The Hale Rocket and Rocket Launcher—The American Connection

Elmo Phillips

The modern rockets that changed warfare and sent satellites into orbit and man to the moon all evolved from the plain gunpowder rocket developed by Chinese alchemists in the 13th century. They were not trying to develop weapons but were searching for a medicine to cure all ills. This involved mixing and heating a wide variety of substances including sulfur, charcoal and saltpeter, or potassium nitrate. Saltpeter made the mixture either an explosive or a propellant, depending upon the percentage of each ingredient. It was discovered that if the mixture was lighted in the open end of a paper or bamboo tube that was closed at the other end, it would propel the tube forward. This was the first rocket. The Chinese rockets were called flying fire arrows, after their arrow guide-sticks.[1]

William Congreve, Jr., loved inventions and military weaponry and made the first substantial improvements to the rocket. He developed the stick-stabilized war rocket (Figure 1) that carries his name. He also developed rocket range tables based on angle of discharge, worked out explosive and incendiary warhead compositions, made more powerful gunpowder, attached longer, stronger guide-sticks and fashioned special launchers that allowed firing elevations to be adjusted.[2]

William Hale's rocket (Figure 2) was a major improvement to the Congreve system and was the first to reflect modern rocket technology. Hale was born in Colchester, Essex, England on 21 October 1797 and is believed to be descended from the 17th century Lord Chief Justice of England, Sir Matthew Hale. William Cole, his maternal grandfather and first teacher, an educator and writer on diverse subjects ranging from comets to algebra, was the major influence in fostering William's mechanical interest. William Hale received his first patent in England in 1827 for an internal ship's screw. The ship used a crude form of "jet propulsion" in that water was sucked into the ship by a steam-powered screw, which in turn discharged the water through an opening in the stern to drive the ship forward. This invention won him the first-class Gold Medal of the Royal Society of Arts in Paris. In addition, he invented a method of producing gas in "aerated liquors." This was done in partnership with George Purt, a soda-water manufacturer in London. It is believed that

Hale's interest in spinning mechanisms coupled with soda-water gas production led to his belief that rocket stability could be achieved by the spinning created by escaping gas. In 1839, William Hale moved near the Royal Arsenal in Woolwich where Congreve had designed his rocket. Here Hale's interest in rocketry and in Congreve's achievements flourished. He set out to improve the stick-stabilized rocket and, by 1843, wrote that "use of the stick could be dispensed with."[3]

In January 1844, William Hale patented his rotary rocket (Figure 3). It improved the accuracy problem of the Congreve rocket that had been used by the U.S. Army since the War of 1812. As the propellant burned, resulting gases were expelled through the exhaust hole in the base of the rocket, providing thrust. Exhaust gas also escaped from oblique base holes, causing the entire rocket to spin around its longitudinal axis, which stabilized the rocket and eliminated the need for a stabilizing stick.[4]

The rocket used gunpowder as the propellant and was referenced by its diameter or weight. The 2.25-inch rocket, which is 13 inches long and weighs 6 pounds, has a maximum range of 1760 yards at 47° elevation, according to the 1850 *U.S. Army Ordnance Manual.* The 3.25-inch rocket weighs 16 pounds and has a maximum range of 2200 yards at the same elevation. Burning rates were modified by increasing or decreasing the amount of saltpeter and/or charcoal in the propellant. The rocket (Figure 4) consisted of a warhead, propellant tube and base. The propellant tubes made in the United States were fabricated from sheet-iron

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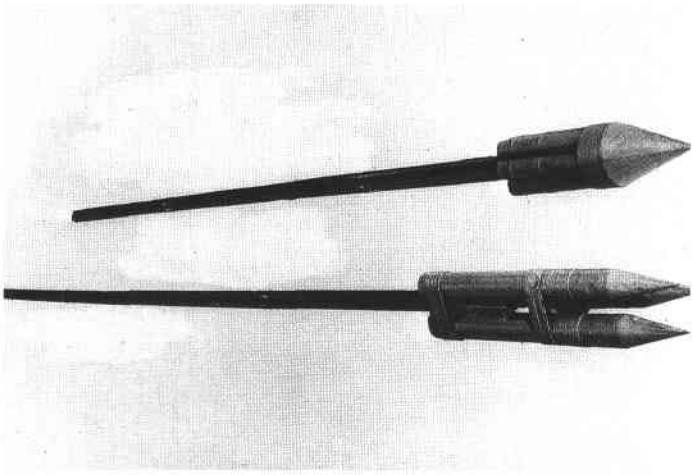

Figure 1. Congreve experimental rocket. Photo courtesy The Science Museum, London.

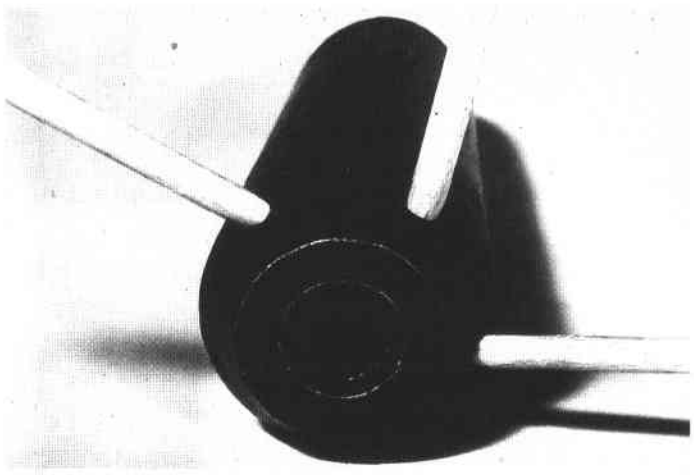

Figure 3. Hale rocket showing exhaust exits. Photo courtesy Smithsonian Institution.

lined with paper or wood veneer. The rocket was manufactured by inserting a false base in the propellant tube. Propellant was put into the tube and pressed against the false base using a hydraulic press (Figure 5) with a pressure of seven tons per square inch. The false base was removed and a conical hole was drilled into the propellant column two-thirds the length of the propellant chamber. This provided a greater burning area and created a combustion chamber. The real base with exhaust exits was then inserted and attached by rivets. Gas seepage was prevented by a lead washer and a millboard washer between the body and the base piece. Prior to the introduction of curved vanes in 1862, the exhaust exits were drilled directly into the rocket case. The rounded warhead was made of cast iron, was connected to the top of the propellant chamber by rivets and was solid shot or shell. The shell warhead, which served as a shrapnel round, had an internal fuse connecting to the propellant chamber. The sheer force of a solid projectile fired at short ranges was sufficient to cause severe damage against hard targets or earthworks. In addition, the rocket had incendiary value because the burning propellant could cause a fire if the rocket hit a combustible target.[5] The rocket was ignited for launch by a fuse train or quick match.

The launcher (Figure 6) weighs 30.5 pounds and is 58.5 inches long. It was set close to the ground for firing because the rockets were normally fired at around 15–25° elevation since their flight path was on a horizontal plane. Velocities using known flight times and ranges indicate that rocket speed was approximately 200 miles per hour (293 ft/sec). By the time the rocket had traversed the length of the tube, it was in its third or fourth rotation and well on its way to attaining stability. Propellant burn time was 8–10 seconds.[6] I believe the launch process began with a estimation of range to the target. Required launcher elevation for the range was set by a gunner's quadrant, which was established by raising or lowering the launching tube on the bipod legs (Figure 7) and securing the elevation with set screws.

The launcher had a restraining lever and counterweight (Figure 8) with a wafer (Figure 9) that blocked the tube at the rocket's head when positioned for launch. The

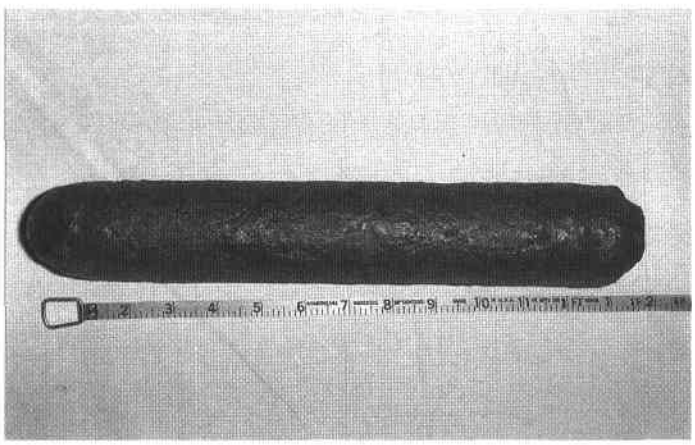

Figure 2. Hale Rocket dug at Malvern Hill battlefield in 1982. Author's photograph.

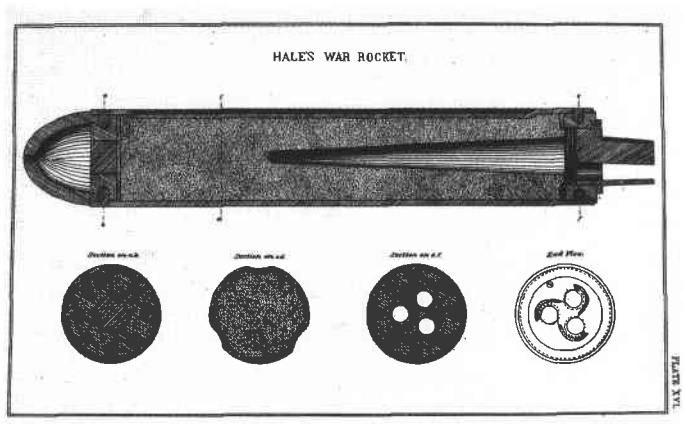

Figure 4. Hale rocket, cutaway view. Photo courtesy Smithsonian Institution.

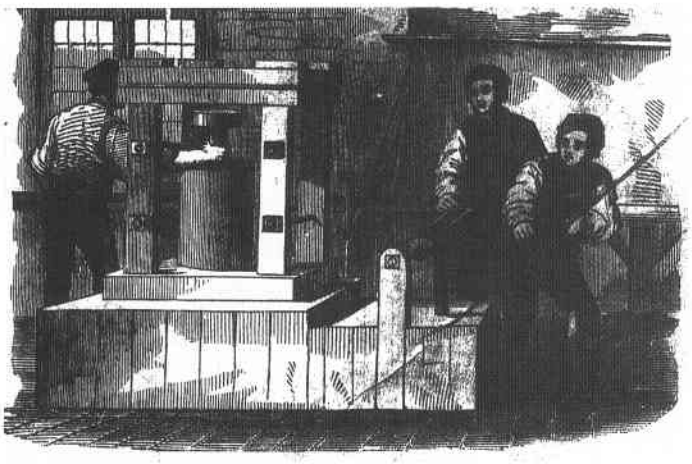

Figure 5. Hale rocket manufacture by hydraulic Press. Photo courtesy Smithsonian Institution.

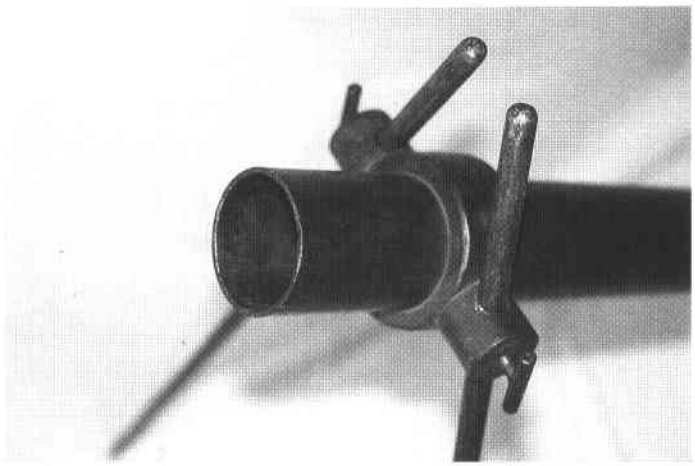

Figure 7. The bipod legs are attached by set screws. Author's photograph.

repressive weight of a 3-inch (9-pound) rocket was 6 pounds. The wafer prevented the rocket from launching until enough thrust was generated to overcome its resistance. The rocket needed to develop 15 pounds of thrust before it launched with no resistance from a wafer. The rocket then launched by pushing the wafer (Figures 10, 11 and 12) out of its flight path in the launcher. The amount of propellant burn time in the launcher was controlled by the sliding counterweight on the restraining lever. The counterweight was set to the number of required seconds (8 seconds in Figure 8) of propellant burn time in the launcher that would leave enough propellant at launch for the rocket to cover the range to the target and set off the warhead as the rocket reached its target. With the counterweight set at 4, the rocket will launch with 6 seconds of burn time remaining, which provides maximum range. Firing with the counterweight set at 8 seconds takes more propellant burn to provide the thrust necessary to overcome the wafer, which decreases the range.

Results of U.S. Navy trials (Figure 13) conducted at the Washington Navy Yard on 20 October 1858 on a 3-inch, 13-pound rocket showed a circular error of probability of 50-60 yards at the maximum ranges at 15°, 25°, and 30° elevation. Hits 50 yards to the left of target at 1200 yards and 60 yards to the right at 2250 yards and 3000 yards were recorded.[7]

THE WAR WITH MEXICO

In the autumn of 1846, Joshua Hyde, a Connecticut-born engineer who met Hale in London, offered to sell Hale's rockets to the U.S. Government. In November 1846, General Winfield Scott was interested in the possibility of a brigade of rocketeers being part of his planned expedition to Vera Cruz and Mexico City. During the war of 1812, he was impressed with the Congreve rockets he encountered at the hands of the British during the battles of Chippewa and Lundy's Lane. Hale's new rockets were tested before a joint Army-Navy board at the Washington Arsenal on 24-27 November, 1846.

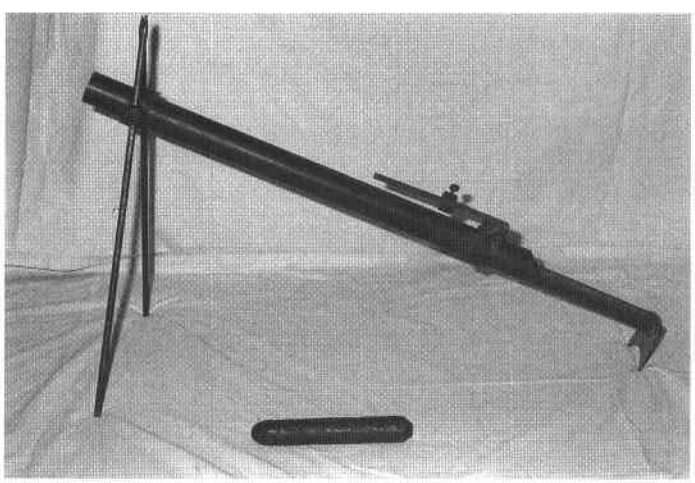

Figure 6. Hale rocket launcher with rocket. Author's photograph.

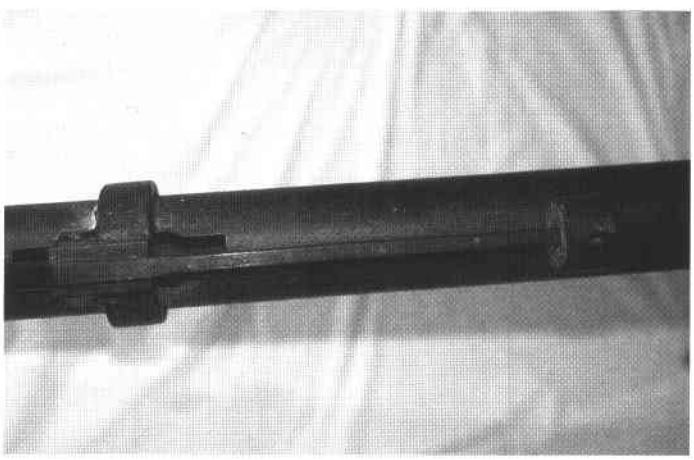

Figure 8. Restraining lever showing seconds of rocket burn time and the counterweight set on eight seconds. Author's photograph.

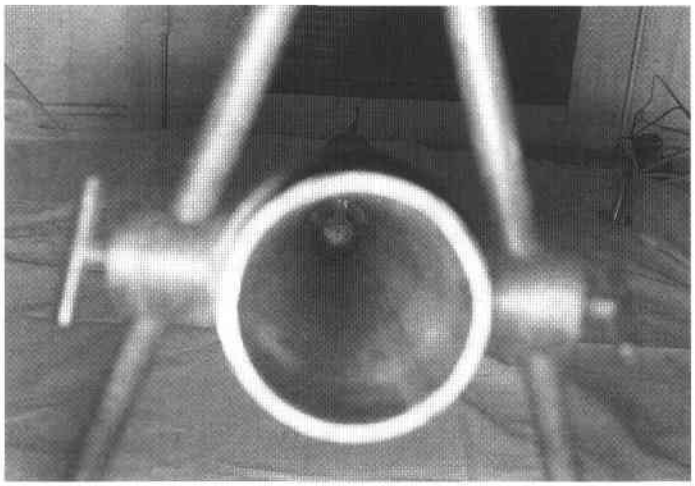

Figure 9. Launcher muzzle showing wafer in "down" position to restrain rocket from launching. Author's photograph.

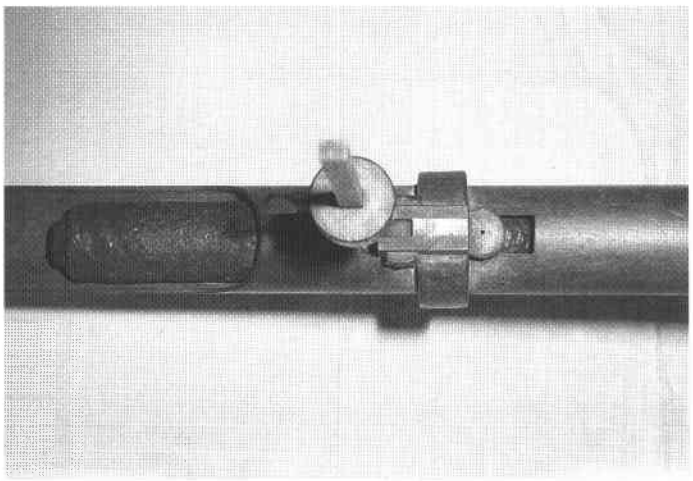

Figure 11. Wafer and restraining lever pushed out of the launcher to allow the rocket to launch. Author's photograph.

The United States became the first country to buy Hale's rockets after additional tests were held on 5 January 1847. The U.S. Army and Navy purchased from Hyde for $20,000 the rights to manufacture rockets and launchers.[8]

In conjunction with the tests, Col. Joseph G. Totten, Chief of Ordnance, ordered the organization of rocketeers from the Ordnance Corps into a unit called the Mountain Howitzer and Rocket Battery to support the war with Mexico. The battery, commanded by 1st Lt. George Talcott, was equipped with 12-pound mountain howitzers and Hale's rockets. His subordinates were 2nd Lts. Franklin Callendar and Jesse Reno, commander of the rocketeers. Lt. Reno, an 1846 graduate of West Point, was on his first assignment in a military career that ended 16 years later when, as a Major General, he was killed at the battle of South Mountain, Maryland, on 14 September 1862. The battery trained at Fort Monroe, Virginia, and sailed (105 strong) on February 1 1847. They were equipped with six mountain howitzers and 1200 rounds of ammunition plus an initial supply of 50 2-inch Hale's rockets. The number of launchers on board was not reported, but the Washington Arsenal had produced 2200 rockets and 14 "conductors" or stands by June 30 1847, with 1328 rockets having been issued to the Army. These were 6-pound 2 ¼-inch rockets and 16-pound 3 ¼-inch rockets. The stands, at 30–35 pounds, were very light and mobile compared to a 500-pound mountain howitzer (tube and carriage).[9]

The Mountain Battery landed in Mexico about three miles southeast of Vera Cruz on 9 March 1847. As General Scott began his siege of the city, the rocket battery was placed within 1000 yards of the city. On 24 and 25 March, Lt. Callender fired both the old Congreve and new Hale's rockets into the city, which surrendered on 29 March. Lt. George B. McClellan (Figure 14) noted in his diary during the Battle of Vera Cruz that "the discharge of our rocketeers caused a stampede amongst the Mexicans."[10]

The army then moved toward Mexico City, fighting the battle of Cerro Gordo halfway to Mexico City on 24 April, where 30 Hale's rockets and 40 rounds of howitzer case shot

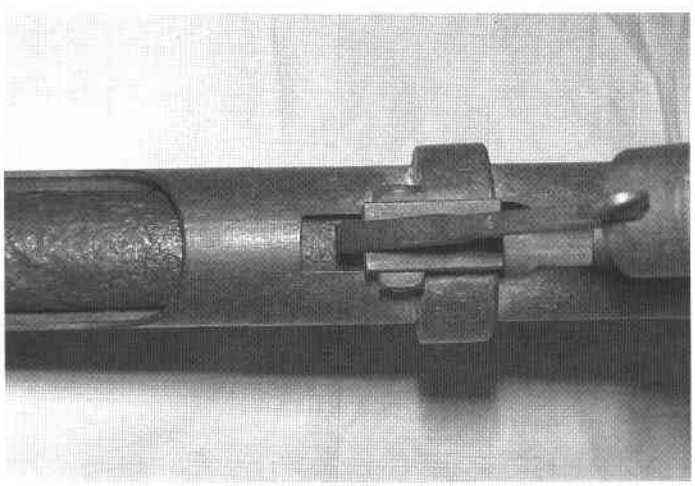

Figure 10. Rocket pushing up wafer to effect launch. Author's photograph.

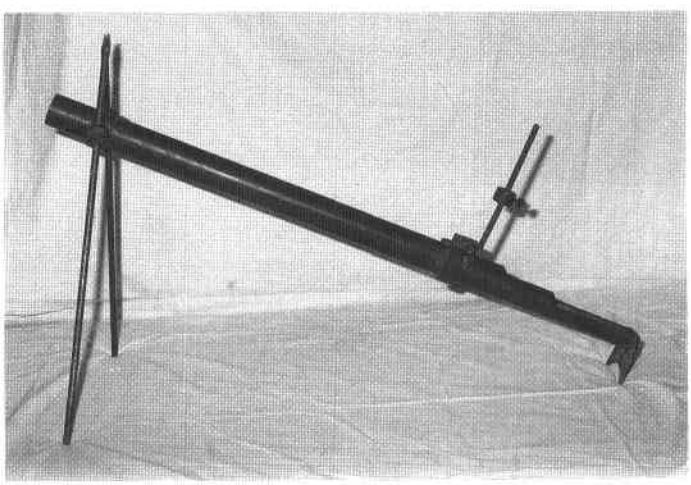

Figure 12. View of launcher in launch configuration. Author's photograph.

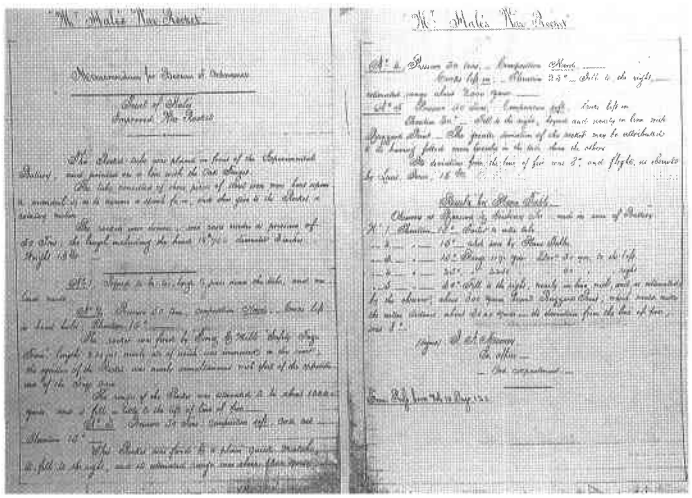

Figure 13. Results of the 20 October 1858 Hale's rocket trials at the Washington Naval Yard as cited in National Archives Records.[7]

covered the advance of the infantry. Lt. Reno, who commanded the battery in this action, was breveted to first lieutenant for "judicious placing of his battery and cool and gallant conduct." The advance slowed as Scott's army awaited the arrival of new regiments to replace the volunteer regiments whose enlistments had expired. It was July before new regiments began arriving. On 7 August, Scott continued his advance toward Mexico City where, by 17 August, he was at San Augustin, about 10 miles south of Mexico City. There the army turned east on 19 August, following a route to Mexico City selected by Captain Robert E. Lee and Lt. P.G.T. Beauregard.[11]

An artillery duel at 900 yards commenced at Contreras upon contact with a large Mexican force. The howitzer and rocket battery was positioned by Captain Lee a mile forward of the supporting infantry to counter Mexican siege guns. Heavy shelling by the Mexicans for more than an hour resulted in the battery being withdrawn with a loss of men and guns crippled. Lt. Callender was severely wounded during the engagement and Lt. George B. McClellan took command of the battery, winning a brevet first lieutenancy for efficiency and gallantry. The next day the Americans drove the Mexicans before them to Churubusco, but the rocket battery didn't arrive until most of the fighting was over.[12]

The advance resumed on 8 September, with Scott's Army within a half mile of the fortified college atop Chapultepec Hill. This had been selected as the point of entry into Mexico City. Captain Benjamin Huger, Scott's ordnance officer, assisted by Lieutenants Peter Hagner, Josiah Gorgas (Figure 15) and Charles Stone, prepared the bombardment plans, which were approved by Captain Lee. Lt. Reno's battery fired on the parapet atop Chapultepec Hill to cover the infantry and marine assault on the hill, and then advanced with the storming column, providing supporting fire at the base of the height. When Lt. Reno was disabled by wounds, Lt. Beauregard (Figure 16) replaced him for the remainder of the assault. General Scott stated that "The mountain howitzer and rocket battery, under Lt Reno, deserves to be particularly mentioned" in his high praise of the performance of the Ordnance Corps during the war. The battery, 69 men remaining, was discharged in the late summer of 1848.[13]

After the Mexican War, no regular organization of rocket batteries was established or arranged. The 1850 *Ordnance Manual* stated that "the nature and number of rockets, and of carriages and conductors, would be determined by the character of the service for which they may be required."[14]

William Hale continued efforts to maintain U.S. interest in his rockets. In 1851, William Hale, Jr. brought an improved stand for firing the rockets, and some rocket cases, to the War Department. After trials, the Secretary of War authorized payment of $770 for the stand, cases and Mr. Hale's expenses. In 1855, William's brother Robert Hale came to the United States with improved stands and rockets. He was authorized to make a few under his own supervision at the Washington Arsenal at $5 per day. These rockets were stored in Baton Rouge, Louisiana, and New Mexico. They were tested in 1857 and only the rockets from New Mexico failed to perform. The Chief of Ordnance reported that these rockets were superior to previous ones, and $1000 was paid to Mr. Hale. In July 1858 he was paid an additional $4000. The Hales had a total of $27,770 to show for their promotion efforts in the United States prior to "our great unpleasantness" of the 1860s.[15]

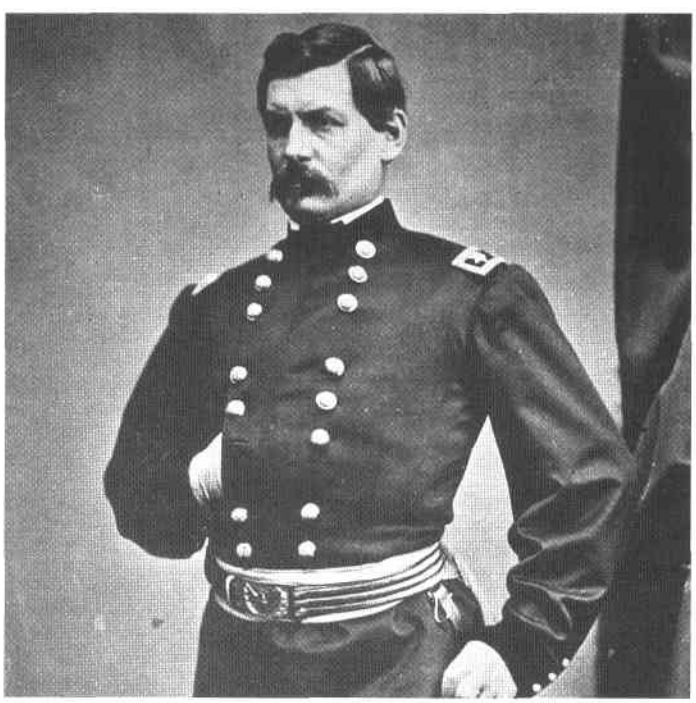

Figure 14. U.S. Lt. and Gen. George B. McClellan. *Divided We Fought,* 1956, p. 26.

Figure 15. U.S. Lt. in Mexican War, later C.S. Major, Josiah Gorgas, Chief of Ordnance. *Firearms of the Confederacy,* 1944, p. 122.

THE CIVIL WAR

Rocket interest in the Civil War was the result of the experience of both Northern and Southern leaders who had served either in or with the Mexican rocket battery. We always prepare to fight the previous war. Reports in *The Official Record of the Union and Confederate Army,* in addition to relic hunter finds, substantiate that Hale's rockets were used at the battles of Gaines Mill, Malvern Hill, Franklin, Evelington Heights and Petersburg in Virginia. They were also used at Legareville, Stono River and the siege of Charleston in South Carolina.

The first rocket initiative was Confederate. Rockets stored in arsenals in the South had fallen into their hands. In August 1861, General P.G.T. Beauregard directed his Chief of Ordnance, Captain E. Porter Alexander, along with Major Josiah Gorgas, Chief of Confederate Ordnance, to approach President Davis to gain approval for the formation of rocket batteries. Unable to meet with Davis, Alexander got approval from Adjutant Inspector General Samual Cooper. Major Gorgas began steps to manufacture the rockets.[16] Meanwhile, General Beauregard authorized the enlistment of a rocket battery.[17]

However, Acting Secretary of War Judah Benjamin shut down Beauregard's plan, charging that he had "exceeded his authority." President Davis concurred with Benjamin when Beauregard appealed. President Davis pointed out in a friendly letter to Beauregard on 25 October 1861 that "not even the President could appoint officers and recruit a company (except for the regular army)." Beauregard, also involved in a controversy over his report on the Manassas battle, took his case to the press. He sent a letter to the *Richmond Whig,* defending his report with an odious comparison between patriotism and office seeking. In a 10 November 1861 letter to Beauregard, President Davis defended Benjamin's position on the rocket battery, stating "you surely did not intend to inform me that your army and yourself are outside the limits of the law. It is my duty to see that the laws are faithfully executed, and I can not recognize the pretension of anyone that their restraint is too narrow for him." Beauregard never again had the confidence of President Davis.[18] This first Confederate attempt to organize a rocket battery resulted in a political fight that proved more destructive to the South than to the North.

The Confederates were capturing rockets and launchers and turning them against the Federals. Captain John Tidball of Battery A, 2nd U.S. Artillery, issued a report that contained this description of Jeb Stuart's shelling of Union positions on the James River from Evelington Heights. "On the morning of July 3 the enemy, taking position on the high ground commenced

Figure 16. U.S. Lt. and C.S. Gen. P.G.T. Beauregard. *Divided We Fought,* 1956, p. 17.

shelling the low ground occupied by our troops. They also threw with great precision a score or so of war rockets."[19]

Captain Samuel T. Wright's Halifax Artillery was equipped with rocket launchers captured from the Federal Army at Gaines Mill. Reports state that the battery, stationed at Petersburg, had 13 pieces of field artillery. Battle reports indicate that they were equipped with rockets.[20] In September 1862, Maj. Gen. John Peck of the Federal Army advanced on Franklin, Virginia, from Suffolk with a force of 2000 under Col. Samuel Spear of the 11th Pennsylvania Calvary.[21] The Confederates were deployed across the Blackwater River from Franklin to protect a bridge head. The Federals never attacked but conducted an artillery duel. Two sections of Captain Wright's Halifax battery were in the duel. Gen. Peck's report states that "shell, grape and rockets were fired in great profusion with little or no damage to our well posted troops."[22] The 11th Pennsylvania Cavalry reported "The fearful noise and hissing of rocket shells was disquieting."Again on 1 December, the same force moved on Franklin, which resulted in a running cavalry engagement between the 11th Pennsylvania Cavalry and the 62nd Georgia Cavalry and a section of Wright's artillery battery. On 2 December 1862, Maj. Gen. John Dix, U.S.A., reported that Maj. Gen. Peck had captured "the celebrated Petersburg Rocket Battery which was taken from our army."[23]

Other small rocket ventures were attempted by the Confederates using private funds. In the west, Captain Greer, commander of a howitzer battery under Maj. Gen. John B. Magruder, was ordered to Galveston, Texas, on 14 December 1863 to take charge of a rocket battery being fitted out. The next day the battery was assigned to Gen. Bee's command, the Western Sub-District with headquarters at San Antonio, Texas. In January 1864, Mr. G.H. Schroeder, an Ordnance Officer of General John Magruder's staff, established a rocket factory in Galveston to fit out the battery. By 1 June 1864 he had produced six "rocket shooting machines" and only 43 rockets. Captain Greer reported that he needed at least 600 rockets to take to the field. On 6 July 1864, at Captain Greer's request, his battery was broken up and the ordnance stores turned over to the Ordnance Department due to the failure to secure adequate men and munitions.[24] The Confederacy never achieved battlefield success as a result of employing rockets. However, one Hale's rocket and launcher in Federal hands almost inflicted a mortal wound in support of the Southern cause.

At the outbreak of the Civil War, William Hale offered to come to America to make rockets for the Union, but was refused. Fellow Englishman Thomas William Lion, a soldier of fortune, wrote Secretary of War Simon Cameron on 1 October 1861 "offering his services in the formation of rocket brigades and production of rockets." Secretary Cameron liked the idea and in a week General George McClellan met with Lion to discuss the details. All production would be done at the Washington Arsenal. Lion's assistance was not needed. General McClellan gave the Chief of Artillery for the Army of the Potomac, General William Barry of New York, the responsibility for forming the "New York Rocket Battalion."[25]

The *Scientific American,* dated 23 November 1861, reported that "a very formidable weapon is about to be introduced into our army on the Potomac. It is an improved Congreve rocket . . . one of the most fearfully destructive weapons devised by man and will drive the rebels out of their masked retreats." The rocket test results were less then expected. Since the rocket battalion was scheduled to be part of an April 1862 campaign under General Burnside, the rockets and launchers were exchanged for 6-pound rifled cannons.[26] In February 1863, the battalion's name was changed to the 23rd and 24th Independent Batteries of Light Artillery, New York Volunteers.[27]

In 1862, Joshua B. Hyde, Hale's Mexican War agent, persuaded President Lincoln to support the purchase of an improved Hale's rocket. President Lincoln, with Secretary of State Seward, Secretary of Treasury Chase and Chief of Naval Ordnance Captain Dahlgren, went to view the trial of this rocket, which had an explosive head, at the Washington Navy Yard on 15 November 1862 (Figure 17). The rocket almost struck a blow for the South when it exploded in the launcher. The viewing party was engulfed by smoke, but when it cleared Capt. Dahlgren saw that a miracle had saved President Lincoln and his cabinet.[28]

In April 1864, Union General Alexander Schimmelfennig reported from Folly's Island outside Charleston, South Carolina, that he had been testing Hale's rockets, considered them serviceable and organized a rocket battery.[29] By mid-April, the Federals had 700 rockets and an additional 4000 Hale's rockets and 10 stands were requisitioned. They were used to drive

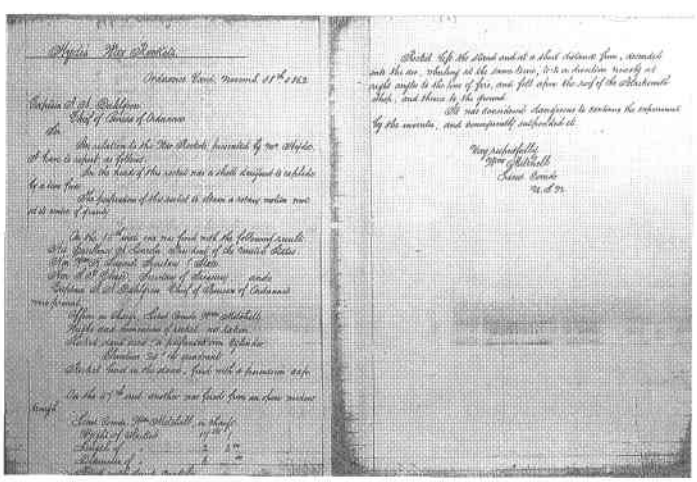

Figure 17. Naval report of November 1862 incident at Washington Naval Yard as cited in National Archives Records.[28]

Confederate picket boats off the creeks and the enemy out of positions unapproachable with artillery fire.[30] The rocket battery was used on raids and reconnaissance missions to Legareville, South Carolina, on 19 June, 11 July and 6 August, 1864.[31]

The interest of the U.S. Army in rockets as an effective weapon ended in July 1864. The rifled cannon had rendered them obsolete. The endorsement of Brig. Gen. George D. Ramsay, Chief of Ordnance on the U.S. Consul at Aix-la-Chapelle, on a request for instructions from the Secretary of War on the purchase of available Congreve rocket batteries, stated, "Experience with rocket batteries during this war is not at all favorable to their usefulness. The same number of men and horses can produce more effect with the improved cannon and projectiles now used. Rockets have but little range and accuracy compared to rifled projectiles, and are liable at times to premature explosions and great eccentricity of flight. I cannot recommend their purchase.[32]

The Confederacy got the last word. C.S. Commander James Bullock wrote Secretary of the Confederate Navy S.R. Mallory from London on 10 January 1865: "I have long thought that a severe blow might be struck at New Bedford, Salem, Portland, and other New England towns by sending from this side ships prepared with incendiary shells and Hale's rockets."[33] But the idea was too late, the South was beaten. The Hale's rocket had won no battles but it represented high technology for the Civil War. Their ineffectiveness, coupled with the continued improvement of rifled cannon, resulted in rockets not being considered as a weapon by the United States until World War II.

In 1867, England officially purchased William Hale's rocket patents. Hale, then 70, ceased working on rockets. He died on 30 March 1870 of typhoid fever in London. In 1970 the International Astronomical Union chose his name, along with that of astronomer George Ellery Hale (not related to William), to designate the Hale Crater on the Moon and to honor him as a rocket pioneer.[34] Hale's rockets were used by the British Royal Artillery until 1890. Mark VII 9- and 24-pound Hale rockets were finally declared obsolete on 11 September 1919.[35]

The only other Hale's rocket launchers located by the author are presently displayed at the Aberdeen Proving Grounds Museum, the West Point Museum and the Fort Ward Museum. Four or five others are in private collections.

ACKNOWLEDGMENTS

I thank Frank Winter, Curator of Rocketry at the National Air and Space Museum in Washington, D.C., for his support in my expansion of the American connection of the Hale's Rocket.

NOTES

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2. Winter, ch. 1, pp. 6–11
3. Ibid., pp. 180, 181
4. *U.S. Army Ordnance Manual,* 1850 edition, p. 289
5. Ibid., p. 289
6. Winter, ch. 10, pp. 209–211
7. National Archives Records Group 74, Entry 145, Boxes 1 and 2, Ordnance Book, vol. 10, p. 122
8. Winter, ch. 7, pp. 148–149
9. Olejar, pp. 24–26
10. Ibid., p. 27
11. Ibid., p. 29
12. Ibid., p. 30
13. Ibid., p. 31–32
14. *U.S. Army Ordnance Manual,* 1850 edition, p. 331
15. Olejar, p. 31
16. *The War of the Rebellion: Official Records of the Union and Confederate Armies,* ser. I, vol. LI, pt. 2, p. 255
17. Ibid., p. 256
18. Donnelly, p. 79
19. *Official Records of the Union and Confederate Armies* (OR), vol. XI, p. 246
20. OR, vol. XVIII, p. 750
21. OR, vol. VIII, p. 104–107
22. OR, vol. XVIII, no. 17. Report of Maj. Gen. John J. Peck, 9 October 1862
23. OR, vol. XVIII, no. 35. Report of Maj. Gen. John A. Dix, 2 December 1862
24. Donnelly, p. 86
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