort Fisher was captured we burned her and the stocks and fell back to Halifax, NC, where we had a yard, and where the Albemarle was fitted out which done such important service at the capture of Plymouth.

I must here relate my adventures more particularly, from the capture of Wilmington to the surrender of General Joseph E. Johnston at Greensboro, NC, and after the surrender of General Robert E. Lee.[94]

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[93] *Ironclad:* Probably the C.S.S. Wilmington.

[94] *Robert E. Lee:* Lee surrendered his Army of Northern Virginia to Union General Ulysses S. Grant, at Appomattox Court House VA, on April 9, 1865. "Surrender Dates", in: *The Civil War Dictionary*, Revised Edition, by Mark May Boatner, III (New York: Vintage Books, 1991), p.822.

I did not think from the beginning that the Confederacy could succeed if the Federal Government chose to prosecute the war. It was a new government against an old one, a great many incompetent men placed in positions of trust and responsibility, with no navy to keep our ports open, and no money but paper to carry on a war, no resources in men while the U. S. had all Europe to draw from and fill up her decimated ranks. It was almost as hoping against hope that we would ever gain our Liberty.

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I had orders to take all my forces, stores & which I had at Wilmington and fall back to Halifax on the Roanoke River. I had two small flats at the yard and commenced to load them up immediately and by three o 'clock, had them both across the river at the railroad depot, but the army had taken possession of all the trains and I could get no transportation. So I detailed twelve men to go in the flats, gave some a furlough, and

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sent the remainder on the train to Halifax in charge of Acting N. C. Richard Meads. About sunset we put out from Wilmington up the North East River intending to intersect the railroad[95] at the bridge and send my tools, stores & to Halifax. The weather was cold with a heavy frost at night. We continued up the river that night until the tide began to ebb. We then landed on the banks made a fire, cooked something to eat, and waited for the tide to turn. We then set out again up the river and reached the bridge within four miles, and had to stop again on account of the head tide. While we were lying at the bank of the river & were cooking again, we saw the heavy cloud of smoke arise from the bridge and knew it was on fire but was at a loss to know who did it. In a short time a pontoon boat came drifting along, filled with water. I had it caught and put in order, ready for service

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[95] *Railroad*: The Wilmington & Weldon Railroad passes through Halifax on its way to Weldon. Confederate Railroads website © 2002-2003, David L. Bright www.csa-railroads.com.

when the tide turned again. I did not think it prudent to move, not knowing who had burned the bridge, and I concluded to stay just there until I could find out something. So I sent out two scouts who returned without having found out any thing. I ordered the men to bring their things ashore and prepare to spend the night on the ground. We made fire and lay all night wrapped in our blankets. The federal troops were firing and yelling nearly all the night on the side of the river opposite where we lay, but higher up towards the bridge. Early next morning,[96] I took a man and went out to reconnoiter myself. I came to trenches where our troops had dug and thrown up the night before, and made rifle pits to keep back the feds who were pressing them and it was our own men who had fired the bridge to keep the federals from coming up them.

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[96] Early next morning: i.e. the morning of February 23, 1865.

I soon returned to our camp and gave the men fifteen minutes to get ready to start. I took two men with axes and scuttled the lighters, and sank them and, whatever could be carried conveniently, was taken. We proceeded very cautiously, not knowing in whose hands we might fall, and struck the main road leading to Fayetteville. We were afraid to go up higher to the railroad for fear of capture. There were twelve men besides myself. We continued up this road and saw two men on horse back approaching. They told us we were in the wrong road to go to Halifax but, if we would return a short distance, they would set us right. We went back with them, and soon saw several horsemen standing in the road before us about 40 yards off. We saw them dismount, when they opened fire on us with rifles, and we had to take the woods in order to get out of

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the way of the balls, which came whistling amongst us. The two horsemen went like lightning. Their horses made straight tails, and we did not come up to them until sun down where they had halted. The men who fired away were Confederates, but took us for Yankees, which we afterwards learned.

We continued on our retreat for several days until we struck the railroad at Magnolia, with the loss of two toenails, swelled feet, & from tight shoes. Arriving at Halifax, we commenced work on a gunboat partly built, but it seemed as hoping against hope, our national affairs getting worse every day.

At this time, I received a letter from Major William P. Williamson at Richmond stating that in his opinion Richmond would be evacuated in less than ten days. As my family was there, I started immediately, but by the time I reached Raleigh, I learned that it had been done.[97]

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[97] *Richmond, VA*: The Confederates evacuated Richmond on the night of April 2-3, 1865. *The Civil War Dictionary*, Revised Edition, by Mark May Boatner, III (New York: Vintage Books, 1991), p. 699.

President Jefferson Davis had fallen back to Danville, and General Robert E. Lee to Appomattox Court House, where he had surrendered his small force to General Ulysses S. Grant.

I went on to Greensboro and there rented a room and made myself as contented as I could. After General Lee's surrender the President and cabinet fell back to Greensboro also. General Johnston's forces also fell back to Greensboro and everything for a while seemed in a fog. I remained in Greensboro a month. General Johnston saw that the cause was lost, and made arrangements with General William T. Sherman who was then near Raleigh to surrender his forces which was done on the first day of May / 64 [i.e. 1865][98].

We were paroled and allowed to go to our homes and not to be molested by the U. S. Government so long as we did not violate the terms of the agreement. I went to Richmond found my family had gone to Portsmouth.

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[98] *First day of May / 65*: As noted above the surrendered occurred on April 26, 1865.

I will here relate several incidents which happened at Greensboro. When the President and all the departments fell back to Greensboro I walked to the rail road depot and found Major William P. Williamson our engineer in chief, C. S. N. in a box horse car uncomfortable and sick. I invited him to go with me and share my room which he very gladly did and soon got well. We used to go out to a pond of water and wash our clothes. One day we expected Sherman would make a raid on the place and I disguised myself as a farmer and took to the woods, but they did not come nearer than 10 miles and burned the railroad bridge.

I had considerable Confederate money in my hands, belonging to the men who had deserted and I thought I would use it so long as it would pass. And, as the soldiers had more than they could carry home - which was divided out to them at Greensboro in the way of shoes, blankets,

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cloth, &, & - I bought what was offered, as much as I could take care of and bring home. I gave $50 a piece for grey blankets, $50 a piece for shoes, $100 a yard for cloth, &, until I got a goods box full, and had much trouble in getting it home. I kept several pairs of shoes to pay my way with along the road. When we came to the bridge, which was burned, I gave a pair to a Negro to carry my box to the next train. I gave the conductor a pair to hold on a few minutes for a friend on mine.

As Confederate money depreciated, the prices of all articles advanced until butter was $20 per pound, sugar $10, shoes $100 a pair, bonnets $125, cloth $100 per yard & and every thing else in proportion. I gave $350 for a small 2nd hand stove, $175 for a white counterpane, $10 for a pound of beef, or coffee, and every thing in proportion but we had enough to eat. John L. Porter.

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[Addendum]

During the war, my house on County St.[99] was confiscated and sold to a man named Husted for $700, by the U. S. Marshall, and a deed given by him. At the close of the war every one seemed for himself. No one seemed to sympathize with me for my losses of house, Negroes and situation as U. S. N. Constructor. I applied for several small offices in the gift of the city council but had no showing whatsoever. While I was a constructor in the navy I had friends a plenty, but after the war I had none being left poor, and needy, and I often regretted that I ever gave up my situation which offered me a good living for life, instead of roughing it for a

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[99] County Street: in Portsmouth, VA.

living which I had to do afterwards in the ship yards.

G. R. Boush, U.S.N.C., took me in the Navy Yard July 2 / 77 and placed me in charge of the whip sawyers which was the first kindness I had received from any one, in these parts, since the close of the war. Strange events occur during a life time. I had given him employment many times when I was in authority, but now the scene changes, he is a constructor, I am disrated and have to apply to him for employment as a carpenter. I appreciate Mr. Boush's kindness to me [;] also Mr. Wm. Smith's, the master ship wright. <u>May neither of them have such misfortunes as I have had.</u> [B]ut their [sic] is one consolation, <u>and end to all things.</u> Fifty years from today and very many of us will have passed away, and if we save our souls alive we shall not have lived in vain.

> Soon will the toilsome strife be o'er
> Of sublunary care:
> And life's dull vanity no more,
> This anxious breast ensnared.

May 27th 1878

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Glossary of Mathematical, Nautical, Naval Terms, Etc.

Abaft (nautical) Toward or at the stern of a ship; aft; to the rear; behind. *Webster's Seventh New Collegiate Dictionary*, (Springfield, MA, G. & C. Merriam Company, Publishers, ©1967)

Abscissa (mathematics) Coordinate representing the position of a point along a line perpendicular to the *y*-axis in a plane Cartesian coordinate system. *The Free Dictionary.Com, by Farlex*. http://www.thefreedictionary.com/abscissa

Apothine / Apothem (mathematics) Perpendicular distance from the center of a regular polygon to any of its sides. http://www.answers.com/topic/apothem

Ballast (nautical) Stabilizing heavy weights; heavy material carried in the hold of a ship, especially one that has no cargo, or in the gondola of a balloon, to give the craft increased stability. *Encarta® World English Dictionary [North American Edition]* © & (P) 2003 Microsoft Corporation. All rights reserved. Developed for Microsoft by Bloomsbury Publishing Plc.

Box horse car: i.e. a railroad boxcar for horses.

Bung (cooperage) Stopper in the bunghole of a cask. *Webster's Seventh New Collegiate Dictionary*, (Springfield, MA, G. & C. Merriam Company, Publishers, ©1967)

Cant (nautical) Slanting with respect to a particular straight line; to set at an angle. *Webster's Seventh New Collegiate Dictionary*, (Springfield, MA, G. & C. Merriam Company, Publishers, ©1967)

Casemate (naval) Armored compartment for a gun and the gun crew. *Naval Glossary*, *USS Oregon website*: http://members.tripod.com/~ussoregon/NavalGlossary.html.

Cast iron (metallurgy) Hard brittle iron; iron with a high carbon content, making it hard but brittle, so that it must be shaped by casting rather than hammering or beating *Encarta® World English Dictionary [North American Edition]* © & (P) 2003 Microsoft Corporation. All rights reserved. Developed for Microsoft by Bloomsbury Publishing Plc.

Chord (mathematics) Line segment joining two points on a curve. *Wikipedia*, http://en.wikipedia.org/wiki/Chords

Cycloid (mathematics) Curve traced by a point on the circumference of a circle that rolls on a straight line. *The Free Dictionary.Com, by Farlex*. http://www.thefreedictionary.com/cycloids

Deadwoods (nautical) Solid blocks of timber fastened just above the keel at each end of the ship, to strengthen those parts. *Oxford English Dictionary. 2nd edition* (1989) (http://dictionary.oed.com/cgi/entry/50058118.)

Ellipse (mathematics) Curved line forming a closed loop, where the sum of the distances from two points (foci) to every point on the line is constant. http://www.mathopenref.com/ellipse.html

Fantail (nautical) Rounded part of the stern: a rounded overhanging part of a ship's stern. *Encarta® World English Dictionary [North American Edition]* © & (P) 2003 Microsoft Corporation. All rights reserved. Developed for Microsoft by Bloomsbury Publishing Plc.

Fay (nautical) To fit (a piece of timber) closely and accurately *to* (another); To fit a timber close, so as to leave no intervening space. *Oxford English Dictionary. 2nd edition* (1989) (http://dictionary.oed.com/cgi/entry/50082958.)

Flats: i.e. railroad flat cars.

Frustrum (mathematics) Part of a solid, such as a cone or pyramid, between two parallel planes cutting the solid, especially the section between the base and a plane parallel to the base. http://www.answers.com/topic/frustum

Fuze: i.e. fuse A fixed fuse is a continuous length of cord or cable containing a flammable material used to ignite an explosive charge, such as the gunpowder inside an artillery shell; when the shell is fired the fuze burns for a specific period of time before igniting the explosive charge in the shell; the officer in charge of the weapon selects the fuse depending on the range to the target; the greater the range, the longer the fuse. *Webster's Seventh New Collegiate Dictionary*, (Springfield, MA, G. & C. Merriam Company, Publishers, ©1967)

Gripe (nautical) Outside timber of the fore-foot, under water, fastened to the lower stem-piece. A vessel *gripes* when she tends to come up into the wind. *The Seaman's Friend: Containing a Treatise on Practical Seamanship, with Plates; A Dictionary of Sea Terms; Customs and Usages of the Merchant Service; Laws Relating to the Practical*

Duties of Master and Mariners, by R. H. Dana, Jr. *The Sixth Edition, Revised and Corrected.* Boston: Thomas Groom & Co., 1851. (http://www.people.fas.harvard.edu/~morris3/DanaSFLex.html)

Grumment: ie grommet (nautical) A loop or eyelet on the shell casing used for securing the shell during transportation and loading. A grummet would not be needed if the shell where being held in place by a Sabot.

Heel (nautical) Piece of iron-work applied to the lower part of a rudder, to protect against damage to the lower pintles (heel-brace); heel-chain, a chain for holding out the jib-boom; heel-jigger, a light tackle fastened to the heel of a spar to assist in running it in and out; heel-knee the compass-piece connecting the keel to the sternpost; heel-lashing, a rope attaching the inner part of a studding-sail-boom to the yard or jib-boom, etc. *Oxford English Dictionary. 2nd edition* (1989) http://dictionary.oed.com/cgi/entry/50104142

Hyperbola / Hyperboloid (mathematics) Plane curve having two branches, formed by the intersection of a plane with both halves of a right circular cone at an angle parallel to the axis of the cone. It is the locus of points for which the difference of the distances from two given points is a constant. *The Free Dictionary.Com, by Farlex*. http://www.thefreedictionary.com/hyperbola

Hypotenuse (mathematics) Longest side of a right triangle, the side opposite the right angle. The Pythagorean theorem states that the length of the hypotenuse of a right triangle equals the square of the length of the hypotenuse equals the sum of the squares of the lengths of the other two sides. *Wikipedia*, http://en.wikipedia.org/wiki/Hypotenuse

Imperial gallons (measurement) In Great Britain, *1824–20th century*, a unit of capacity, by the Weights and Measures Act of 1985, exactly "4.54609 cubic decimeters" (i.e., liters), approximately 277**.**4193 cubic inches. The unit was defined by Act 5 George IV c 74 1824 as the volume of 10 Avoirdupois pounds of water at 62°F. *Imperial System of Weights and Measures*. http://www.sizes.com/units/gallon_imperial.htm

Knees (nautical) Crooked timbers, securing the beams to the ship's side. *The Practical Ship-Builder*, by Lauchlan McKay (1839)

Knightheads / Knight-Heads / Bollard-Timbers (nautical) Timbers adjacent to the stem on each side, and continued high enough to form a support for the bowsprit. *The Seaman's Friend: Containing a Treatise on Practical Seamanship, with Plates; A Dictionary of Sea Terms;*

Customs and Usages of the Merchant Service; Laws Relating to the Practical Duties of Master and Mariners, by R. H. Dana, Jr. *The Sixth Edition, Revised and Corrected.* Boston: Thomas Groom & Co., 1851. (http://www.people.fas.harvard.edu/~morris3/DanaSFLex.html)

Knuckle (nautical) Convex portion of a vessel's figure where a sudden change of shape occurs, as in a canal boat, where a nearly vertical side joins a nearly flat bottom. *Webster's Revised Unabridged Dictionary* (1913)

Lune / Lunette (mathematics) Shape in plane geometry; a concave area bounded by two arcs; the corresponding convex shape is a lens. *Wikipedia* http://en.wikipedia.org/wiki/Lune_(mathematics)

Magazines (naval) Compartments used for the stowage of ammunition and explosives. http://www.battlebelow.com/glossary.htm#M

Masting spars (nautical) Poles used to make ships' yardarms, booms, gaffs, or masts. *Random House Dictionary of the English Language*, Jess Stein, Editor in Chief, (New York, Random House, ©1966)

Mensuration (mathematics) Act, process, or science of measurement; branch of geometry dealing with measurement of length, area, or volume. *The Free Dictionary.Com, by Farlex*. http://www.thefreedictionary.com/mensuration

Minnie ball (military) Conical shaped bullet, with grooves around its body to hold a lubricant and used in rifled guns was more accurate than previous round bullets. *From Round Ball to Bullet, Blackpowder*, by B. W. Hicks, *Online Magazine*, v. 2, n. 3 (March 2002 ©2002 Nada Publishing. All rights reserved.) http://www.blackpowderonline.com/MARCH02Rndballtoblltl.htm

Moulding (nautical) Transferring the form of the mould to the timber by marking round the mould with chalk or a racing knife. *The Practical Ship-Builder*, by Lauchlan McKay (1839)

Ordinary (naval) Ships "laid up in ordinary" are a reserve fleet fully equipped for service but not needed and partially or fully decommissioned. Presently the U. S. Navy describes such vessels as the Ghost Fleet. Reserve Fleet Wikipedia http://en.wikipedia.org/wiki/Reserve_fleet

Ordinate (mathematics) Value of a coordinate on the vertical axis. *The Free Dictionary.Com, by Farlex*. http://www.thefreedictionary.com/ordinates

Orlop (nautical) Lowest deck of a ship. *The Practical Ship-Builder*, by Lauchlan McKay (1839)

Parabola (mathematics) Plane curve formed by the intersection of a right circular cone and a plane parallel to an element of the cone or by the locus of points equidistant from a fixed line and a fixed point not on the line. *The Free Dictionary.Com, by Farlex*. http://www.thefreedictionary.com/parabola

Parallelohedron / Parallelogram (mathematics) Polyhedron shape with all its edges equal and the opposite edges of any face parallel. http://thesaurus.maths.org/mmkb/entry.html?action=entryById&id=4049

Peak form (nautical) Shaped like a ship's peak; the narrow portion of a ship's hull at the bow or stern. http://www.bmts.com/~sterling/nautical_terms.htm

Pig iron (metallurgy) Form in which cast iron is made at the blast furnace, being run into molds, called pigs. *Webster's Revised Unabridged Dictionary* (1913)

Pivot guns (naval) Guns mounted on a pivot or revolving carriage and able to turn in any direction. *Webster's Revised Unabridged Dictionary* (1913)

Plank-sheer (nautical) Thick plank let down over the stanchions to cover the ends of the timbers. *The Practical Ship-Builder*, by Lauchlan McKay (1839)

Ports (nautical) Any opening in a ship's sides. *Sailors Choice Nautical Terms Index*, (Makai Promotions ©1997-2003; FP, Web-Design by Makai Promotions) http://www.sailorschoice.com/Terms/scterms.htm.

Quarter (nautical) Section of a boat behind the shrouds and in front of the stern, the aft sides. "Off the quarter" is in a direction 45 degrees behind the beam. *Sailors Choice Nautical Terms Index*, (Makai Promotions ©1997-2003; FP, Web-Design by Makai Promotions) http://www.sailorschoice.com/Terms/scterms.htm

Quick match (nautical) A type of fast-burning fuse that can burn anywhere from 100 to 300 feet per second. Originally used to ignite muzzle-loaded cannon, it is still used to ignite fireworks. Quick Match, Pyro Universe. http://www.pyrouniverse.com/show/fusing/quickmatch.htm

Quotient (mathematics) Result of a division. For example, when dividing 6 by 3, the quotient is 2, while 6 is called the dividend, and 3 the divisor. One may also define the quotient as the number of times the divisor divides into the dividend. *Wikipedia*, http://en.wikipedia.org/wiki/Quotient

Rabbet (carpentry) Channel, groove, or slot (usually of rectangular section) cut along the edge or face of a piece (or surface) of wood, stone, etc., and intended to receive the edge or end of another piece or pieces, or a tongue specially wrought on these to fit the groove. Oxford English Dictionary. 2nd edition (1989) (http://dictionary.oed.com/cgi/entry/50195721.)

Ram (naval) Heavy beak or spur projecting from the bow of a warship for penetrating the hull of an enemy's ship. *Webster's American Dictionary College Edition* (New York: Random House, ©1967) ISBN 0-679-45213-3.

Rhombus / Rhomboid (mathematics) Quadrilateral shape with all four sides equal in length. http://www.mathopenref.com/rhombus.html

Rifled (military) To cut spiral grooves within (a gun barrel, for example); having rifling or internal spiral grooves inside the barrel; as opposed to having a smooth bore. *Webster's Revised Unabridged Dictionary (1913)*; *The Free Dictionary.Com, by Farlex.* http://www.thefreedictionary.com/rifle

Sabot (military) A device used in a firearm or cannon to fire a shell that is smaller than the bore diameter, or which must be held in a precise position. Sabot is a French word for wooden shoes. *Webster's Seventh New Collegiate Dictionary*, (Springfield, MA, G. & C. Merriam Company, Publishers, ©1967)

Sine (mathematics) Ordinate of the endpoint of an arc of a unit circle centered at the origin of a Cartesian coordinate system, the arc being of length x and measured counterclockwise from the point (1, 0) if x is positive or clockwise if x is negative. In a right triangle the ratio of the length of the side opposite an acute angle to the length of the hypotenuse. *The Free Dictionary.Com, by Farlex.* http://www.thefreedictionary.com/sine

Solidity (geometry) Solid contents of a body; volume; amount of enclosed space. http://onlinedictionary.datasegment.com/word/solidity

Spar deck (nautical) Upper deck of a vessel, extending from stem to stern; a weather deck. *The Random House Dictionary of the English*

Language, Jess Stein, Editor in Chief, (New York: Random House, ©1966) LC # 66-21939.

Stem (nautical) Bow of a vessel; an upright into which the side timbers or plates are jointed; also, the forward part of a vessel (often opposed to stern). *The Random House Dictionary of the English Language*, Jess Stein, Editor in Chief, (New York: Random House, ©1966) LC # 66-21939.

Sternpost (nautical) Vertical post rising from the after end of the keel; a rudderpost or propeller post. *The Random House Dictionary of the English Language*, Jess Stein, Editor in Chief, (New York: Random House, ©1966) LC # 66-21939.

String·piece (nautical) Long, usually horizontal, piece of timber, beam, etc. for strengthening, connecting, or supporting a framework. *The Random House Dictionary of the English Language*, Jess Stein, Editor in Chief, (New York: Random House, ©1966) LC # 66-21939.

Studding sail (nautical) Light sail set at the side of a principal square sail of a ship in free winds. *Webster's Seventh New Collegiate Dictionary*, (Springfield, MA, G. & C. Merriam Company, Publishers, ©1967)

Transverse (mathematics) Line or position at right angles to the long axis of structure. http://www.merriam-webster.com/dictionary/transverse

Trapezium / Trapezoid (mathematics) Shape without parallel sides. Any quadrilateral drawn at random would probably be a trapezium. If the quadrilateral had one pair of parallel sides, it would be a trapezoid. If both pairs of sides are parallel, it would be a parallelogram. http://www.mathopenref.com/trapezium.html

Trestle-tree (nautical) One pair of timber crosspieces fixed fore and aft on the masthead to support the crosstrees, top, and fid of the mast; usually used in plural. *Webster's Seventh New Collegiate Dictionary*, (Springfield, MA, G. & C. Merriam Company, Publishers, ©1967)

Trussletree: See Trestle-tree.

Tug (nautical) Tug boat; a small powerful boat for towing or pushing ships, barges, etc. *The Random House Dictionary of the English Language*, Jess Stein, Editor in Chief, (New York: Random House, ©1966) LC # 66-21939.

Ungula (mathematics) Section or part of a cylinder, cone, or other solid of revolution, cut off by a plane oblique to the base; shape having a resemblance to the hoof of a horse. *The Free Dictionary.Com, by Farlex*. (http://www.thefreedictionary.com/Ungula).

Versed (mathematics) Trigonometric function of an angle equal to one minus the sine of that angle. Also called *coversine. The Free Dictionary.Com, by Farlex.* *http://www.thefreedictionary.com/versed+cosine*

Wrought iron (metallurgy) Form of refined iron, almost entirely free of carbon and having a fibrous structure including a uniformly distributed slag content that is readily forged and welded. *Webster's American Dictionary College Edition* (New York: Random House, ©1967) ISBN 0-679-45213-3.

Yoke (nautical) Rudder crossbar; a crossbar fitted to the top of a rudder and connected to the front of a boat by ropes or cables for steering. *Encarta® World English Dictionary [North American Edition]* © & (P) 2003 Microsoft Corporation. All rights reserved. Developed for Microsoft by Bloomsbury Publishing Plc.

Ships and Places Mentioned in the Text

CSS ALBEMARLE was a Confederate vessel built in the Roanoke River at Edwards Ferry, North Carolina, in 1863-64 under supervision of Comdr. J. W. Cooke, CSN, who became her first commanding officer. The Confederate Navy commissioned her on 17 April 1864 and, 2 days later, she played the leading role in an attack on the Union forces at Plymouth, NC. A small U. S. Navy force torpedoed and sank on 27-28 October 1864. Union forces raised *ALBEMARLE* after they captured Plymouth. Following the end of hostilities, the U. S. Navy towed her to Norfolk Navy Yard and condemned her as a prize. The Navy bought her and then sold her in October 1867. *Dictionary of American Naval Fighting Ships, Vol. II: Confederate Forces Afloat*, (Washington, DC: Office of the Chief of Naval Operations, 1963) p. 495. See also: http://www.hazegray.org/danfs/csn/a.txt

CSS ELIZABETH was a Confederate vessel Porter described as a small wooden gunboat. However, this researcher can find no record of a ship by this name in either U. S. or Confederate naval records. Union forces may have destroyed her before her official naming. From: *Dictionary of American Naval Fighting Ships, Vol. II: Confederate Forces Afloat*, (Washington, DC: Office of the Chief of Naval Operations, 1963), p. 490. See also: http://www.hazegray.org/danfs/csn/classes.txt.

CSS FREDERICKSBURG was an enlarged *ALBEMARLE*-type ironclad ram. The Confederates built her at Richmond, VA during 1862-63. On 30 November 1863, she was completed and awaiting armament. One of the ships of the James River Squadron, *FREDERICKSBURG* was in frequent action from mid-1864 until the end of the war. The day after the Confederates evacuated Richmond on 3 April 1865, they also blew up *FREDERICKSBURG* and other ships in the vicinity [cf. *CHICKAHOMINY*]. *Dictionary of American Naval Fighting Ships, Vol. II: Confederate Forces Afloat*, (Washington, DC: Office of the Chief of Naval Operations, Naval History Division, 1963), p. 521. See also: http://www.hazegray.org/danfs/csn/f.txt.

CSS NANSEMOND was a small wooden steamer built at Norfolk, VA, in 1862, and assigned to duty with the James River Squadron. Small enough to navigate upstream, she sailed from Norfolk with the other vessels of the squadron on 4 May 1862, just prior to the evacuation of the Gosport Navy Yard. *NANSEMOND* continued on active duty in the James River until the end of the war. She took part in the engagements in Virginia at Howlett's Line (or Bermuda Hundred), 21 June 1864; Dutch Gap, 14 August 1864; and Fort Harrison, 29 September-1 October 1864. When they evacuated Richmond, on 3 April 1865, the Confederates destroyed *NANSEMOND* to prevent her capture by the Union. *Dictionary of America Naval Fighting Ships: The Confederate Navy, Vol. II* (Washington, DC: Office of the Chief of Naval Operations, 1963), p. 551. See also: http://www.hazegray.org/danfs/csn/n.txt.

CSS RICHMOND was an ironclad ram carrying four rifled guns, two on each side, and 2 shell guns, one on each side, plus one spar torpedo. The Confederates constructed the *RICHMOND* at Gosport Navy Yard to John L. Porter's design with money and scrap iron collected by the citizens of Virginia. Consequently, Southerners sometimes referred to her as *VIRGINIA II, VIRGINIA NO. 2* or *YOUNG VIRGINIA*; Northerners referred to her similarly as *VIRGINIA NO. 2, NEW VIRGINIA* or *YOUNG VIRGINIA*. The Gosport Navy Yard launched *RICHMOND* on 6 May 1862 and towed her up to the Confederate capital the same night. *RICHMOND* was thus finished at Richmond in July 1862 and placed in commission by Comdr. R. B. Pegram, CSN. During 1864, *RICHMOND* took part in engagements at Dutch Gap, 13 August; Fort Harrison, 29 September-1October; Chapin's Bluff, 22 October. On 23-24 January 1865, she was under heavy fire while aground with *VIRGINIA* above the obstructions at Trent's Reach - fortunately at an angle that encouraged Federal projectiles to ricochet harmlessly off her armor. *RICHMOND* had to be destroyed prior to evacuation of the capital, 3 April 1865. *Dictionary of American Naval Fighting Ships, Vol. II: Confederate Forces Afloat*, (Washington, DC: Office of the Chief of Naval Operations, 1963), pp. 561-562. See also: http://www.hazegray.org/danfs/csn/r.txt.

CSS TEXAS was a twin-screw, ironclad that carried four pivot and two broadside guns. A sister ship of the *CSS COLUMBIA*, she had a shortened casemate, she was one of the most valuable hulls the Confederates ever built. Launched about mid-January 1865, Union troops captured her while she was still in an outfitting berth at the Richmond Navy Yard, on 3 April 1865. The Union forces moved her to Norfolk Navy Yard but did not keep her long. The Navy sold her on 15 October 1867. *Dictionary of American Naval Fighting Ships, Vol. II: Confederate Forces Afloat*, (Washington, DC: Office of the Chief of Naval Operations), p. 575. See also: http://www.hazegray.org/danfs/csn/t.txt.

CSS VIRGINIA (OR *MERRIMAC*) was the former *USS MERRIMACK,* burned to the waterline by Union forces when they evacuated the Gosport Navy Yard on 20 April 1861. The Confederates raised and rebuilt her as the ironclad ram CSS VIRGINIA. *MERRIMACK* had been a wooden-hull, screw frigate of 3,200 tons. She was 275 feet long and had a beam of 38' 6". She drew 24' 3" of water and had a top speed of 12 knots. She had fourteen 8*"*, two 10*"*, and two 9-*"* guns. She was launched by the Boston Navy Yard 15 June 1855 and commissioned 20 February 1856, Capt. Garrett J. Pendergrast in command. *MERRIMACK* was in ordinary undergoing repairs when the U. S. Navy evacuated Gosport Navy Yard. When the Confederates occupied the yard, they raised her and renamed her *CSS VIRGINIA.* However, most northerners and many southerners, including Porter, continued to refer to her as *MERRIMACK* OR *MERRIMAC*. Clad in thick iron armor, she was the first ironclad warship to see combat. *Dictionary of American Naval Fighting Ships, vol. IV* (Washington, DC: Office of the Chief of Naval Operations, Naval History Division, 1969), pp. 337-38. See also: http://www.hazegray.org/danfs/frigates/merrimac.htm

CSS WILMINGTON was a twin-casemated ironclad, which was under construction at Wilmington, NC but never completed. The Confederates destroyed her on the stocks in January 1865 after the fall of Fort Fisher. *Dictionary of America Naval Fighting Ships, Vol. II: The Confederate Navy*, (Washington, DC: Office of the Chief of Naval Operations, Naval History Division, 1963), p. 582. See also http://www.hazegray.org/danfs/csn/w.txt.

Fort Fisher, North Carolina was a Confederate defensive position on the Cape Fear River in New Hanover County, below Wilmington, NC. The fort kept the port of Wilmington open to blockade runners throughout the Civil War until January 1865. After a preliminary bombardment directed by Union Rear Adm. David D. Porter on January 13, Union forces landed and prepared an attack on Confederate Maj. Gen. Robert Hoke's infantry line. On the 15th, a select force moved on the fort from the rear. A late afternoon attack, following the bloody repulse of a naval landing party, carried the parapet. The Confederate garrison surrendered, opening the way for a Federal thrust against Wilmington, the south's last open seaport on the Atlantic coast. Selected sources: *American Battlefield Protection Program*, *Heritage Preservation Services*, *National Park Service*. From: http://www.ehistory.com/world/BattleView.Cfm?BID=629.

Fort Monroe, Virginia was a Union defensive position guarding the entrance to Hampton Roads, VA where the James River flows into Chesapeake Bay at Point Comfort. It lies opposite Sewell's Point on the south shore of Hampton Roads. The United States built the fort in 1818 on the site of previous forts dating to the 17th century. Named after President James Monroe, the fort could hold as many as 200 guns. Fort Monroe was one of four permanent Union forts in the region that the Confederates never captured.

Gosport Navy Yard, Virginia was located near the city of Portsmouth. It was the largest Navy base in the United States during the Civil War. Confederate forces seized the yard after the outbreak of the war and it became the main base for the Confederate Navy. Retaken by Union forces, the shipyard remains an active Navy yard known as the Norfolk Naval Shipyard. *Mariners Museum website*: http://www.mariner.org/baylink/control5.html. Http://www.nnsy1.navy.mil/History/name.htm.

Greensboro, North Carolina was the site of Confederate General Andrew Johnston headquarters during his negotiations with Union General William T. Sherman over the surrender of the last major Confederate army in arms against the Union. The negotiations occurred between April 15 and 26 1865. Johnston and Sherman signed the actual surrender agreement at the Bennett farmhouse, near Durham Station, midway between Johnston's headquarters in Greensboro and Sherman's headquarters in Raleigh, NC. *Bennett Place, North Carolina Historic Sites website* (© 2003 North Carolina Office of Archives and History): http://www.ah.dcr.state.nc.us/sections/hs/bennett/bennett.htm.

Halifax, North Carolina is the county seat of Halifax County and lies about 165 miles north of Wilmington.

Hampton Roads, Virginia is the wide body of water at the mouth of the James River, where it flows into Chesapeake Bay between Norfolk and Newport News, VA.

Magnolia, North Carolina is about 45 miles north of Wilmington, NC.

MERRIMAC (OR MERRIMACK): See *CSS VIRGINIA*

North East River, North Carolina (i.e. the Northeast Branch of the Cape Fear River).

Old Point, or Old Point Comfort, Virginia is the location of Union-held Fort Monroe.

Pinner's Point, Virginia is located in the city of Portsmouth, where the East and West branches of the Elizabeth River meet before it flows into Hampton Roads. It controlled access to the Gosport Navy Yard.

S. R. SPALDING was a 1,100-ton steamship, belonging to the Merchants & Miners Transportation Company, but chartered to War Dept., 1859 – 1861. In 1864, the company sold her to the War Dept. In 1865, the Navy sold her to Empire Line, which renamed her *SAN SALVADOR*. *The Ships List website*: http://www.theshipslist.com/ships/lines/merchants.htm.

Sewell's Point, Virginia is located on the south shore of Hampton Roads, in Norfolk, VA. Confederate forces still held the position at the time of the *CSS VIRGINIA* – *USS MONITOR* clash.

Tredegar Iron Works, established in 1837, at Richmond, Virginia was one of the largest iron works in the United States from 1841 to 1865. During the Civil War, the works supplied the South with a major share of the iron products that helped the Confederacy sustain four years of war. *Tredegar Iron Works*, National Parks Service, National Historical Landmarks Program, http://tps.cr.nps.gov/nhl/detail.cfm?ResourceId=1186&ResourceType=District

USS BRANDYWINE was a 1708-ton Potomac-class frigate. She carried forty-four guns. Originally named *SUSQUEHANNA* she was renamed Brandywine prior to her launching by Washington Navy Yard, with President John Quincy Adams on board, 16 June 1825. She was laid up in ordinary at the New York Navy Yard, 1851-60. In 1861 *BRANDYWINE* returned to service and, converted to a store ship, took station in Hampton Roads Virginia. Re-commissioned on 27 October 1861, she later moved to Norfolk where a fire destroyed her on 3 September 1864. The Navy raised her wreck and sold it on 26 March 1867. *Dictionary of America Naval Fighting Ships, Vol. I*, (Washington, DC: Office of the Chief of Naval Operations, 1959, reprint with corrections, 1970), pp. 151. See also: http://www.hazegray.org/danfs/frigates/brandywi.htm.

USS COLUMBUS was a ship of the line of 2,480 tons carried a crew of 780 men and ninety-two guns. Built by the Washington Navy Yard and launched 1 March 1819, *COLUMBUS* received her commission on 7

September 1819. After service in the Mexican War, she lay at Norfolk Navy Yard in ordinary until 20 April 1861. Then withdrawing Union forces burned her to the waterline to prevent her falling into Confederate hands. *Dictionary Of American Naval Fighting Ships, Vol. II*, (Washington, DC: Office of the Chief of Naval Operations, 1963), p. 150. See also: http://www.hazegray.org/danfs/line/columbus.htm.

USS CONGRESS was a frigate that displaced 1,867 tons. She carried a crew of 480 and four 8*"* and forty-eight 32-pounder guns. The Portsmouth Navy Yard, in New Hampshire, built and launched *CONGRESS* on 16 August 1841. *CONGRESS* received her commission on 7 May 1842. On 9 September 1861, the Navy ordered her to the Atlantic Blockading Squadron. *CONGRESS* lay at anchor off Newport News, Virginia, on 8 March 1862, when she fell under attack by the *CSS VIRGINIA*. After exchanging broadsides with *VIRGINIA*, *CONGRESS* slipped her moorings and ran aground in shallow water. The ironclad and her consorts attacked from a distance and inflicted great damage on the ship, killing 120, including the commanding officer. Ablaze in several places and unable to bring guns to bear on the enemy, *CONGRESS* struck her colors. Heavy Union shore batteries prevented *VIRGINIA* from seizing her. Instead, she fired several rounds of hot shot and incendiary causing *Congress* to burn to the water's edge, and her magazine to explode. In September 1865, the Navy raised *CONGRESS*, towed her to the Norfolk Navy Yard, and later sold her. *Dictionary of American Naval Fighting Ships, Vol. II: Confederate Forces Afloat*, (Washington, DC: Office of the Chief of Naval Operations, 1963), p. 163-164. See also: http://www.hazegray.org/danfs/frigates/congres4.htm.

USS CUMBERLAND was a frigate of 1,726 tons. She carried a crew of 400 and had forty 32-pound guns and ten 8" guns. The Boston Navy Yard built *CUMBERLAND* and launched her on 24 May 1842. She became flagship of the Navy's Home Squadron in 1860. At the outbreak of the Civil War *CUMBERLAND* was at Norfolk Navy Yard. Towed out of the yard she escaped destruction on 20 April 1861 when Union forces scuttled and burned the other ships at the Navy Yard on to prevent their capture by the Confederates. She served as one of the North Atlantic Blockading Squadron. On 8 March 1862, *CSS VIRGINIA* rammed and sank *CUMBERLAND* the day before her famous engagement with the *USS MONITOR*. *Dictionary of American Naval Fighting Ships, Vol. II: Confederate Forces Afloat*, (Washington, DC: Office of the Chief of Naval Operations, 1963), pp. 214-215. See also: http://www.hazegray.org/danfs/frigates/cumberla.htm.

USS DELAWARE was a Union ship of the line of 2,633 tons was 196' 2" long and 53' in the beam. *DELAWARE* had a complement of 820 men. Originally, she carried fifty-six 42-pounders and thirty-four 32-pounder guns. The third U. S. naval vessel to carry the name *DELAWARE,* the Norfolk Navy Yard began work on her in August 1817 and launched her on 21 October 1820. She then became the flagship of Commodore W. M. Crane in the Mediterranean. In 1845, the Navy decommissioned her at Norfolk Navy Yard. *DELAWARE* remained there in ordinary there on 20 April 1861 when Union forces burned her along with other ships and the yard facilities to prevent their falling into Confederate hands. *Dictionary of America Naval Fighting Ships, Vol. IV*, (Washington, DC: Office of the Chief of Naval Operations, 1963), p 255. See also: http://www.hazegray.org/danfs/line/delaware.htm.

USS GERMANTOWN was a sloop-of-war that carried eighteen 32-pound guns. Built and launched at the Philadelphia Navy Yard on 22 August 1846 and commissioned 9 March 1847, Comdr. Franklin Buchanan was *GERMANTOWN's* first commander. She served during the Mexican War with Commodore M. C. Perry's Home Squadron. Completely equipped for sea and awaiting a crew, the Navy scuttled *GERMANTOWN* at the Gosport Navy Yard 20 April 1861 as Union forces evacuated Norfolk. The Confederates raised her in June; fitted her out as a floating battery to serve near Craney Island for the protection of Norfolk; then sank her as an obstruction in the Elizabeth River shortly before evacuating Norfolk 10 May 1862. Raised by Union forces 22 April 1863, *GERMANTOWN* saw no further service. The Navy sold her hulk at auction at Norfolk 8 February 1864. *Dictionary of American Naval Fighting Ships, Vol. III*, (Washington, DC: Office of the Chief of Naval Operations, 1968), p. 91. See also: http://www.hazegray.org/danfs/sloops/germanto.htm.

USS MONITOR was a revolutionary iron hulled warship designed and built by John Ericsson, in New York, New York. Launched on January 30, 1862 and commissioned on February 25, 1862, she weighed 987 tons and displaced 11' 4" of water. She had a length of 172' and a beam of 41' 6". *MONITOR's* draft was 10' 6". She carried a complement of forty-seven officers and men and was armed with two 11" Dahlgren smoothbore cannon. Possibly *MONITOR's* most notable feature was her revolving turret, which was composed of eight layers of 1" iron plates which allowed her to fire her guns in any direction. With Lt. John L. Worden in command, she departed New York Navy Yard 6 March 1862, headed for the Virginia Capes. As *MONITOR* passed Cape Henry on the afternoon of 8 March, her crew could hear the roar of cannon of *CSS VIRGINIA's* battle against the Union fleet. At dawn the next day, when *VIRGINIA* again emerged and attempted to attack the Union ships, *MONITOR* intercepted her. For four hours, *MONITOR* fought *Virginia* to a standstill. While neither ship suffered any serious damage, the battle revolutionized naval warfare. The two ships faced off again, off Sewell's Point, on 11 April, but strategic considerations on both sides prevented a return engagement between them. Early in May, Confederate forces withdrew from Norfolk and retired toward the Confederate capital. Unable to follow up the shallow James River the Confederate forces set *VIRGINIA* afire on 11 May and destroyed her. Thereafter, *MONITOR* performed blockade duty in Hampton Roads until ordered on Christmas Eve to proceed to North Carolina for operations against Wilmington. Towed by *USS RHODE ISLAND*, she foundered in a storm off Cape Hatteras shortly after midnight 31 December. Four officers and 12 men went down with the *MONITOR*. *Dictionary of America Naval Fighting Ships, Vol. IV* (Washington, DC: Office of the Chief of Naval Operations, 1969), p. 414. See also: http://www.hazegray.org/danfs/monitors/monitor.txt

USS PAWNEE was a screw sloop. She displaced 1,533 tons, drew 10' of water and had a top speed of 10 knots. *PAWNEE* carried a complement of 181 officers and men and carried eight 9" guns and two 12-pounder guns. Launched on 8 October 1859, *PAWNEE* received her commission on 11 June 1869. After an unsuccessful attempt to relieve Fort Sumter, the Navy ordered *PAWNEE* to Norfolk, Virginia to secure the ships and stores at the Norfolk Navy Yard. When she arrived, on the evening of 20 April 1861, she found that all the ships already scuttled. She then assisted in the generally unsuccessful attempt to burn the docks and stores. Afterwards, she did succeed in towing the frigate *USS CUMBERLAND* out of danger. For the rest of the war *PAWNEE* operated successfully in a number of engagements. They Navy decommissioned her in 1882 and sold her to M. H. Gregory on 3 May 1884. *Dictionary of America Naval*

Fighting Ships, Vol. V (Washington, DC: Office of the Chief of Naval Operations, 1970), p. 239.

USS PENNSYLVANIA was a ship of the line of 3,105 tons. She was the largest sailing warship ever built for the U.S. Navy. She had a draft of 24' 4" and carried a complement of 1,100 men. *PENNSYLVANIA's* armament included sixteen 8" shell guns and one hundred and four 32-pounders. The Navy began construction on *PENNSYLVANIA* in September 1821, but launched her almost 16 years later on 18 July 1837. She was in the Gosport Navy Yard 20 April 1861. Union forces burned her to the waterline to prevent her falling into Confederate hands. *Dictionary of America Naval Fighting Ships, Vol. IV*, (Washington, DC: Office of the Chief of Naval Operations, 1970), p 250. See also: http://www.hazegray.org/danfs/line/pennsy.htm.

USS PENSACOLA was a screw steamer of 3,000 tons. She drew 18' 7" of water and had a top speed of 9.5 knots. She carried eleven 1" guns and sixteen 9" guns. Pensacola Navy Yard launched *PENSACOLA* on 15 August 1859; the Navy commissioned her there 5 December. Attached to the West Gulf Blockading Squadron, she participated in the historic dash past Confederate forts St. Philip and Jackson that protected New Orleans 24 April and assisted in the capture of the city. During the next two years, she helped guard the lower Mississippi, returning to New York Navy Yard where she decommissioned 29 April 1864. The Navy burned and sunk *PENSACOLA* in San Francisco Bay near Hunter's Point early in May 1912. *Dictionary of American Naval Fighting Ships, Vol. V*, (Washington, DC: Office of the Chief of Naval Operations, Naval History Division, 1970), p. 255. See also: http://www.hazegray.org/danfs/steamers/pensacol.htm.

USS PLYMOUTH was a sloop-of-war of 189 tons. Built by the Boston Navy Yard in 1844, she had a draft of 17' 2" and carried four 8" and eighteen 32-pounder guns. *PLYMOUTH* served in European waters and then, in 1853, participated in Commodore Matthew Perry's voyage to "open" Japan to foreign commerce. *PLYMOUTH* was in Norfolk Navy Yard for repairs when the Civil War started. When Virginia seceded from the Union forced burned and scuttled her (20 April 1861) to prevent her falling into Confederate hands. *Dictionary of American Naval Fighting Ships, Vol. V*, (Washington, DC: Office of the Chief of Naval Operations, 1970), p. 331. See also: http://www.hazegray.org/danfs/sloops/plymouth.htm.

USS PORPOISE a Union vessel that Porter describes as one of the ships burned in the Gosport Navy Yard on April 20 1861. In fact, she had sunk years before. *PORPOISE* was a hermaphrodite brig built in Boston in 1835 and launched in 1836. She spent most of her career as an exploring vessel, serving with Lt. Charles Wilkes coastal survey voyages and his 4-year circumnavigation of the earth in the 1830s. After serving on anti-slavery patrol in the early 1850s, *PORPOISE* joined Commander Cadwallader Ringgold's anti-piracy expedition in the Pacific. In 1854, she was lost with all hands and never heard from again. Therefore, she could not have been one of the ships at Norfolk in April of 1861. The Navy did not launch another ship to bear the name *PORPOISE* until 1911. *Dictionary of America Naval Fighting Ships, Vol. V*, (Washington, DC: Office of the Chief of Naval Operations, 1970), p. 353. See also: http://www.history.navy.mil/faqs/faq102-2.htm.

USS POTOMAC was a 1,726-ton Raritan-class frigate. She drew 20' 6" of water; she carried a complement of 480 men. Her armament included eight 8" guns and forty-two 32-pounder guns. *POTOMAC* was laid down by the Washington Navy Yard in August 1819 and was launched March 1822 but her fitting out was not completed until 1831. In September 1861, she departed New York for the West Gulf Blockade Squadron off Vera Cruz. The Navy decommissioned her on 13 January 1877 and sold her to E. Stannard & Co. on 24 May 1877. *Dictionary of America Naval Fighting Ships, Vol. V*, (Washington, DC: Office of the Chief of Naval Operations, 1970), pp. 362-363. See also: http://www.hazegray.org/danfs/frigates/potomac.htm.

USS ROANOKE was a steam frigate in the United States Navy and later converted to an ironclad. She was the second U. S. Naval vessel to bear the name. *ROANOKE* was launched on 13 December 1855 at Norfolk Navy Yard; and commissioned 4 May 1857. Assigned to the Home Squadron as flagship, *ROANOKE's* repatriated the American filibuster and former President of Nicaragua, William Walker, and 205 of his men to the United States. *ROANOKE* was decommissioned at Hampton Roads on 12 May 1860. Following the outbreak of the American Civil War, *ROANOKE* was recommissioned on 20 June 1861 and assigned to the North Atlantic Blockading Squadron. During the CSS *VIRGINIA*'s attack on the Union warships in Hampton Roads, 8 March 1862, *ROANOKE*'s deep draft prevented her from engaging the *VIRGINIA*. However, she did embark 268 men rescued from the *USS CONGRESS* and the *USS CUMBERLAND*, which *VIRGINIA* had sunk, and transported them to New York City on 25 March, and decommissioned the same day. See: *USS Roanoke (1855)*, Wikipedia http://en.wikipedia.org/wiki/USS_Roanoke_(1855)

Wilmington, NC fell to Union forces during the night of February 21-22, 1865. Gen. Braxton Bragg ordered the Confederate forces to evacuate the town, burning cotton, tobacco, and government stores. *Wilmington, American Battlefields, American Battlefields Protection Program, National Park Service website*: http://www2.cr.nps.gov/abpp/battles/nc016.htm.

Biographical Notes

James Armstrong (1794-1868), an elderly Kentuckian, who had served as a naval officer since 1809, was in command of the Navy yard at Pensacola, Florida, when that state seceded in 1861. He surrendered without resistance when a greatly superior Confederate force demanded possession. Edited Appletons Encyclopedia, Copyright © 2001; Virtualology™ http://www.famousamericans.net/jamesarmstrong/; See also: *Recollections of a Naval Life: Including the Cruises of the Confederate States Steamers, "SUMTER" and "ALABAMA"*, by John McIntosh Kell (Washington, The Neale Company, 1900), p. 139-140; http://www.webroots.org/library/usamilit/roanlic4.html.

George R. Boush, a U. S. Navy naval constructor, from 1863, had been serving at the Norfolk Navy Yard, since 1873. *Navyhistory.com* http://www.navyhistory.com/gunboat/Alliance.html

John M. Brooke (1826-1906), a former lieutenant in the US Navy, was an ordnance expert and consultant, from Tampa, Florida. S. R. Mallory ordered him to produce plans for an armored warship in 1861. He later served as chief of the Confederacy's Bureau of Ordnance and Hydrography and was responsible for producing he *CSS VIRGINIA's* guns. Brooke patented his design for the *CSS VIRGINIA* and later carried on a 30-year dispute with John L. Porter over who deserved the credit for designing the *CSS VIRGINIA.* William N. Still. *Confederate Shipbuilding* (Athens, Georgia: University of Georgia Press, ©1969), pp. 10, 27, 40-41; For a portrait and biographical sketch, see: Commander John M. Brooke, Confederate States Navy, (1826-1906), Naval Historical Center Home Page, Department of the Navy -- Naval Historical Center, Washington Navy Yard, Washington DC 20374-5060: http://www.history.navy.mil/photos/pers-us/uspers-b/jm-brook.htm. For his patent on the CSS VIRGINIA, see: History of the United States Patent Office The Patent Office Pony A History of the Early Patent Office Appendix http://www.myoutbox.net/popchapx.htm.

Franklin Buchanan (1800-1874), a U.S. naval officer, 1815-1855, he served as the first Superintendent of the U.S. Naval Academy, 1845-1847; in 1859-61, he was commandant of the Washington Navy Yard. In May 1861, he joined the Confederate States Navy, receiving a Captain's commission in September. After heading the Confederate Navy's Office of Orders and Detail, he obtained command of the defenses of the James River, Virginia. He captained the ironclad *CSS VIRGINIA* in her successful attack on the Federal warships *USS CUMBERLAND* and *USS CONGRESS* in Hampton Roads on 8 March 1862. Wounded in the action he had to leave the ship before her battle with *USS MONITOR* on the following day. In August 1862, Buchanan earned promotion to the rank of Admiral and went to command Confederate Navy forces on Mobile Bay, Alabama. He oversaw the construction of the ironclad *CSS TENNESSEE* and was on board her during her battle with Rear Admiral David Glasgow Farragut's Union fleet on 5 August 1864. Wounded and taken prisoner, the Confederates exchanged him for a prisoner in Union hands in February 1865. He was on convalescent leave until the Civil War ended a few months later. Following the conflict, Buchanan lived in Maryland, and then went into business in Mobile, Alabama until 1870, when he returned to Maryland. He died there on 11 May 1874. *Admiral Franklin Buchanan, Confederate States Navy, (1800-1874)*, Naval Historical Center home page. http://www.history.navy.mil/photos/pers-us/uspers-b/f-buchan.htm.

French C. Forrest (1796 – December 22, 1866), a United States naval officer who served later the Confederate States Navy. Before the American Civil War he served in the War of 1812 and the Mexican-American War. After Union forces abandoned it, on 21 April 1861, Forrest served as Commandant of the Gosport Navy Yard in 1861 and supervised the raising of the *MERRIMACK*. Later, he served as an admiral in commanded all Confederate naval forces on the James River. *Wikipedia* http://en.wikipedia.org/wiki/French_Forrest; *Civil War Naval History April 1864, navyhistory.com.* http://www.navyhistory.com/cwnavalhistory/April1864.html.

Joseph Eggleston Johnston (1807-1891), a civil engineer and professional soldier, he graduated from West Point in 1829 and served in the Mexican War. Promoted to brigadier general in June 1860, he resigned from the U. S. Army in April 1861 to join the Confederacy. In May 1861, he became a brigadier general in the Confederate Army. He commanded Army of the Shenandoah at Harper's Ferry, in August 1861. He commanded the Confederate forces at First Manassas (Bull Run). Promoted to General he commanded the Army of Northern Virginia during the Peninsula campaign. Wounded at the Battle of Seven Pines, his command passed to Robert E. Lee. After his recovery, Johnston commanded Department of the West in the Vicksburg campaign. He commanded the Army of Tennessee in the

Atlanta campaign. In July 1864, Jefferson Davis relieved him of command for failing to prevent Sherman from taking Atlanta. Davis restored him to command all the Confederate forces in the Carolinas, in February 1865, and he led them through the Carolinas campaign and the Battle of Bentonville on March 19. Outnumbered better than four to one and realizing that the situation was hopeless after Lee surrendered on April 9, Johnston agreed to an armistice with Sherman's forces on April 14, 1865. He surrendered his 21,000-man army on April 26, 1865 at Greensboro, North Carolina. After the war, Johnston won a seat in Congress. "Carolinas Campaign" in: *The Civil War Dictionary*, *Revised Edition*, by Mark May Boatner, III (New York: Vintage Books, 1991), pp. 123-127; See also: *American Civil War Homepage website* (© 2003 George H. Hoemann): *Civil War Generals*: http://sunsite.utk.edu/civil-war/cong_j.html. See also: *Bennett Place, North Carolina Historic Sites website* (© 2003 North Carolina Office of Archives and History): http://www.ah.dcr.state.nc.us/sections/hs/bennett/bennett.htm

Catesby ap Roger Jones (1821-1877), a U. S. naval officer. He had served as ordnance officer aboard the *CSS VIRGINIA* when she was a US naval vessel. He left the US Navy when his state seceded from the Union. He then received a commission as a lieutenant in the Confederate Navy and became executive officer of the *VIRGINIA*. He assumed command on March 9, 1862, in the *VIRGINIA's* fight against the *USS MONITOR* after Capt. Buchanan fell wounded. Later in 1862, he commanded a shore battery at Drewry's Bluff, on the James River, and the gunboat *CSS CHATTAHOOCHEE* while she was under construction at Columbus, Georgia. Promoted to the rank of commander in April 1863, Jones went to Selma, Alabama, to take charge of the Ordnance Works there. For the rest of the Civil War, he supervised the manufacture of heavy guns for the Confederate armed forces. With the end of the conflict in May 1865, Jones went into private business. He was murdered in Selma, Alabama on 20 June 1877. *Commander Catesby ap R. Jones, Confederate States Navy, (1821-1877)*, Department of the Navy -- Naval Historical Center, Washington Navy Yard, Washington DC 20374-5060; *Naval Historical Center home page*: http://www.history.navy.mil/photos/pers-us/uspers-j/ca-jones.htm.

John M. Kell (1823-1900), who later served in the Confederate Navy, was in Pensacola with Porter and had this to say of him: ". . . Porter was the naval constructor. To his inventive brain, some believe we are indebted for the original idea of the ironclad, brought into service some years later. Porter was a very modest man, of few words, and not being on the "side of the strongest artillery," or the winning side, of the Civil War, he died shortly after its close almost penniless." Actually, Porter died in 1893. *Recollections of a Naval Life: Including the Cruises of the Confederate States Steamers, "Sumter" and "Alabama", by John McIntosh Kell* (Washington, The Neale Company, 1900), p. 130. http://www.webroots.org/library/usamilit/roanlic4.html.

Stephen Russell Mallory (1812-1873), a Key West and Pensacola admiralty lawyer, who served as U. S. Senator (D-FL), 1851-1861. He also served as Confederate Secretary of the Navy, 1861-1865, and consistently supported construction of ironclads like the *CSS VIRGINIA*. William N. Still. *Confederate Shipbuilding* (Athens, GA: University of Georgia Press, ©1969), pp. 3-5, 75; for a portrait and biographical sketch, see: *eHistory.com website* (Copyright © 2003 eHistory.com LLC. All rights reserved) http://www.ehistory.com/local/gulfcoast/escambia/books/mallory.

Charles Stewart McCauley, (1793-1869), the commandant of the Gosport Navy Yard. A naval officer, he was a nephew of Admiral Charles Stewart, and became a midshipman in the Navy in 1809, rising to the rank captain in 1839. In 1860, he took command of the Gosport Navy Yard, and in 1861, he destroyed a large amount of property there, to prevent its falling into the hands of the Confederates. He retired 21 December 1861 and the Navy promoted him to commodore 4 April 1867. *Edited Appletons Encyclopedia, Copyright © 2001 Virtualology™* http://famousamericans.net/charlesstewartmccauley.

James Meads, listed as "Carpenter, C. S. Navy" in Official Records as late as November 1864. He had worked with Porter to estimate the value of vessels and wrecks found at the Gosport Navy Yard after the Union Forces abandoned it in April 1861. *Official records of the Union and Confederate Navies in the War of the Rebellion. Series I – Volume 11: North Atlantic Blockading Squadron (October 28, 1864 – February 1, 1865)*, (Washington, DC: Govt. Printing Office, 1900), p. 771; See also: http://cdl.library.cornell.edu/cgi-bin/moa/pageviewer?frames=1&cite=http%3A%2F%2Fcdl.library.cornell.edu%2Fcgi-bin%2Fmoa%2Fsgml%2Fmoa-idx%3Fnotisid%3DANU4547-0011&coll=moa&view=50&root=%2Fmoa%2Fofre%2Fofre0011%2

F&tif=00007.TIF&pagenum=771; *Series II – Volume 1: Statistical Data of Union and Confederate Ships; Muster Rolls of Confederate Government Vessels; Letters of Marque and Reprisals; Confederate Department Investigations*, (Washington, DC: Govt. Printing Offices, 1921), p. 321. See also: http://cdl.library.cornell.edu/cgi-bin/moa/pageviewer?frames=1&cite=http%3A%2F%2Fcdl.library.cornell.edu%2Fcgi-bin%2Fmoa%2Fsgml%2Fmoa-idx%3Fnotisid%3DANU4547-2001&coll=moa&view=50&root=%2Fmoa%2Fofre%2Fofre2001%2F&tif=00842.TIF&pagenum=321; *Series II – Volume 2: Navy Department Correspondence 1861 – 1865, with Agents Abroad*, (Washington, DC: Govt. Printing Offices, 1921), p. 108. See also: http://cdl.library.cornell.edu/cgi-bin/moa/pageviewer?frames=1&cite=http%3A%2F%2Fcdl.library.cornell.edu%2Fcgi-bin%2Fmoa%2Fsgml%2Fmoa-idx%3Fnotisid%3DANU4547-2002&coll=moa&view=50&root=%2Fmoa%2Fofre%2Fofre2002%2F&tif=00015.TIF&pagenum=108.

Robert Dabney Minor (1827-1871), second in command of the *VIRGINIA*. Formerly an officer in the United States Navy he had served in Japan and at the U.S. Naval Observatory in Washington, D.C., he had enlisted in Confederate States Navy and served primarily at the Naval Ordnance Works in Richmond, Virginia he was second in command of the *CSS VIRGINIA* in the Battle of Hampton Roads, Virginia, with the *USS MONITOR;* he later served as ordnance officer of the James River Squadron. He later worked for the Tredegar Company in Richmond, Virginia and the Dover Company Iron Mines in Chesterfield County, Virginia. See: *Farrar/Timberlake Family web site*: http://www.cdcd.vt.edu/kdf/fo/d190.html#P3387; Minor Family Papers, Virginia Historical Society, Richmond, Virginia. http://vhs3.vahistorical.org/starweb/vhs/servlet.starweb

Garrett Jesse Pendergrast (1802-1862), a naval officer, born in Kentucky, he entered the United States Navy, 1 January, 1812, and saw twenty-two years of sea service, becoming lieutenant in 1821, commander in 1841, and captain in 1855. In 1860, he earned promotion to admiral of the home-squadron. At the beginning of the Civil War, he was in command of the West Indies squadron, and subsequently commanded the frigate *USS CUMBERLAND* at Norfolk Navy Yard. Before the surrender of Norfolk to the Confederates, the authorities of Virginia blocked the mouth of the channel and trapping the U. S. ships at

Gosport. Among other vessels trapped was the *CUMBERLAND*. Pendergrast announced that he would open fire on the city if the Confederates did not clear the blockage. This message worked as intended and the *CUMBERLAND* and other trapped vessels escaped. Soon afterward, he became commandant of the Philadelphia Navy Yard, which post he filled until two days before his death. *Edited Appletons Encyclopedia, Copyright © 2001 VirtualologyTM* http://www.famousamericans.net/garrettjessependergrast/.

Samuel Moore Pook (1804-1878), a naval constructor for the U. S. Navy, from 1841 until his retirement in 1866, he built the sloops-of-war USS *PREBLE* and USS SARATOGA, the frigates USS CONGRESS and *USS FRANKLIN*, and the steamers *USS MERRIMACK* and *USS PRINCETON* among other vessels. He designed and built the "Pook Turtles" armed riverboats during the Civil War. He was also active in fitting out the fleet of Admiral DuPont and others during the Civil War. Pook was the inventor of numerous devices connected with his profession. He wrote *A Method of Comparing the Lines, and Draughting Vessels Propelled by Sail or Steam, with Diagrams* (New York, 1866). One of John L. Porter's instructors, he had been a naval constructor at the Gosport Navy Yard since 1859. John L. Porter replaced him as naval constructor at the Gosport Navy Yard in 1861. *John L. Porter: Naval Constructor of Destiny*, by Alan B. Flanders, White Stone, Virginia. Brandylane Publishers, Inc., © 2000, pp. 17; *Edited Appletons Encyclopedia*, © *2001 Virtualology*™ *website*: http://www.famousamericans.net/samuelmoorepook/

Thomas Oliver Selfridge (1804-1902), a naval officer, he was wounded and disabled from sea duty during the Mexican War. He gained promotion to captain, in 1855, and to commodore, in 1862. When the Civil War broke out, he commanded the steam frigate MISSISSIPPI in the Gulf squadron, for a few months, but his wound incapacitated him for sea-service. From 1862-1865, he commanded the Navy yard at Mare Island, California. He won promotion to rear admiral in 1866. He was president of the examining board in 1869-1870, lighthouse inspector at Boston, and a member of the examining board in 1870-1871. At that point, he was the senior officer of the Navy on the retired list. In 1874, he was living in retirement in Boston. He was the father of Thomas Oliver Selfridge, Jr., who was aboard the USS CUMBERLAND during her battle with the CSS VIRGINIA in 1862. See Wikipedia: http://en.wikipedia.org/wiki/Thomas_O._Selfridge;

Virtuology.com. http://www.famousamericans.net/thomasoliverselfridge/

Selfridge, Thomas Oliver, Jr. (1836-1924), also a naval officer, he graduated first in his class from the US Naval Academy in 1854 and was serving as 2nd lieutenant aboard the *USS CUMBERLAND* when the CSS VIRGINIA destroyed her on March 8, 1862. He then commanded the *USS MONITOR*, March – July 1862. He later went on to achieve a successful naval career during and after the Civil War. He earned promotion to commander in 1869, and in that year took charge of surveys for a canal across the isthmus of Darien. He received a commission as captain, in 1881, and took charge of the torpedo station at Newport, Rhode Island, where he remained until 1885. During his service at Newport, he invented the torpedo net to protect a ship from attacking torpedoes. *Concise Dictionary of American Biography*, Joseph G. E. Hopkins, Managing Editor. New York: Charles Scribner's Sons, © 1964. P. 933; see also: Wikipedia: http://en.wikipedia.org/wiki/Thomas_O._Selfridge,_Jr. & Virtuology.com. http://www.famousamericans.net/thomasoliverselfridge/

Joseph B. Smith, a sailor in the U. S. Navy, who according to Edward Shippen, US Navy Medical Director, in a letter to *The Century Magazine*, died at the foot of the after ladder of the *USS CONGRESS's* gun deck during its battle with the *MERRIMACK*. *Notes of the Congress-Virginia Fight*, by Edward Shippen, in "Memoranda on the Civil War," *The Century Illustrated Monthly* v. 30, new ser, n. 8 (May – October 1885), p. 642. Cited in *Cornell Making of America website*: http://cdl.library.cornell.edu/cgi-bin/moa/pageviewer?frames=1&coll=moa&view=50&root=%2Fmoa%2Fcent%2Fcent0030%2F&tif=00652.TIF&cite=http%3A%2F%2Fcdl.library.cornell.edu%2Fcgi-bin%2Fmoa%2Fmoa-cgi%3Fnotisid%3DABP2287-0030-153 .

Josiah Tattnall, Jr. (1795-1871), a Confederate Navy officer who commanded the *CSS VIRGINIA* after March 23, 1862. He faced a court martial for burning the *VIRGINIA* (May 11, 1862) rather than letting her fall into the hands of Union troops. However, the court acquitted him. Mabry, W. S. *Brief Sketch of the Career of Catesby ap Roger Jones*. (Privately published, Selma, AL, January, 1912) Mabry Tyson has an electronic version as well. *Bibliography of CSS Virginia*

(Merrimack) vs. USS Monitor website: http://www.cssvirginia.org/vacsn/base/biblio.htm#MabryWS12.

Gideon Welles (1802-1878), a journalist and Democratic Party politician, who served as President Lincoln's secretary of the Navy, stemmed from a long-established Connecticut family. An early supporter of Andrew Jackson he won a seat in the state legislature, and served until 1835 as a Jacksonian Democrat. Jackson appointed Welles as postmaster of Hartford in 1836. He held that office until the Whig President, William Henry Harrison, removed him in 1841. A religious and pious man, who deplored slavery, Welles left the Democratic Party in the 1850s. He opposed the Kansas-Nebraska Act, and in 1856 helped establish the *Hartford Evening Press* to promote the new Republican Party. As a reward for his political contributions, Lincoln appointed Welles as secretary of the Navy. He remained in that position during the presidencies of Lincoln and Andrew Johnson, serving longer than any previous Navy secretary had done. After Lincoln's assassination, Welles supported Johnson against congressional radicals. Dissatisfied with the Republican Party, he returned to the Democratic Party in 1868. He retired from the Navy Department in 1869. Until his death in 1878, he remained active in politics and published numerous articles that have become important resources for understanding the Civil War period. *Howard K. Beale, "Gideon Welles,"* DAB, 19: 629-32; Niven, Gideon Welles, cited in: http://www.tulane.edu/~latner/Welles.html.

William P. Williamson, was Engineer-in-Chief of the Confederate Navy, 1862-1865. A pilot, he had served as a member of the crew of the *CSS VIRGINIA*. *CivilWarTalk.com website*, (©1999-2003. All Rights Reserved). http://www.kinkade.ws/cwt_alt/resources/navy/cs_org.htm. See also: http://cdl.library.cornell.edu/cgi-bin/moa/pageviewer?root=%2Fmoa%2Fofre%2Fofre2001%2F&tif=00677.TIF&cite=http%3A%2F%2Fcdl.library.cornell.edu%2Fcgi-bin%2Fmoa%2Fmoa-cgi%3Fnotisid%3DANU4547-2001&coll=moa&frames=1&view=50; See also: *CSS Virginia Home Page website*, (©1997-2003 by Mabry Tyson): http://www.cssvirginia.org/vacsn4/original.

John Ellis Wool (1784-1869), a U. S. Army officer, whose career dated to the start of the War of 1812, when he had raised and commanded a company of volunteers in Troy, New York. He later earned a commission as captain in the 13th Infantry. He led his troops in the battles of Queenstown and Plattsburgh and ended the war as a lieutenant colonel. He later achieved the rank of colonel and inspector general of the Army on 29 April 1816. He stayed in this rank for more than a quarter of a century. During the Mexican War of 1846-1848, Wool, a brigadier general, mobilized, trained, and marched an army, composed mostly of western volunteers, for the invasion of Mexico by land. He was second in command to Commander in Chief General Zachary Taylor when Taylor won the Battle of Buena Vista in 1847. The Civil War provided Wool one last opportunity for military service. Aged seventy-seven and second in seniority and rank in the U. S. Army, Wool performed duties of remarkable variety and intensity. In 1861, he commanded the Department of Virginia, with headquarters at Fort Monroe. There he extended the Union line by capturing of Norfolk. General Wool's final tour of duty was in 1863, as military commander of New York City. After the draft riots, he was partly blamed for the great loss of life. He retired from active duty on 1 August 1863. *John Ellis Wool Papers, 1810-1869*, SC15361, Finding Aid, New York State Library cited from NYSL website. http://www.nysl.nysed.gov/msscfa/sc15361.htm.

John Lorimer Worden (1818-1897), a naval officer, served from 1835-1886. Commissioned a lieutenant, on 30 November 1846, he served on various vessels and at the naval observatory until the Civil War. He then superintended the construction of John Ericsson's *USS MONITOR* and served as her commander. He arrived at Hampton Roads in the Virginia on 8 March 1862, after *CSS VIRGINIA* had come down from Norfolk and had sunk the USS CONGRESS and the *USS CUMBERLAND*. Midway during the *VIRGINIA - MONITOR* battle the next day, Worden commanded the *MONITOR* during the first two hours of the fight. At 11.30 AM, a shell exploded on the pilothouse of the *MONITOR*, while Worden was looking through the observation slit in the turret, and the powder and flame blinded him. Lt. Samuel Dana Greene, the second in command, continued the action; but the *VIRGINIA* soon withdrew to Norfolk. It was a drawn battle, but Worden received numerous battle honors for his service. Congress twice voted their thanks and recommended him for promotions. He received a promotion to commander, 12 July 1862, and, in accordance with the second vote of thanks, a promotion to captain, 3 February 1863. He recovered from the injuries to his eyes, and commanded many ships. After the war, he became a commodore and then rear admiral (1872) served as superintendent of the Naval

Academy, and as commander-in-chief of the European Squadron. He retired in 1886. *Edited Appletons Encyclopedia, © 2001 Virtualology™ website:* http://famousamericans.net/johnlorimerworden/; *Rear Admiral John L. Worden, USN, and (1818-1897)*. Naval Historical Center Home Page, Department of the Navy -- Naval Historical Center, Washington Navy Yard, Washington DC 20374-5060, http://www.history.navy.mil/photos/pers-us/uspers-w/j-wrdn.htm.