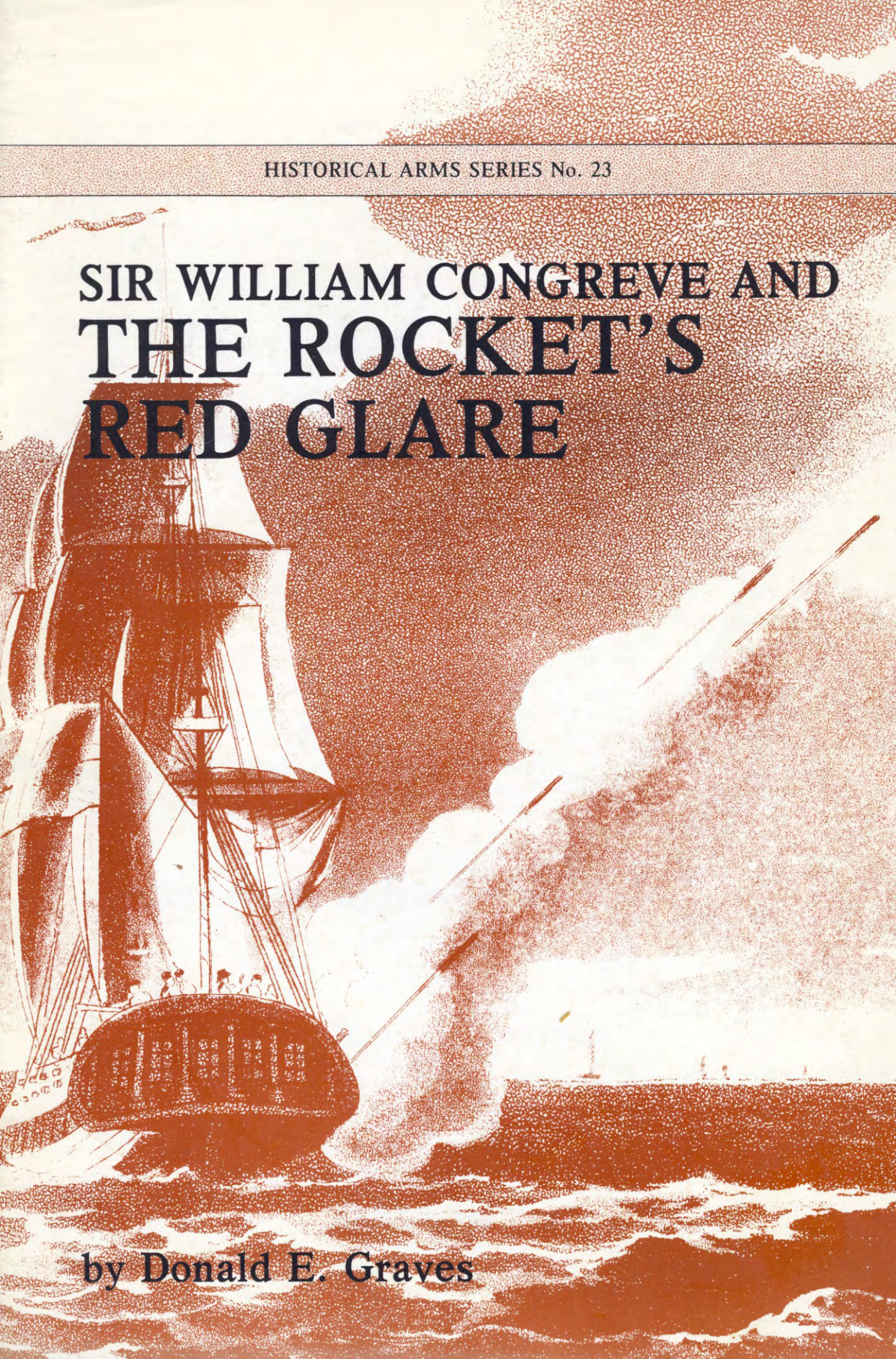
HISTORICAL ARMS SERIES No. 23

SIR WILLIAM CONGREVE AND THE ROCKET'S RED GLARE



by Donald E. Graves

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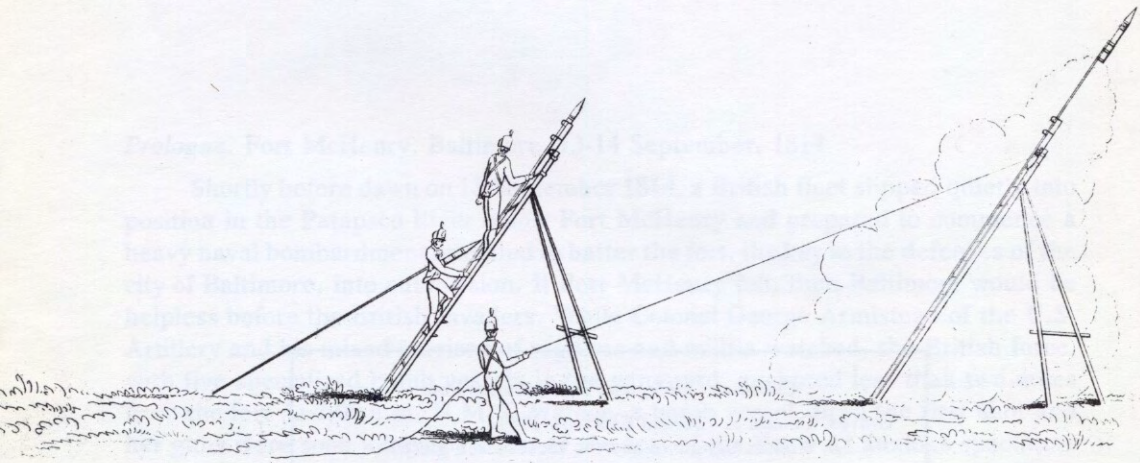

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SIR WILLIAM CONGREVE

Prologue: Fort McHenry, Baltimore, 13-14 September, 1814

Shortly before dawn on 13 September 1814, a British fleet slipped quietly into position in the Patapsco River below Fort McHenry and prepared to commence a heavy naval bombardment intended to batter the fort, the key to the defenses of the city of Baltimore, into submission. If Fort McHenry fell, then Baltimore would be helpless before the British invaders. While Colonel George Armistead of the U.S. Artillery and his mixed garrison of regulars and militia watched, the British force, with five specialized bomb vessels in the vanguard, anchored less than two miles from the fort At 7:00 a.m. H.M.S. *Meteor*, a bomb vessel, fired the first shot and her guns were soon joined by those of the rest of the fleet. As anxious spectators looked on, the little fort on Whetstone Point became obscured by the smoke of explosions punctuated by the flash of shell bursts but observers on both sides knew that as long as Fort McHenry's large "Stars and Stripes" flag was flying, the post was still in American hands.

The bombardment continued through the entire day of 13 September and the fort was the target of not only shot and shell from the conventional guns and mortars of the ships but also of a novel artillery weapon — Congreve rockets fired by H.M.S. *Erebus*, a sloop specially fitted for this service. The fiery contrails of the rockets and their spectacular explosions added to the visual drama of the scene for eyewitness Francis Scott Key. Key was a young lawyer aboard a British ship to negotiate the release of an American civilian who had been taken prisoner. Throughout the long day, he watched the bombardment. When night fell, Fort McHenry was still defiant and the British ships, one by one, began to cease fire. They renewed the bombardment with redoubled fury at 1:00 a.m. on 14th September to cover the attempted surprise landing of an amphibious force near the city. For three hours, Key, unable to sleep, witnessed the shell and rocket bursts over the fort and when the gunfire began to diminish at 4:00 a.m., he worried whether it and the city of Baltimore, had fallen to the British. As dawn crept over the Patapsco on 14

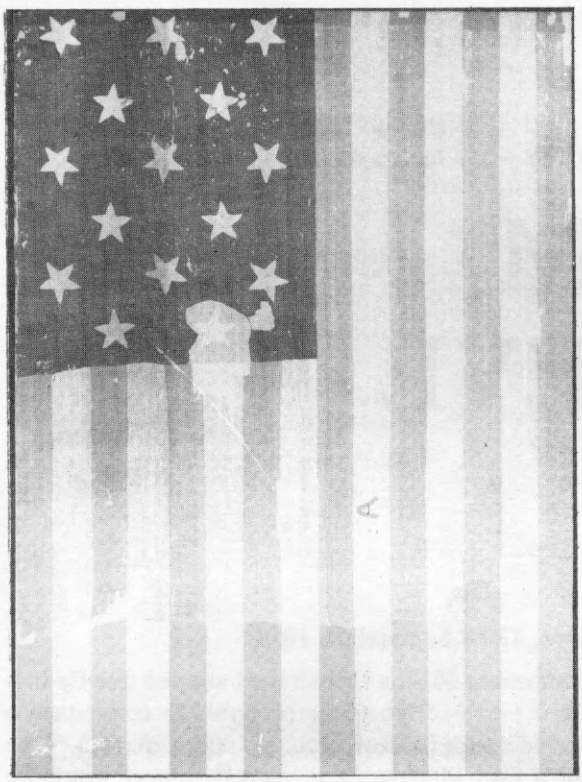


Figure 1. "Old Glory." The flag that Francis Scott Key eagerly looked for as dawn broke over the beleaguered Fort McHenry on 14 September 1814. This large, forty by thirty-two foot garrison flag was made to the special order of Lt. Col. George Armistead, commander of Fort McHenry. *Smithsonian Institution collection.*

September, Key anxiously trained his telescope on the fort and "Through the clouds of the war the stars of that banner still shone in my view." [1] The British attack had failed, — Fort McHenry and Baltimore were safe. Inspired by this sight, Key began to compose a poem that, set to music, would eventually become the national anthem of the United States of America. In the stirring first stanza, he described the battle he had witnessed:

O say can you see, by the dawn's early light,
What so proudly we hailed at the twilight's last gleaming
Whose broad stripes and bright stars through the perilous fight,
O'er the ramparts we watched, were so gallantly streaming?
And the rocket's red glare, the Bombs bursting in air,
Gave proof through the night that our Flag was still there; [2]

In immortalizing the gallant defense of Fort McHenry, Francis Scott Key also immortalized, in the phrase "and the rocket's red glare" one of the more curious weapons of the Napoleonic Wars — the rocket system of Sir William Congreve.

Sir William Congreve, Practical Genius

William Congreve was born in 1772 into a distinguished British Army family. His father, William Congreve, the elder, was an artillery officer who, throughout his career, demonstrated an interest in the technical side of ordnance matters. In 1778, Congreve the elder was appointed Superintendent of the Royal Military Repository at Woolwich and, in 1783, became the Comptroller of the Royal Laboratory,

Photograph courtesy *The National Army Museum*

Sir William Congreve
1772-1828
"Congreve the Younger"

positions which gave him tremendous influence in the design and production of new weapons and equipment for the Royal Artillery. Congreve the elder had a distinguished career, becoming Colonel Commandant of the Royal Artillery in 1803, lieutenant general in 1808 and a baronet in 1812. [3] His son, William Congreve the younger, never held a regular commission in the British Army although he did receive the largely honorary rank of lieutenant-colonel in the Hanoverian Army. [4]

William Congreve seems to have early evinced an interest in engineering and assisted his father in experiments at the Royal Military Laboratory. Although he is best known for his military projects, Congreve's inventive mind involved him in many different scientific endeavors. In 1808 he registered a patent for a new form of clockwork that worked on gravity and which came close to achieving mankind's elusive dream of perpetual motion. [5] In 1814 Congreve published the results of his research into a "hydro-pneumatic lock" and five years later, described his new design of steam engine which he claimed to be more powerful and fuel-efficient than those currently in use. Towards the end of his life, Congreve became interested in currency reform and in the means of safeguarding against forgery and wrote a number of pamphlets on these subjects. He established that the best security against forgery of paper currency was to be found in the use of very fine and detailed relief engraving in different colors, a system that was used by the banks of major nations for nearly 150 years. A restless but prolific genius, Congreve's work always had a profoundly practical bent and, by the time of his death, he had patented at least eighteen inventions.

Congreve was an extreme patriot and did some of his best work on military and naval projects. He recognized that Britain, engaged in a 20-year death struggle

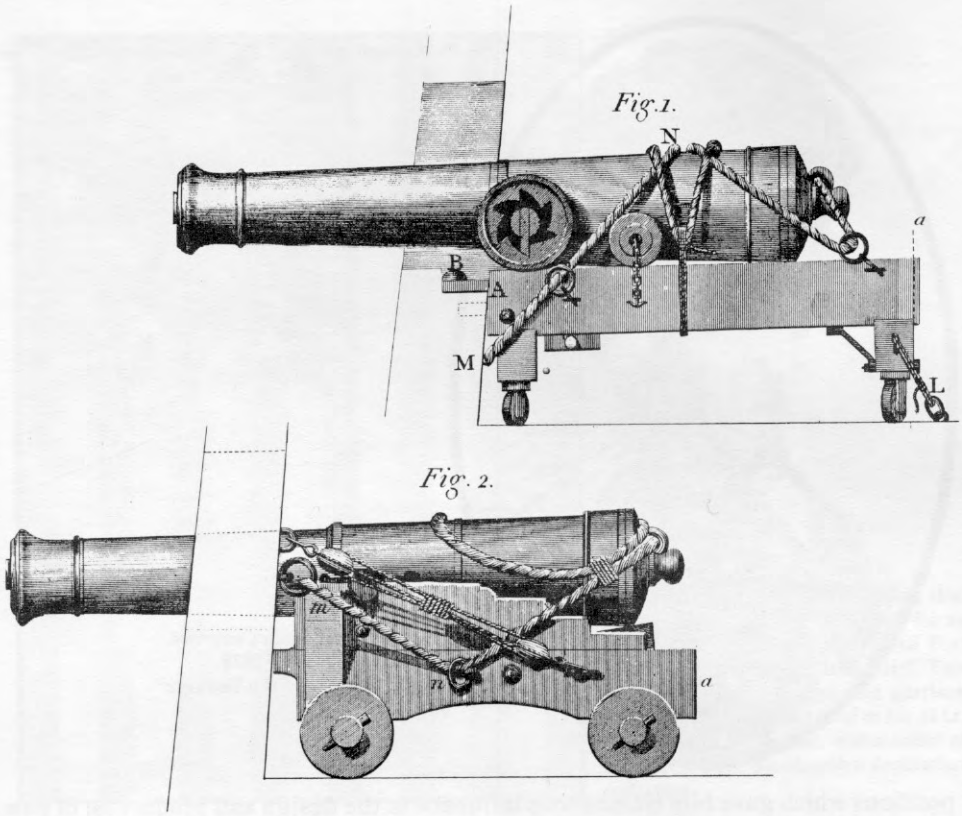


Figure 3. Congreve's plan for the mounting of naval ordnance. The recoil was absorbed by the ratchet gear mounted under the piece. This allowed for quicker return of the piece to action and quicker firing. It also made the carriage lighter and easier to traverse in action and to stow when not in action. The lower illustration depicts the standard method of mounting naval ordnance during this period. The considerable recoil of the gun was stopped by a strong rope, called the Breeching, passed through an eye on the breech of the gun, at which point it was in position for loading with the muzzle just inside the gun port. From *Elementary Treatise on the Mounting of Naval Ordnance,* 1811.

with Napoleonic France, had limited amounts of human, material and financial resources and these had to be utilized in the most efficient and productive manner possible. As Congreve stated in 1811:

> . . . England is now at war with one half of the world, and has the other half to defend! Need one say more to prove that, with a limited population, the ordinary implements of war cannot suffice — that it is one of the first interests of the government to hold this forth as an era for the improvement of military mechanics, . . . that we may thereby take the lead of the enemy in those mechanical aids, which are calculated to increase the powers of our navies and armies, and having got it, that we may maintain it. [6]

This was a thoroughly practical and rational philosophy for a wartime inventor and Congreve applied his technical genius in three significant military projects. The first of these was the rocket system described in detail below; the second was the mounting and aiming of naval ordnance and the third, the production of gunpowder.

Congreve believed that improvements in naval ordnance that would require fewer men to man the guns on board ships would render the Royal Navy more effective against its enemies. [7] His first patent for a naval "gun carriage of the simplest construction" was registered on 24 May 1808 and practical experiments with

Figure 4. Early war rockets and a primitive launching apparatus from J. Hanzelet's *Traites Militaires* published in 1598, after Scoffern, *Projectile Weapons of War,* London, 1858. Although the Chinese had used rockets for centuries, the first recorded use of war rockets in Europe was by the Paduans at the siege of Chiozza in northern Italy in 1379. In the late 17th and early 18th centuries, rockets were relegated to signalling devices and amusements. Congreve restored them to their military role during the Napoleonic period.

this weapon were successfully carried out in 1810 and 1811. [8] Further improvements in his system of mounting naval ordnance led to another patent being registered by Congreve on 11 May 1812. [9] At about the same time, Congreve designed a new 24-pdr. medium gun for the navy and, expanding on an idea of his father, Lieutenant-General Sir William Congreve, proposed a new method for sighting naval ordnance. [10] Congreve the younger was also involved in the improvements in the manufacture of gunpowder begun by his father who, in 1787, had taken the suggestions of Richard Watson, Bishop of Llandaff, and instituted the manufacture of cylinder gunpowder, as opposed to pit powder, in British powder mills. [11] Congreve refined his father's methods and, in 1815, was granted a patent for an improved method of manufacturing gunpowder.

Congreve's services to his country brought him the favor of the Prince Regent (the actual head of state) and much public esteem. He was chosen a Fellow of the Royal Society and commissioned a lieutenant-colonel in the Hanoverian artillery. With his father's death in 1814, Congreve succeeded him as baronet and was appointed Comptroller of the Royal Laboratory and Superintendent of Military Machines at Woolwich. Further honors followed. Congreve became a Knight of the Royal Guelphic Order of Hanover in 1816 and, in 1821, when the Prince Regent came to the throne as George IV, Congreve was appointed his Chief Equerry. In addition to his engineering pursuits, William also followed a political career, being elected as the Member of Parliament for Gatton in 1812 and serving as the member for Plymouth from 1820 until his death in 1828. Having lived an industrious and productive life, William Congreve accomplished many tasks that were of benefit both to his country and to science but his name will always be inextricably linked with the invention that bore his name — the Congreve rocket. [12]

The Origin and Introduction of the Rocket System

The principle of the propulsion of rockets is the reverse of that of conventional artillery. Whereas, in firearms, the sudden expansion of explosive gases in the con-

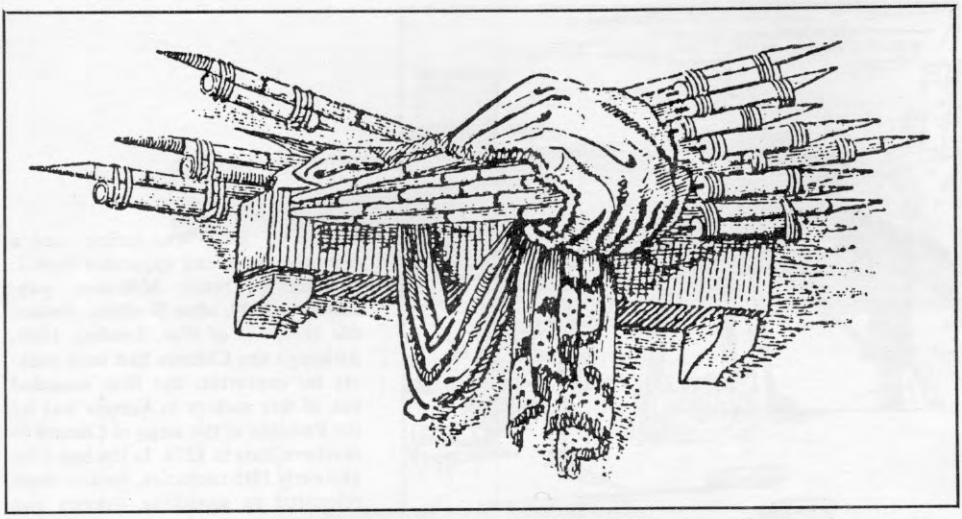


Figure 5. Indian war rockets, an illustration from the title page of *Sketches chiefly relating to the history, religion, learning, and manners, of the Hindoos*, an anonymous book published by T. Cadell at London in 1790.

fined space of the breech forces the projectile out of the bore of the weapon, the propellant in rockets is contained in the projectile itself and the explosive gases, discharging backwards from the projectile, impel it forward at an ever increasing velocity. The principle of rocket propulsion was understood by the ancient Greeks who amused themselves by making a sphere filled with water which, when heated, rotated by means of four jets that allowed the steam to escape. The Chinese are credited with the first warlike use of rockets propelled by gunpowder, an event said to have occurred in 1272, although it probably happened much earlier as, in 1275, Marco Polo brought examples of Chinese war rockets back from his travels. War rockets powered by gunpowder were used by both the Mongols and the Arabs in the 13th century. Their first recorded use in European warfare seems to have been at Chiozza, in northern Ialy, by the Paduans in 1379. By the beginning of the 16th century, knowledge of war rockets was common in Europe. Hanzelet included a crude drawing of such weapons mounted on a primitive launching device in his *Traites Militaires* of 1598. In 1668, the German von Geisslet of Berlin projected shells or bombs into the air by means of large rockets. The use of rockets as a weapon was overtaken by the advances made in the 17th and 18th centuries by conventional artillery and they came to be regarded as an interesting novelty suitable for firework displays and signalling. Details of their construction were well known and information about skyrockets for signalling can be found in the technical treatises of the Royal Artillery in the 18th century and in the semi-official *Little Bombardier & Pocket Gunner* of 1801. [13]

If the European nations did not regard the rocket as a serious weapon, the eastern nations, especially the Indian states, did and used them in battle. In 1780, a British army was unpleasantly surprised and defeated at the battle of Guntor by Hyder Ali of Mysore whose army was equipped with rockets. Hyder Ali's son, Tippoo Sahib, increased the number of rocket troops in his army to 5,000 men armed with iron-cased rockets weighing from six to twelve pounds and guided by bamboo poles ten feet long. [14] These projectiles could achieve a range of 1,000 yards and,

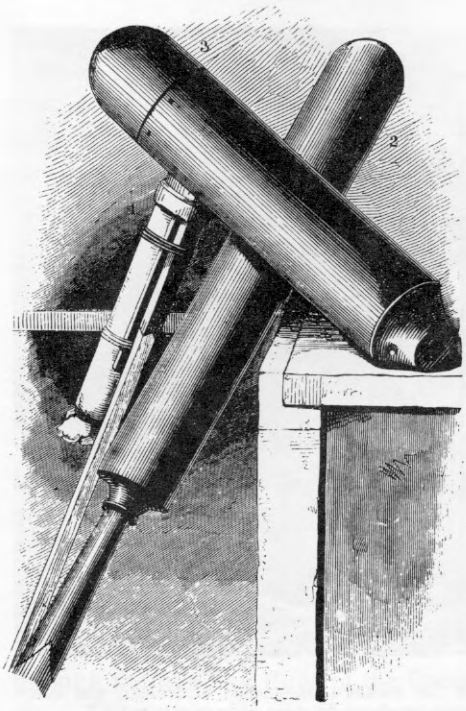


Figure 6. Study of the ordinary sky rocket, the later type Congreve rocket, and Hale's rocket developed about 1845. Note the perforated holes in the baseplate of Hale's rocket. These imparted a rotational spin to the projectile, increasing its accuracy and doing away with the need for a launching stick. Congreve's rocket was not declared obsolete in the British service until 1866.

although wildly erratic, proved to be effective against the native troops of the East India Company. Tippoo Sahib's use of rockets at the sieges of Seringapatam in 1792 and 1799 interested the Board of Ordnance in the potential use of rockets as a weapon and the Board requested the Royal Military Laboratory at Woolwich to investigate the concept. In 1804, William Congreve the younger took up the problem and began the development of a new weapon system. [15]

Congreve began his investigation by buying the best commercial rockets available in England but he found that these fireworks would only reach a range of 600 yards, not as far as the Indian weapons. Using his own funds, he manufactured rockets of his own design and produced a model that could achieve 1,500 yards. Congreve then applied for, and received, permission to have large rockets made at Woolwich and, in 1805, produced a 6-pdr. rocket that could reach a range of 2,000 yards. These early Congreve rockets were basically improved commercial types with casings made from cardboard and filled with a gunpowder-like composition. [16]

Congreve was enthusiastic about the capabilities of his new weapon and, probably having in mind a memoir he himself had written in 1804 on the possibility of using mortar boats to attack the French invasion fleets gathering in the Channel ports, he suggested to Prime Minister William Pitt (the younger) that his rockets might be the ideal weapon for use against this target. After a demonstration of the rockets, Pitt ordered Admiral Keith, the commander of the Channel fleet, to give the new weapons a fair trial. On 19 November 1805, Congreve accompanied a small flotilla of 10 launches, equipped with his rockets, that attempted to enter Boulogne harbor and destroy the assembled shipping. High seas prevented the rockets from being fired and the attack was cancelled. It was to be nearly a year before the wea-

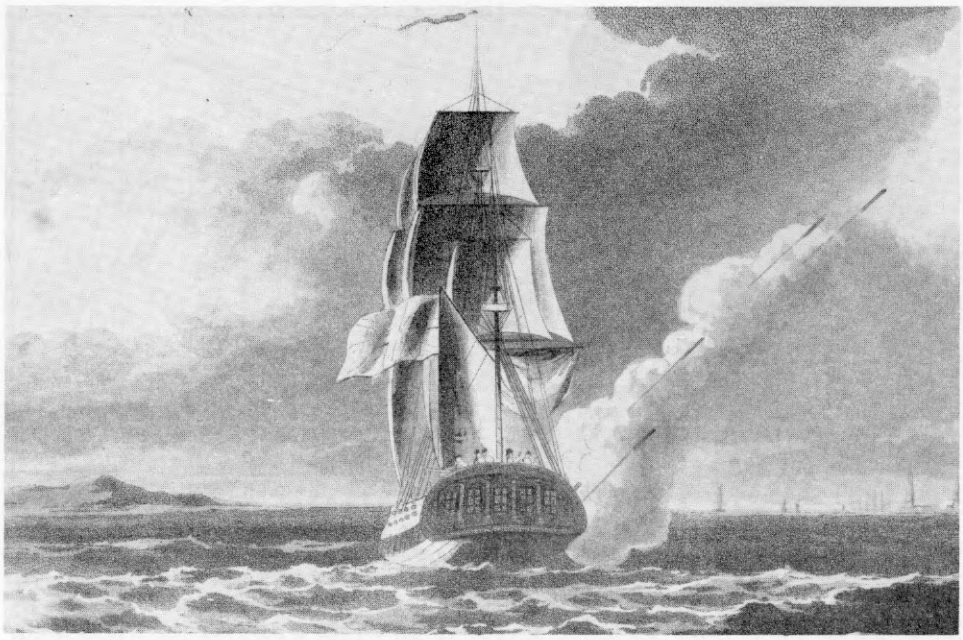


Figure 7. Rocket vessel firing her broadside. Given the rocket's dangerous afterblast, the commanders of these vessels must have watched with some trepidation as their very flammable wooden craft were used for launching platforms. H.M.S. *Erebus,* the rocket vessel that fired on Fort McHenry, would have looked like this during the bombardment.

pons would again be tested and Congreve used this time to improve his design. Taking the advice of several senior naval officers, he produced improved 24 and 32-pdr. models manufactured out of sheet iron. The 32-pdr. rocket with a 10-inch head achieved a range of 3,000 yards and was to become Congreve's standard and most widely-used model. [17]

On 8 October 1806, Congreve participated in a second rocket attack on Boulogne. Under cover of darkness, 24 boats each equipped with two frames for launching 24-pdr. rockets crept in close to the harbor and fired 200 projectiles in the space of 30 minutes. Portions of the town were set on fire although the invasion shipping was not harmed. Congreve was wildly enthusiastic about the results of this attack but the senior naval officer, Owen, was more objective and noted that Congreve's idea that rockets could be ricocheted off the surface of the water into the anchored ships had proved to be unrealistic. Although the 1806 attack had had only limited success, Congreve's rockets were now an established weapon in the British naval arsenal. [18]

A year followed before they were again used in a major bombardment, a year that Congreve put to good use making further improvements. In November 1807, after the refusal of Denmark to surrender its fleet to Britain, a British naval squadron bombarded and largely destroyed the city of Copenhagen. Congreve's rockets played a prominent role in the bombardment — approximately 2,500 were fired from launches and from a new weapon, the rocket ship, a sloop-of-war fitted out to fire rockets. Many of the rockets fired at Copenhagen never hit their target but they had a dramatic effect on the Danes who, as one eyewitness described it, " were very much afraid of the rockets" which " had burnt a great many houses, and be-

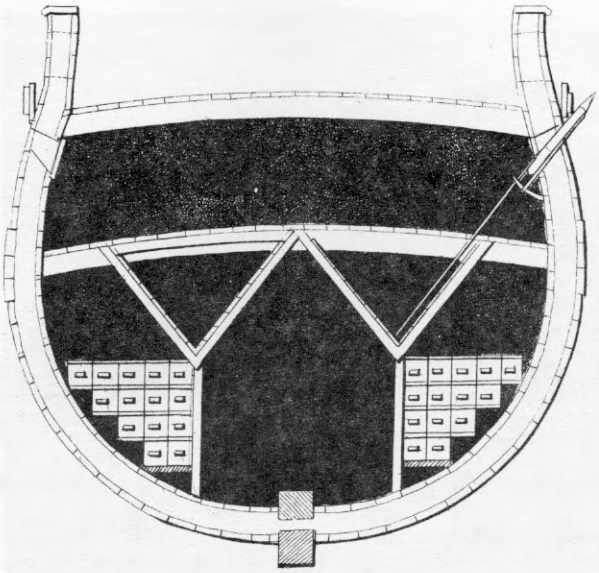


Figure 8. Section of a rocket vessel such as H.M.S *Erebus* or *Galquo*. The launching apparatus consisted of a frame in the hold of the ship supporting the stick which came up through openings in the lower deck to connect with the projectile which rested in a stand on the bulwark of the lower deck. It was aimed through a small port or scuttle in the ship's side. Note the screen around the after part of the projectile to deflect the rocket's afterblast.

sides, warehouses . . . I saw a house . . . which was struck by a rocket which went through the roof and three of the floors, and stuck into the side of the wall." [19]

The next major use of rockets was during the Walcheren expedition of 1809 when H.M.S. *Galquo*, a rocketship, formed part of the fleet accompanying a British force that was landed in the Scheldt Estuary. Under Congreve's personal command, a unit of Royal Marine Artillery equipped with rockets participated in the bombardment of Flushing which soon capitulated after the French commander made a formal protest against their use. [20]

The Rocket at War in Europe and North America, 1810-1815

By 1809, the rocket was accepted as a useful weapon for the naval bombardment of shore installations but Congreve wanted to extend its use to the land service as well. He published a number of pamphlets on the superiority of the rocket against traditional artillery and developed methods of utilizing it in land warfare. Congreve had early obtained the patronage of the Prince Regent and with the backing of this powerful figure, he was successful in having units of rocket troops raised for the army. Although he had little use for the weapon, having served in India against the forces of Tippoo Sahib, even Wellington accepted a troop of rocket artillery into his army in Spain. In fact, he was eager to have them — not for the weapon because "I do not want to set fire to any towns, and I do not know any other use of the rockets," but to get the horses accompanying the troop which he desperately needed for his conventional artillery. [21] At the first opportunity, Wellington ordered the rocket troop be equipped with guns and when told that this order would break the commander's heart, an unsympathetic Duke replied "Damn his heart; let my order be obeyed." [22] By the end of the Napoleonic Wars in 1815, Congreve's rockets were in widespread use in both the British Army and the Royal Navy. [23]

Detachments of rocket troops for the army were formed at Woolwich from gunners of the Royal Horse Artillery in January 1813. One of these detachments proceeded to Spain to join Wellington's army; another, under the command of Cap-

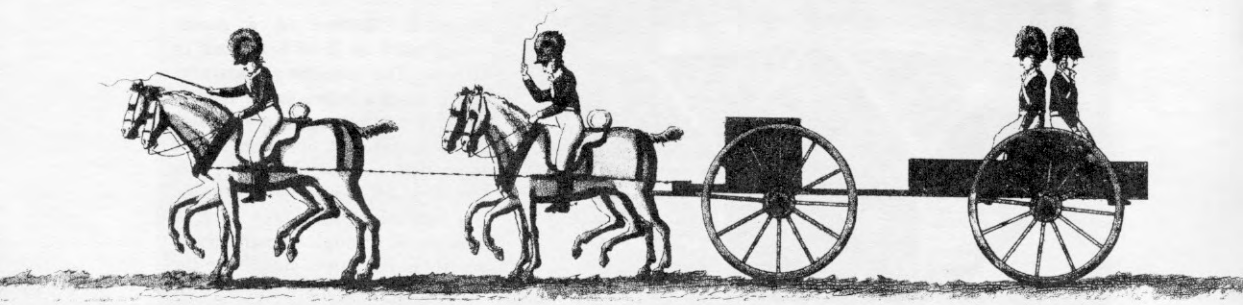


Figure 9. This specially designed "rocket car" was constructed in two sections — one to carry the warheads and projectiles, the other to carry the launching sticks. Equipment like this was used by R.H.A. rocket troops in Spain and North America in 1813-1815 who were equipped with the medium caliber rockets.

tain John Bogue, joined the allied army operating against Napoleon in Germany where it was attached to the Swedish forces. At the battle of Leipzig in 1813, Bougue's detachment put to flight a brigade of French infantry who were panicked by the new weapon. Bogue was killed in the battle but his second in command, Lt. Fox Strangways, was personally decorated on the spot by Czar Alexander of Russia who, with the other allied sovereigns, had witnessed the rocketeers' success. In 1814, the R.H.A. rocket detachments overseas were designated the 2nd Rocket Troop and put under the command of Captain E.C. Whinyates. This troop was present at the battles of Quatre Bras and Waterloo. The units in England were designated the 1st Rocket Troop under the command of Captain W.G. Elliott. A detachment of this unit participated in the New Orleans campaign of 1814-1815. [24]

The Royal Navy had earlier raised units of rocket troops and Congreve had personally trained detachments of the Royal Marine Artillery to man the rocket launches in the Boulogne attacks. The R.M.A. became specialists in the use of the new weapons and used it at Copenhagen in 1807, Flushing in 1809 and in several attacks along the northern coast of Spain in 1811-1812. Throughout this period, marine artillerymen were constantly training at Woolwich in the use of rockets. The navy also fitted out rocket ships, notably H.M.S. *Galquo* which took part in the Walcheren expedition and H.M.S. *Erebus* which participated in the attack on Fort McHenry. [25]

But it was in North America that rockets were most widely used and, to the citizens of the United States, they became a symbol of British oppression. This was due to the fact that British naval commanders often fired rockets at coastal installations and towns as a preliminary to launching raids and the damage and loss of property caused by these attacks was much resented. In 1813, the rockets used in these coastal actions were usually served by a R.M.A. rocket company that had been dispatched to North America direct from Woolwich. This company saw action in an attack on Hampton, Virginia, in June 1813, and in a raid on Ocracoke Inlet, North

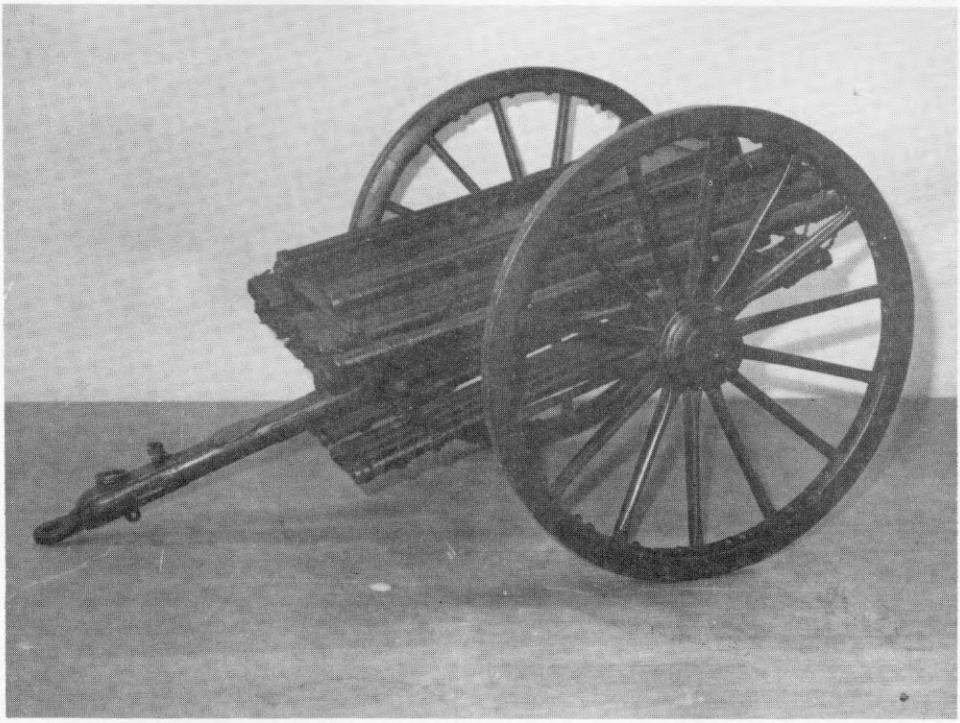


Figure 10. Congreve volley carriage fitted with 34 tubes and ammunition limber. The illustrations of models which are now in the The Royal Artillery Museum at Woolwich were probably produced for Congreve about the time of his appointment in 1814 as Superintendant of Military Machines at Woolwich.

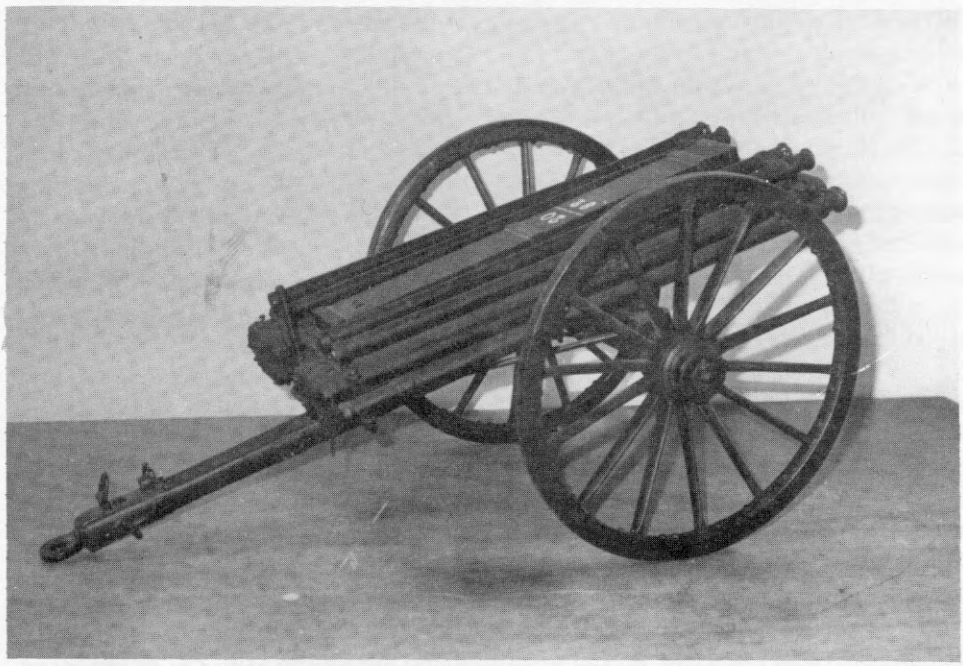


Figure 11. Model of a volley carriage fitted with 22 tubes and limber. This is post-1815 equipment. Courtesy *The Royal Artillery Museum, Woolwich.*

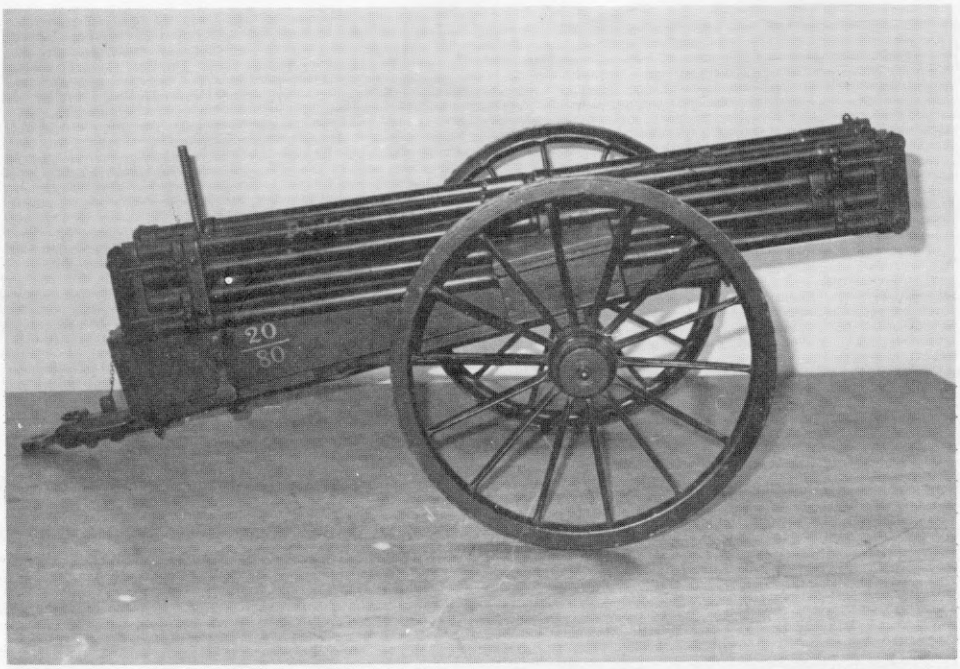


Figure 12. Model of a Congreve 12 pdr. volley carriage with ten tubes and 40 rounds of ammunition. Courtesy *The Royal Artillery Museum, Woolwich.*

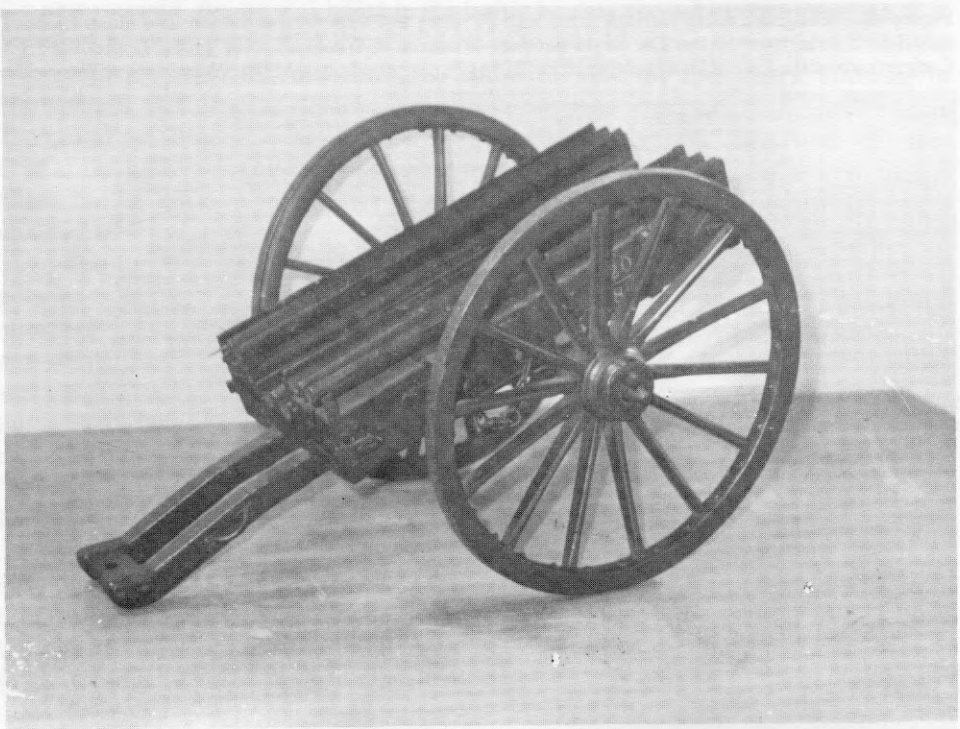


Figure 13 Model of a rocket carriage fitted with six open troughs and ammunition boxes. The carriage also carries a double trough, Bengal pattern. Courtesy The Royal Artillery Museum, Woolwich.

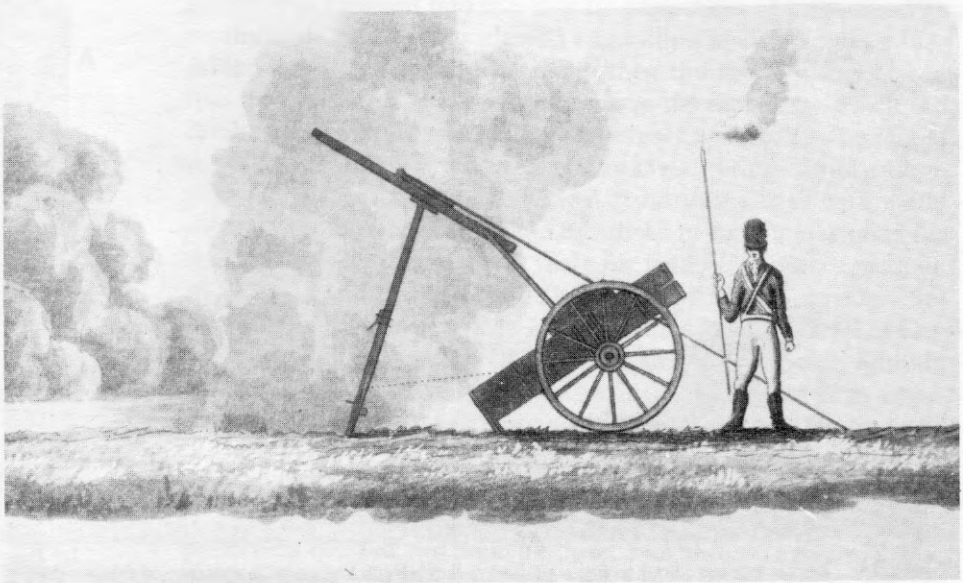


Figure 14. Rocket troops with the rocket car in firing positon. A launching trough on a tripod stands with a rocket ready to be fired by the gunner stationed behind it holding the port fire. The rocket car holding the projectiles and warheads was stationed a safe distance to the rear with a gunner ready to replenish the launching apparatus as required.

Carolina, in July. In September 1813, the R.M.A. rocket company was transferred to Canada and was present at the battle of LaColle Mill, Quebec, in March and the capture of Oswego, New York in May 1814. Sgt. Austin and a rocket detachment of the R.M.A. fought at the bloody battle of Lundy's Lane near Niagara Falls on 25 July 1814, and it was claimed that a rocket may have been responsible for wounding the American commander, Major General Jacob Brown. [26]

R.M.A. rocket troops played a major role in the British invasion of the Chesapeake in the late summer of 1814. A marine land rocket unit fired at a flotilla of U.S. gunboats at Benedict and was present at the battle of Bladensburg near Washington on 24 August where an eyewitness reported that "A few rockets, passing close over the heads of the American militia battalions . . . started them running and they bolted off and could not be stopped." [27] This same unit was in action at the battle of the North Point on 12 September 1814. [28]

While the British Army under Major General Robert Ross marched against Washington on land along the Chesapeake, a flotilla of Royal Navy ships proceeded up the Potomac to Alexandria, Virginia as a diversion. Among these ships was H.M.S. *Erebus*, equipped to fire 10 rockets from each of her sides as well as her regular broadside guns. The rockets of *Erebus* were served by an R.M.A. detachment under the command of Lt. T.S. Beauchant. The British flotilla made its way successfully up the Potomac but had to run a gauntlet of American shore batteries on their return. Several ships ran aground and were only refloated with the utmost difficulty while under constant American fire and *Erebus* and her rockets were engaged on several occasions. [29] The last major use of rockets on the Eastern seaboard of the U.S. was during the bombardment of Fort McHenry described above. Although Lt. Beauchant and his R.M.A. gunners fired their rockets throughout the

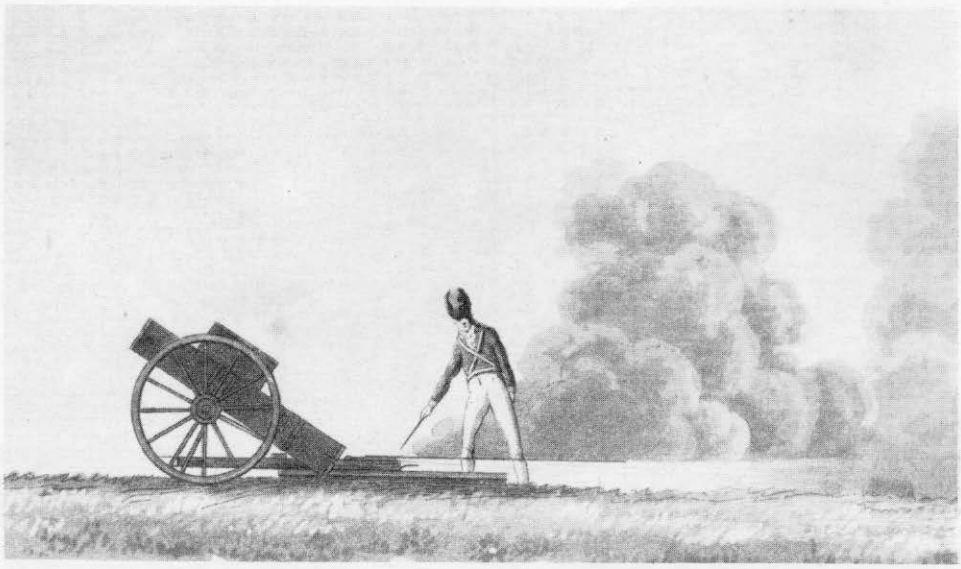


Figure 15. Rocket gunner about to fire a ground rocket. Given the great inaccuracy of this method of firing, rocket troops probably preferred to use the launching apparatus.

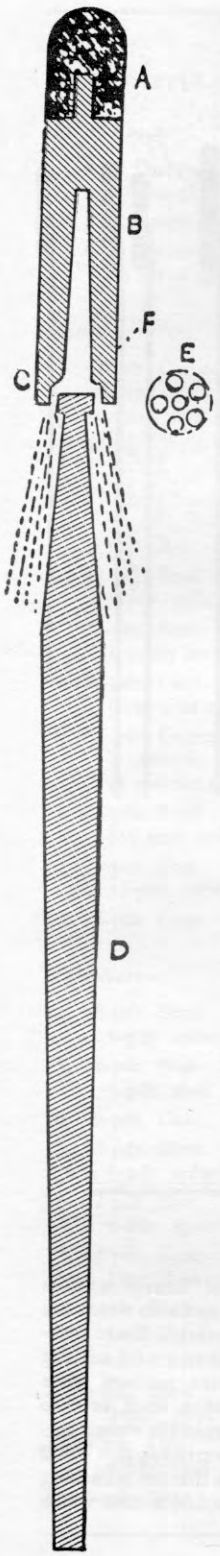
attack, not one hit is mentioned by Lt. Col. George Armistead, the fort's commander, in his official report of the action. [30]

Rockets were again in action in the closing stages of the War of 1812. A detachment of the 1st Rocket Troop, Royal Horse Artillery, commanded by Capt. Henry Lane, was part of the British force which attacked New Orleans in December, 1814. This detachment served throughout the campaign and were present at the battle of 8 January, 1815, on both sides of the river. When, having failed to capture the city, the British retreated, the rocket detachment acted as the artillery rearguard of the army. [31] The Congreve rockets did not play a major role in this campaign as they proved to be ineffective against an American army that was well led, motivated and entrenched.

The Congreve Rocket System, 1807-1814: Description and Performance

By the end of the Napoleonic Wars, William Congreve had developed a complete rocket system with a variety of projectiles, war heads and variations of launching apparatus suitable for different military uses. From the largest 8-inch carcass or explosion rocket to the smallest 6-pdr. rocket, the construction of the projectiles was similar and based on the construction of the skyrockets Congreve had first experimented with in 1804. In essence, the always practical Congreve did not invent a new weapon but took an existing one and improved it. The description below of the rocket system as it stood in 1814-1815 is taken from Congreve's 1814 work, *Details of the Rocket System.* [32]

Congreve rockets consisted of three basic parts: a case, a war head and a launching stick. The case of the rocket was manufactured from a cylinder of sheet iron wrapped with fine wire of about the same thickness as the iron of the case. The case was filled with a combustible mixture similar to gunpowder and composed of nitrate of potash, sulphur and carbon. This combustible mixture (the "fuel" of the



rocket) was rammed into the case by some form of pressure. The combustible mixture was pierced by a hollow shaft that was either drilled into it or created by a mold when the mixture was placed into the case. This shaft or opening was the means by which the combustible mixture was rapidly and evenly ignited. The bottom of the case was sealed with a piece of gun metal (bronze) with a large perforation for the ignition shaft. Affixed to the case with metal clamps was the launching stick; the sticks of rockets designed for sea service were in one piece, those for land service were made in several pieces for easy carriage and jointed with iron ferrules. Separated from the combustible mixture with a layer of metal or clay was the war head which could be either solid or explosive. Ignition of the explosive war heads was accomplished by means of an external fuse of paper which was cut to any desired length for up to 25 seconds of flight and which was communicated to the war head by means of an external tube on the case of the rocket.

By 1814, Congreve's system consisted of 10 major types of projectiles divided, by their purpose, into three "natures." The heavy nature consisting of 8, 7 and 6-inch explosion or carcass rockets designed to destroy buildings and to be fired from ships or, on land, from large ladder-like frames. These rockets had no war heads as such, the combustible mixture acted as an incendiary and the heads of these weapons were formed in a point to increase their penetration powers. These heavy rockets were employed by the Royal Navy and Royal Marine Artillery for the bombardment of cities and fortified installations.

The medium nature consisted of 42, 32, and 24-pdr. rockets which were much lighter and more mobile than those of the heavy nature. The 42-pdr. was strictly an incendiary but the 32-pdr.

Figure 16. John Scoffern writing in *Projectile Weapons of War and Explosive Compounds* (editions in 1845, 1852, 1858, 1859), records "war rockets were precisely similar in form (to the common sky rocket); only their cases were of iron instead of paper, and instead of being headed with ornamental stars, they carried balls, shells, carcasses, &c. according to the use for which they were intended. The construction of the war rocket, as at present modified, will be rendered intelligible by the annexed diagram (The stick is represented somewhat short, for the sake of convenience. The actual length of the 6-lb. rocket stick is *seven feet*, of the 12-lb. rocket stick, *nine feet*).

The part A indicates the piece of iron attached to the end of the rocket, and serving as a shot:—it might have been a shell, a carcass, &c. B corresponds with the body of the rocket, filled with composition [sulphur, saltpetre and charcoal — the same ingredients as gunpowder but in different proportions], and perforated as in a common rocket; the base of this conical opening expands, it will be observed, into a chamber F, which is absolutely necessary, in order to prevent the rocket bursting; although this necessity adds greatly to the mechanical difficulties which must be encountered. C represents a sectional view of a piece of gun-metal, a front view of which is shown by E. In this piece consists the great peculiarity of the Congreve rocket; enabling the stick, or rather the iron with which it is shod, to be screwed into the central opening, whilst the five peripheral orifices communicating with the hollow cone (of which the section of two only are seen in the diagram of the rocket), serve as vents to the flame; and correspond with the one central opening in the common sky rocket. When the rocket composition burns out, the shell charge is not ignited immediately; but takes fire through the intervention of a fuse."

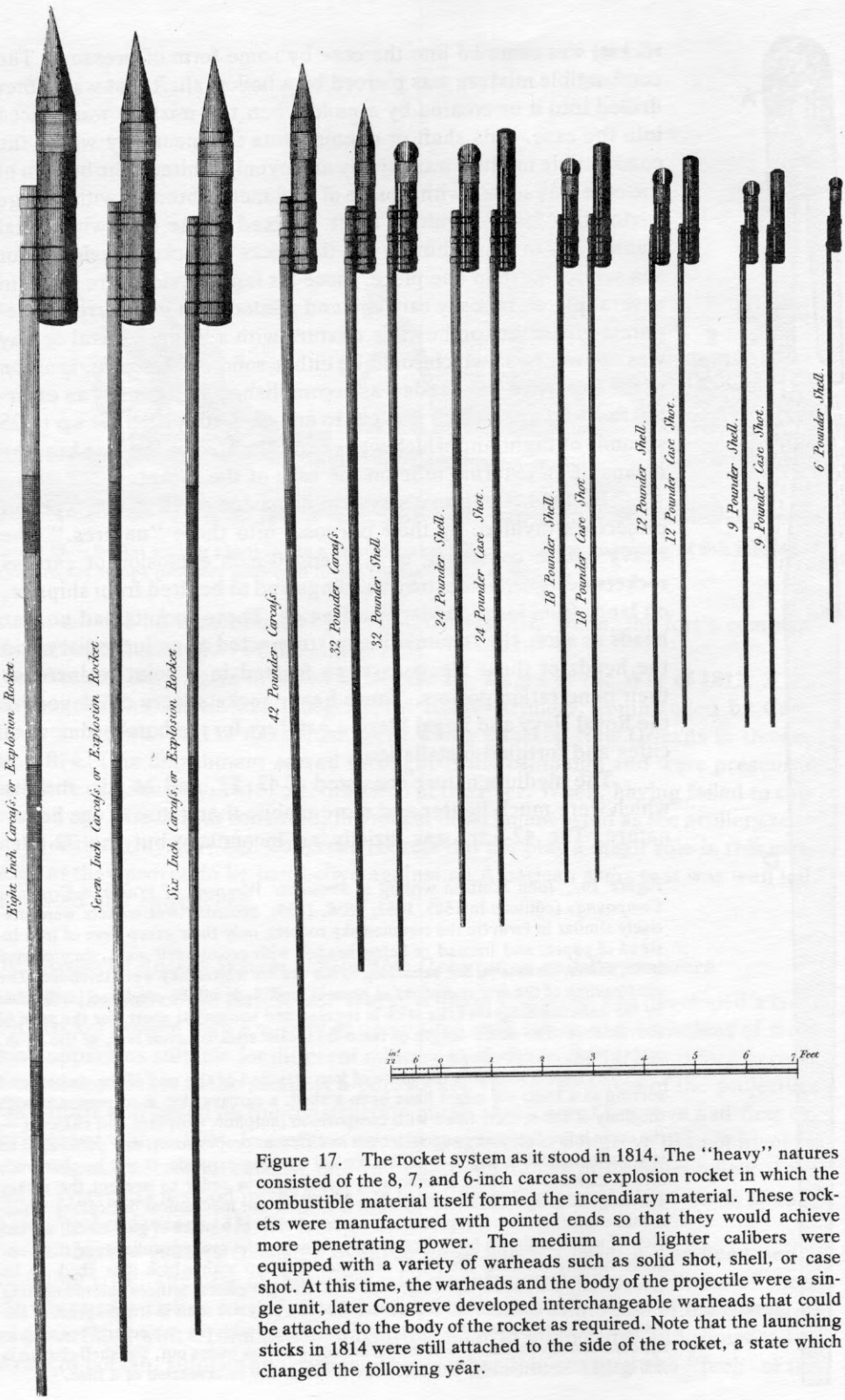


Figure 17. The rocket system as it stood in 1814. The "heavy" natures consisted of the 8, 7, and 6-inch carcass or explosion rocket in which the combustible material itself formed the incendiary material. These rockets were manufactured with pointed ends so that they would achieve more penetrating power. The medium and lighter calibers were equipped with a variety of warheads such as solid shot, shell, or case shot. At this time, the warheads and the body of the projectile were a single unit, later Congreve developed interchangeable warheads that could be attached to the body of the rocket as required. Note that the launching sticks in 1814 were still attached to the side of the rocket, a state which changed the following year.

TABLE 1: THE CONGREVE ROCKET SYSTEM, 1814

ROCKET TYPES & DETAILS OF WAR HEAD	SERVICE USE
Heavy Nature	
1. 8 in. Carcass or Explosion 50 lbs. of combustible mixture	Bombardment by Royal Navy & Royal Marine Artillery
2. 7 in. Carcass or Explosion	
3. 6 in. Carcass or Explosion 25 lbs of combustible mixture	
Medium Nature	
4. 42-pdr. Carcass The large armed with 18 lbs. combustible mixture, the small with 12 lbs.	
5. 42-pdr. Shell Either a 5½ inch howitzer or 12-pdr. spherical shell	
6. 32-pdr. Carcass Varying amounts of combustible mixture from 12 to 18 lbs.	Bombardment by R.N. & R.M.A., Field service by Royal Horse Artillery & R.M.A.
7. 32-pdr. Shell 9-pdr. spherical shell	
8. 32-pdr. Shot Usually an 18-pdr. shot but sometimes a 24-pdr.	
9. 32-pdr. Case Case shot containing either 200 or 100 carbine balls	
10. 32-pdr. Explosion Topped by a strong iron cone containing from 5 to 12 lbs. of powder ignited by a fuse	
11. 24-pdr. Shell 5½ inch shell	Field service by R.H.A. & R.M.A.
12. 24-pdr. Shot 12-pdr. shot	
13. 24-pdr. Case	
Light Nature	
14. 18-pdr. Shell 9-pdr. spherical shell	
15. 18-pdr. Shot 9-pdr. shot	
16. 18-pdr. Case	
17. 12-pdr. Shell 6-pdr. spherical shell	
18. 12-pdr. Shot 6-pdr. spherical shot	
19. 12-pdr. Case Case shot containing either 72 or 48 carbine balls	
20. 9-pdr. Shell Grenade	
21. 9-pdr. Case	
22. 6-pdr. Shell 3-pdr. shell	
23. 6-pdr. Shot 3-pdr. shot	
24. 6-pdr. Case	

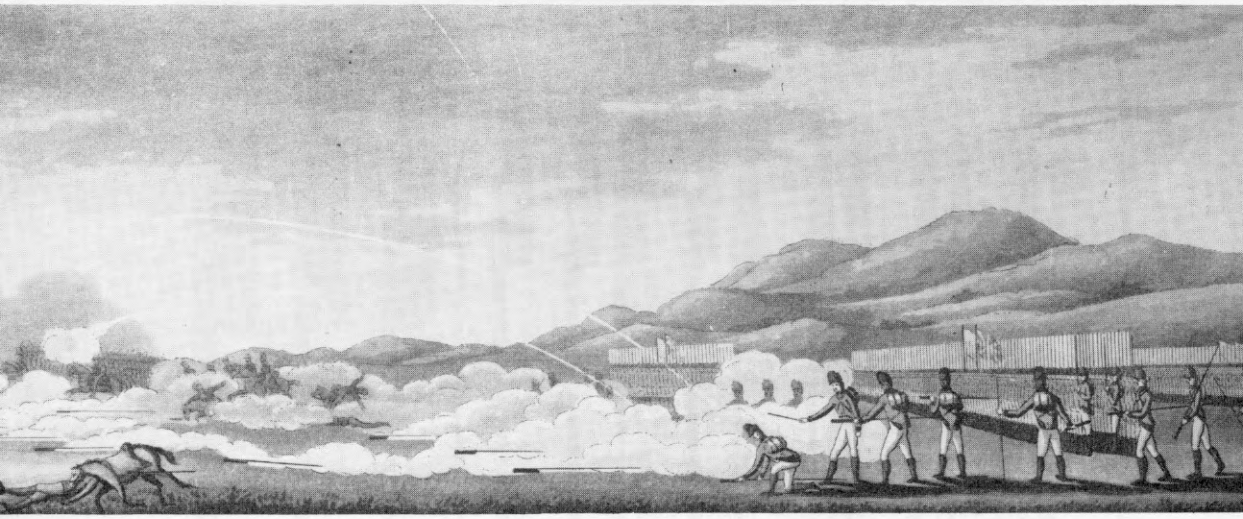


Figure 18. Rocket Troops of the Royal Marine Artillery firing a ground volley of lighter caliber rockets. Captain Richard Bogue's rocket detachment of the R.H.A. attached to the bodyguard of the Crown Prince of Sweden put to flight a brigade of French infantry at the battle of Leipzig in 1813, the first time that Congreve rockets were used successfully in a major land battle. Given the rocket's notorious inaccuracy, their potential danger was less useful than their visual splendor. Illustration from *Details of the Rocket System*, 1814.

could be equipped with a 5½ inch howitzer shell or an 18-pdr. solid shot. The 24-pdr. could be mounted with a 5½ inch shell or a 12-pdr. shot. The shells and shot used for the rocket system were cast in an elliptical rather than spherical form, to reduce the resistance of the air. The medium rockets were used for the bombardment of cities and fortified installations and the 32 and 24-pdrs. were used aboard ships, rocket launches and formed a portion of the ammunition of the R.H.A. rocket troops.

The "light" nature consisted of 18, 12, 9 and 6-pdr. rockets equipped with a variety of war heads. The 18-pdr. rocket took a 9-pdr. shot or shell, the 12-pdr. took a 6-pdr. shot or shell, the 9-pdr. took a grenade and the 6-pdr. rocket, a 3-pdr. shot or shell. These rockets were used almost exclusively by the R.H.A. rocket troops and some were issued to every Royal Navy vessel as part of the ship's complement of ammunition.

All the rocket calibres from the 24-pdr. downwards could be manufactured with case shot war heads (technically spherical case or "shrapnel"). The case shot rockets were very effective because the contents of the explosive war head received an increased velocity from the motion of the rocket. It should be noted that, in 1814, the war heads of Congreve rockets were not interchangeable, the projectile and war head, whatever its type, were fixed together as a unit. The known details of the complete system, both rockets and war heads, as it stood in 1814, are contained in Table I.

The launching apparatuses for the rocket system were almost as varied as the system itself. The lightest calibres equipping the individual troopers of the R.H.A. rocket troops did not require a launching apparatus; the rockets were laid on the ground, aimed at the enemy and fired in volleys although tripods were available. For the 12 to 32-pdr. rockets arming R.H.A. and some R.M.A. units, Congreve de-

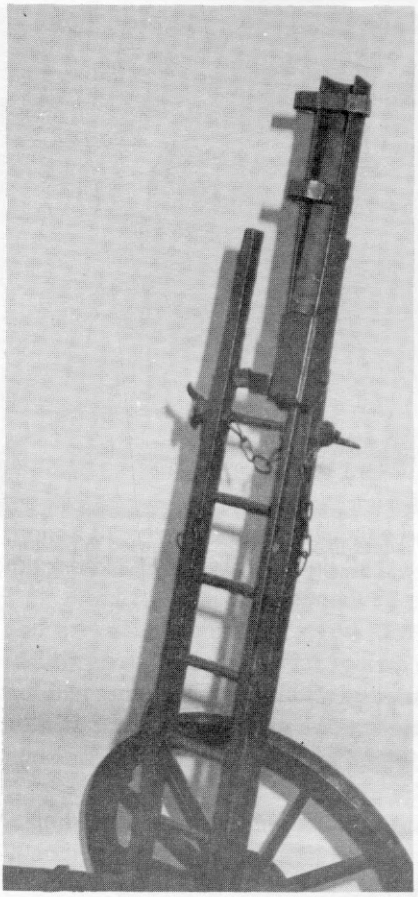


Figure 19-20. Model of a rocket wagon and limber with a detail showing the rocket in place in the trough attached to a ladder. This is similar to the equipment illustrated in Congreve's 1814 book on rockets and probably illustrates Napoleonic War construction. *Courtesy The Royal Artillery Museum, Woolwich.*

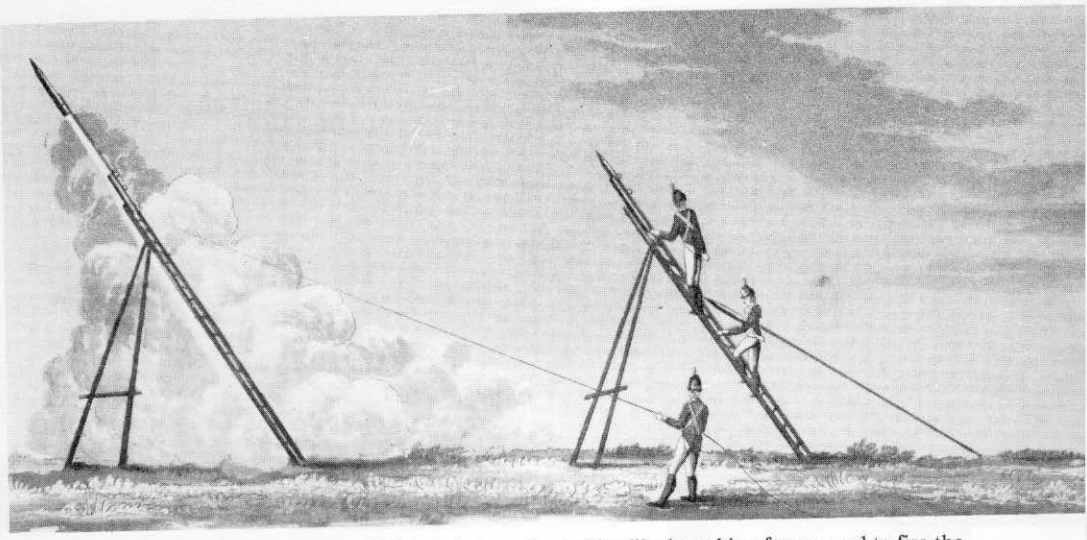


Figure 21. Rocket troops loading and firing rockets on the ladder-like launching frame used to fire the heavy and medium nature of rockets. This method of firing was usually preferred for the bombardment of cities and fortified places.

signed "rocket cars," later to be called rocket carriages, two-wheeled carts which carried the projectiles and the launching sticks separately. When going into action, a rocket "trough" or aiming frame was connected to the cart carrying the sticks. The cart carrying the projectiles was then positioned at a safe distance and firing commenced. Less mobile rocket troops, what Congreve called "rocket infantry," (actually R.M.A. units) were equipped with a simple launching frame mounted on a tripod for the lighter calibres and a large frame resembling a ladder stationed on a bipod for the larger calibres.

For rockets fired from small boats or rocket launches, the heavy ladder-like bombardment frame was positioned on the foremast and the rocket positioned upon it. The boat crew and the rocket detachment sat in the stern of the boat, protected from the rocket's after blast by a sail which had been thoroughly soaked. If smaller boats were used to fire rockets, two were required, one to carry the ammunition and one to fire the rocket.

Two naval vessels, H.M.S. *Galquo* and *Erebus*, were fitted out by the Board of Ordnance under Congreve's direction as rocket ships. The rocket batteries on these two vessels were fired from scuttles cut in the ships' bulwarks and the launching sticks were positioned through the gun deck into frames constructed in the ships' holds. This arrangement did not interfere with the conventional naval armament in the ships and the rockets provided a tremendous increase in the vessels' firepower. After being fitted as rocket ships, these small sloops had the equivalent firepower of a 74-gun ship of the line. [33] *Galquo* and *Erebus* were special vessels but any ship could quickly be fitted out to fire rockets from her rigging using the ladder-like launching frames. If this arrangement was used, however, it would interfere with the operation of the ship's conventional weapons and Congreve suggested that this method of firing be used only for long distance bombardment.

Congreve laid great stress on the fact that his rockets could be launched without any formal apparatus at all. His 1814 work on the details of the rocket system

TABLE 2: RANGE & ELEVATION AFTER ADYE, 1813

CALIBER & TYPE	*DEGREES OF ELEVATION*	*EXTREME RANGE IN YARDS*
42-pdr. Carcass & Shell	60+	3500
32-pdr. Carcass	55-60	2000 to 3000 *
32-pdr. Shell	50	3000
32-pdr. Case (large)	55	2500
32-pdr. Case (small)	50	3000
32-pdr. Explosion	55	2500 to 3000*
12-pdr. Case (large)	45	2000
12-pdr. Case (small)	45	2500

* Depending upon size of war head

contains several diagrams of rocket "batteries" composed of a row of rockets laid on the ground and aimed at the target. These batteries were fired in volleys and, although the visual effect must have been spectacular, the impact effect on the target must have been considerably less so, given the accuracy of the Congreve rocket.

Congreve rockets resembled nothing so much as a large and explosive flare and firing them could be a very dirty and dangerous business as the rocket would remain motionless in its launching apparatus emitting a fiery contrail until it acquired enough momentum to become airborne. The heavier rockets and those used at sea were ignited by means of gun locks while the lighter types were fired by means of portfires. An unsympathetic naval witness aboard H.M.S. *Galquo* described the service of the R.M.A. rocket troops during the bombardment of Flushing in 1809. When the rocket troops came back on board, they

> . . . exhibited a strange appearance. The most part of them had been engaged in discharging the Rock[ets] from machines on a ladder. It was truly laughable to witness the appearance they made. The practice of discharging the Rocket by the ladder machine was a new invention and proved a great injury to the men, burning their hands and faces. Some had no hair on their heads and their hands and shoulder severely scorched.
>
> It appears that upon discharging the Rocket it will rebound and envelop the person discharging them in what appears to be but smoke but at night is a flame of fire. [34]

Congreve claimed substantial ranges for his projectiles although their performance was notoriously unreliable. Based on his experiments, the heavy rockets could achieve between 2,100 and 2,500 yards at 65 degrees of elevation. High degrees of elevation were necessary because these heavy rockets tended to drop as soon as they left the launching apparatus. The medium calibres could achieve between 1,000 and 3,000 yards at an elevation varying between 25 and 60 degrees and Congreve computed that, at between 20 and 50 degrees, the lightest rockets could achieve between 1,000 and 2,500 yards. For rockets fired "point blank" (that is, laid on the ground), Congreve computed that the lighter calibres could range about 800-1,000 yards while the heavier natures could attain 1,000-1,200 yards. The ranges and degrees of elevation for the most widely-used calibres were contained in R.W. Adye's *Pocket Gunner and Bombadier.* [35]

Range was one thing, accuracy was entirely another. The basic weakness of the Congreve rocket as a projectile was that, until 1815, the launching stick was not

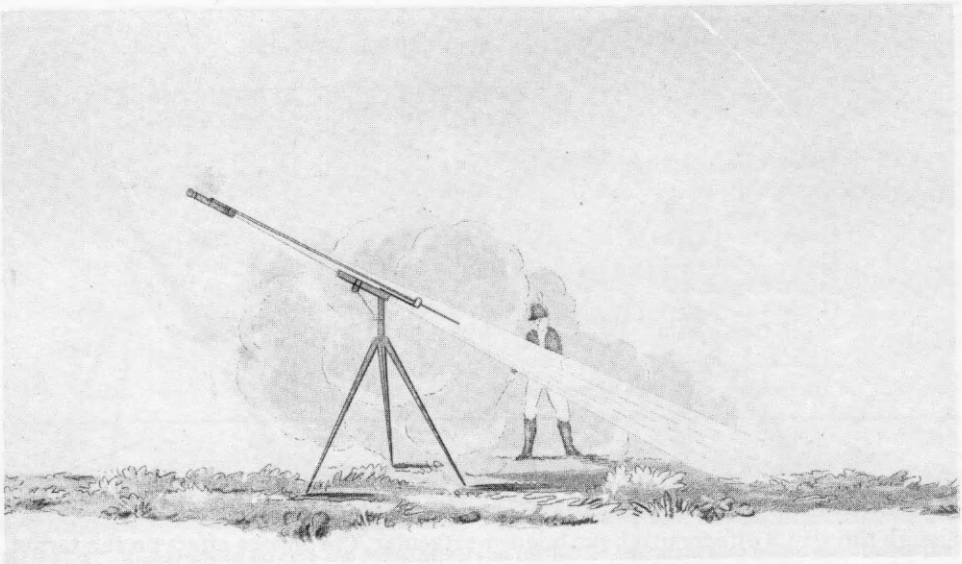


Figure 22. Light caliber rocket being fired from a launching apparatus mounted on a tripod. The apparatus was basically a trough upon which the rocket was rested. Cylindrical or tubular launching apparatuses were not used until the appearance of the first rockets with launching sticks screwed into the center of the base plate of the projectile. Launching apparatuses like the one picture here were used wherever there was need for light caliber rockets with great mobility.

mounted along the same axis as the vertical shaft let into the combustible mixture that provided the propulsion of the rocket. As a result, the stick acted as a drag on the projectile's flight and hampered its performance, sometimes with serious results. Congreve was quite aware of the the uncertain performance of his weapon and always advised that they be used in numbers to achieve any positive effect. Only too often even this recommended use did not answer. A witness to a demonstration of the firing of a volley of ground rockets in Spain noted dryly that, although the rockets "certainly made tremendous noise" and "no cavalry could stand near them if they came near, . . . none of them went within half a mile of the intended object, and the direction seemed extremely uncertain." [36] Even at close ranges, the rocket displayed a maddening (and dangerous) inaccuracy. Captain Cavalier Mercer, R.H.A., described an incident at the battle of Quatre Bras in 1815 when an enemy battery unlimbered down a straight road in Mercer's front and had good practice with their shooting. Mercer proposed to the commander of the 2nd Rocket Troop, which was present, to fire the troop's projectiles against the enemy. Mercer's account of the resulting action is a graphic and not unhumorous record of the difficulty of using the Congreve rocket in battle. The action started with the rocketeers placing

> . . .a little iron triangle in the road with a rocket lying on it. The order to fire is given — portfire applied — the fidgety missile begins to sputter out sparks and wriggle its tail for a second or so, and then darts forth straight up the chaussee [road]. A gun stands right in its way, between the wheels of which the shell in the head of the rocket bursts, the gunners fall right and left, and, those of the other guns taking to their heels, the battery is deserted in an instant . . . our rocketeers kept shooting off rockets, none of which ever followed the course of the first; most of them, on arriving about the middle of the ascent, took a vertical direction, whilst some actually turned back upon ourselves — and one of these following me like a squib until its shell exploded, actually put me in more danger than all the fire of the enemy throughout the day. [37]

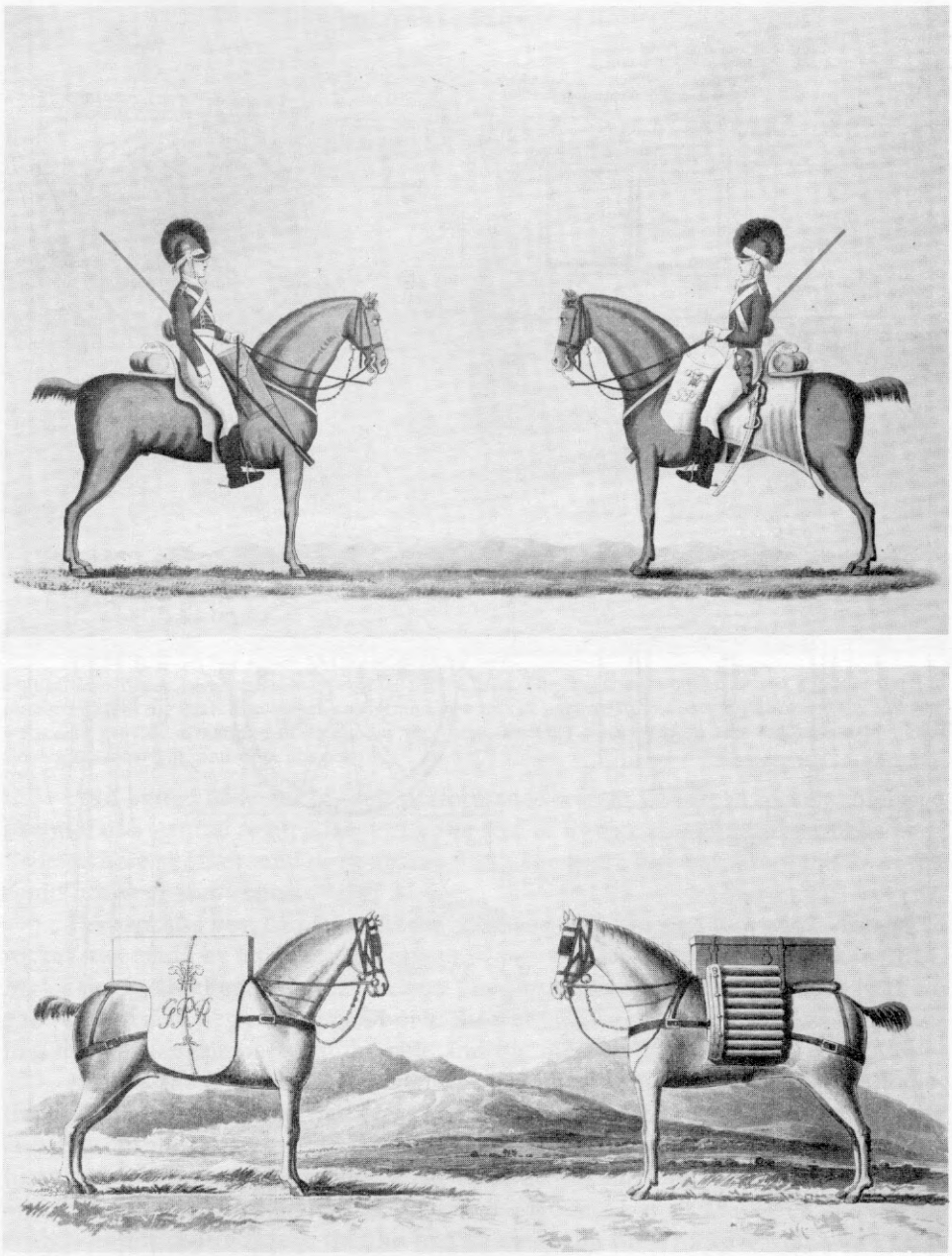


Figure 23-24. Mounted rocket trooper and an ammunition horse of the Royal Horse Artillery. Note the *GPR* (George, Prince Regent) cypher and the Prince of Wales' feathers on the pack covers. The war heads were carried in a large container mounted on the left side of the saddle. The launching stick was carried like a lance and could be used as one if necessary. These units were armed with light 6- and 12-pdr. rockets. The rocket detachment at the battle of Leipzig was equipped as shown here. Every year on 18 October, "O" Battery (The Rocket Troop), Royal Artillery, of the British Army celebrates the anniversary of the Battle of the Nations where Napoleon was halted at Leipzig in 1813. The event commemorates one of the great martial achievements in British history when 200 gunners captured five battalions of the French Army after rockets had "struck terror in the hearts of the enemy." Illustration from *Details of the Rocket System,* 1814.

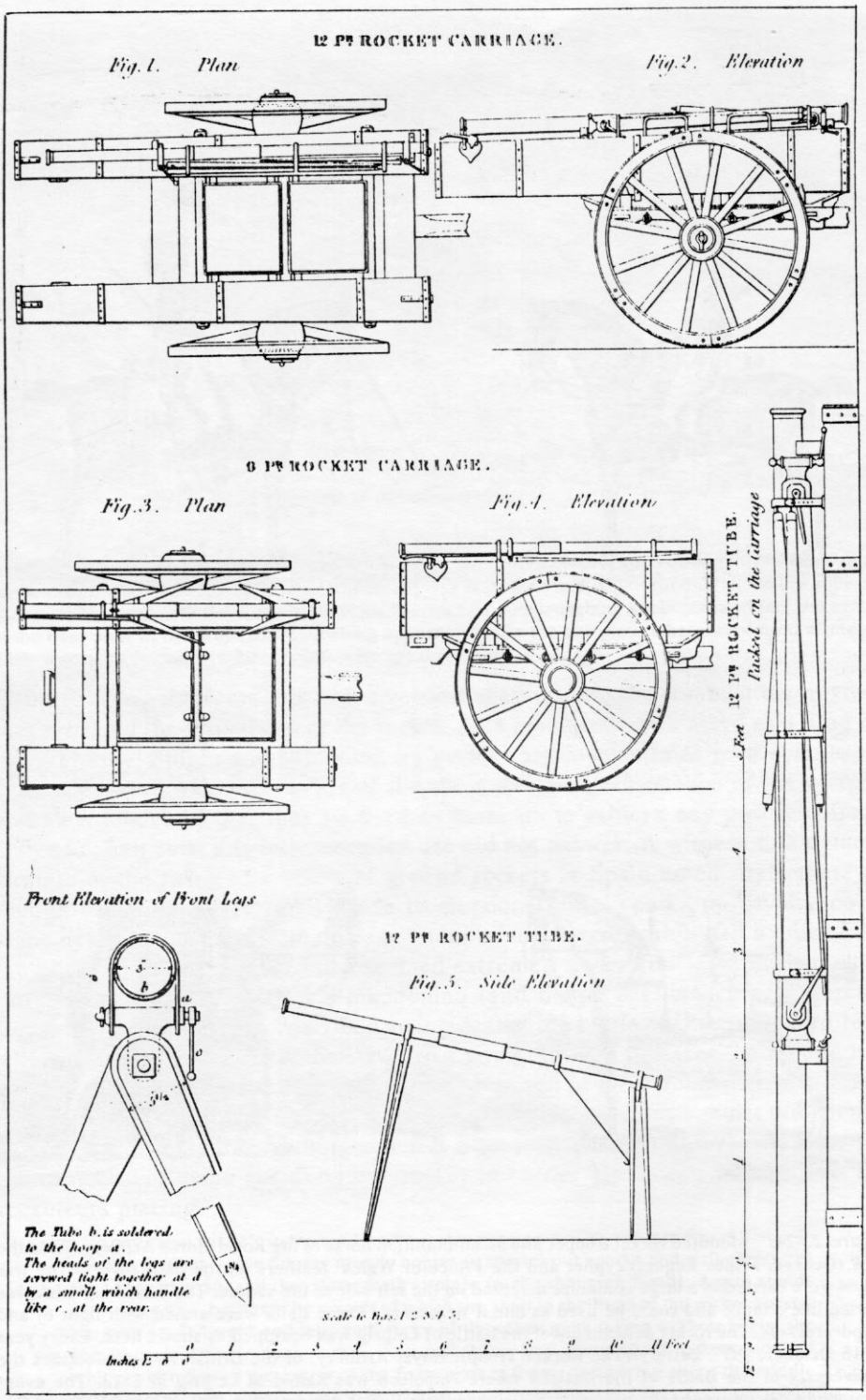


Figure 25. Plans and elevations of rocket equipment from *Aide Memoire to the Military Sciences* edited by "a committee of Royal Engineers" which was published in 1845.

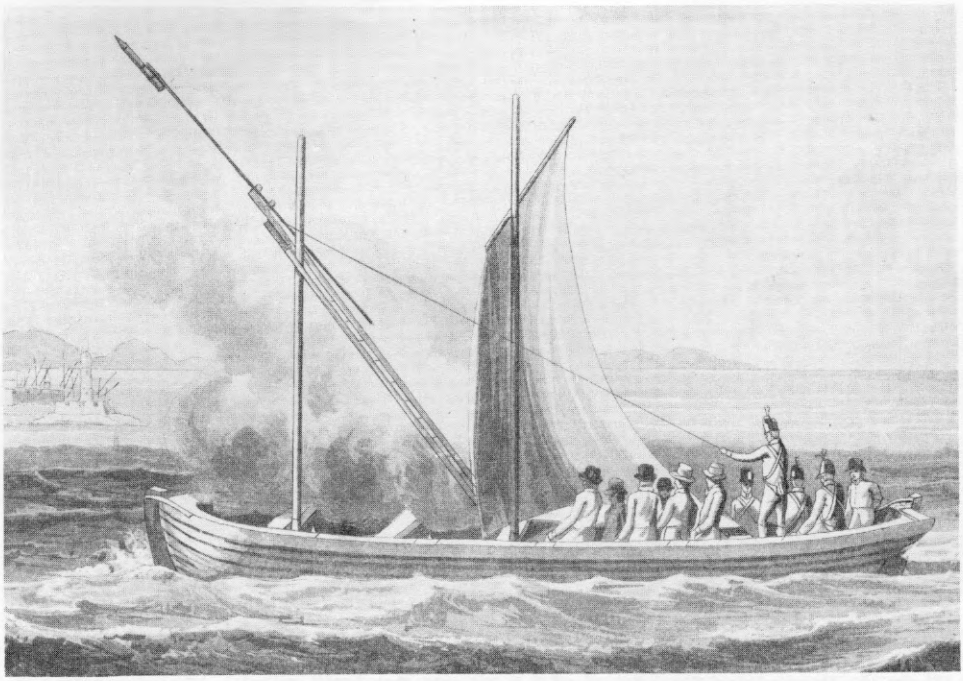


Figure 26. Shore bombardment by rockets from a boat. The launching apparatus was a ladder fixed to the foremast of the boat. The rocket was ignited by a lock or portfire from a safe distance and the sail was wetted to provide a margine of safety for the crew. Rockets were used in this manner to bombard Boulogne, Flushing, and Copenhagen.

As a period observer of their performance stated, Congreve rockets might be useful if one wanted to hit a large city the size of Bayonne and would perhaps hit it "somewhere or other, and no doubt set fire to the town; but the part of the town you could not very well choose." [38]

Perhaps the best comment on the accuracy and effectiveness of the Congreve rocket was made by an American officer whose unit was attacked by them in 1814. Major George McFeely felt that rockets "might answer a good purpose for burning a town or frightening raw troops, but in the field they are a poor contrivance for killing men, when compared to the rifle and the musket." [39]

In sum, the rocket system designed by William Congreve possessed both distinct advantages and disadvantages. The advantages of the rocket lay in its mobility and relative cheapness and in the fact that it took less time to train gunners to use rockets than conventional artillery. The combustible mixture in the projectiles was also less liable to deteriorate than gunpowder; (Congreve also reported and apparently was not contradicted, that he had successfully fired rockets which had been underwater for several hours.) [40] The major disadvantages of the rocket were its deplorable lack of accuracy and its ineffectiveness against trained troops who quickly became aware of the weapon's shortcomings. In the first ten years of the rocket system's development, Congreve made tremendous advances but rockets still did not compare favorably with conventional ordnance which by 1815 had acheived a high degree of accuracy.

Congreve continued to improve on his rocket system until his death in 1828. In 1815, he produced rockets with their launching sticks inserted into the center of

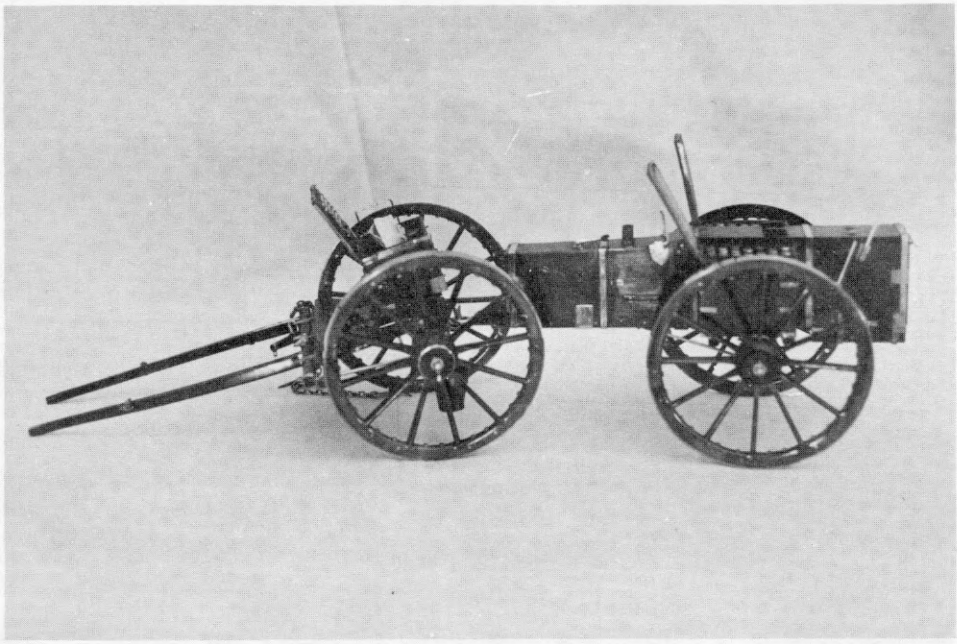


Figure 27 The model of the rocket cart formerly in the Royal United Services Institution. The projectiles and war heads were stored in the compartments shown here and the launching sticks were carried in the coffin-like body of the cart. *Courtesy The West Point Museum.*

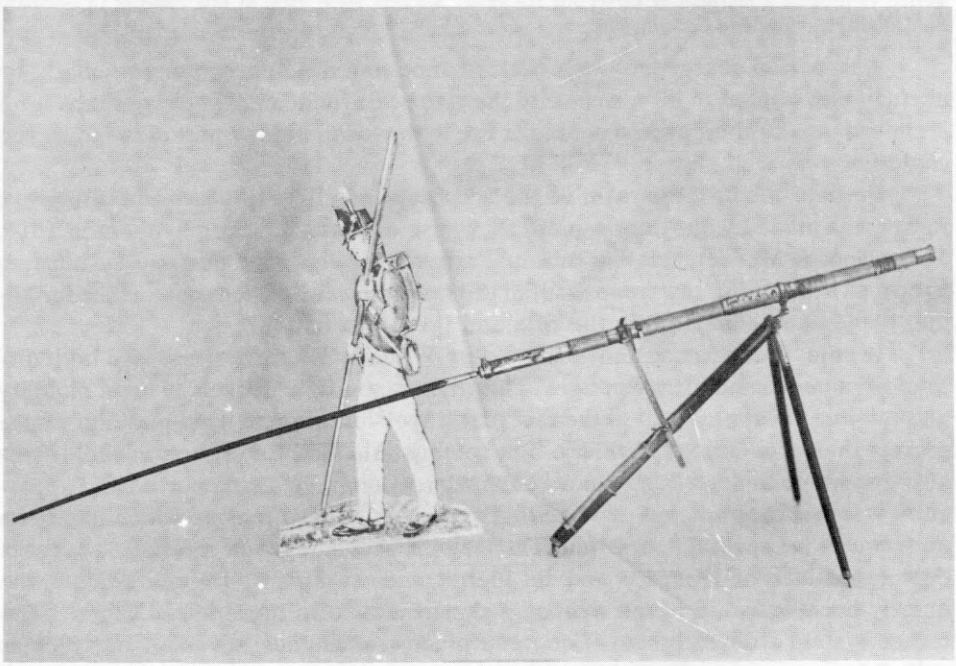


Figure 28. The tripod launching apparatus which accompanies the model illustrated above. The rocket projectile was inserted into a tube which could be elevated or depressed according to the scale attached to the longest of the tripod legs. This was a slightly more accurate method of firing the Congreve rocket than the open trough used during the Napoleonic Wars. *Courtesy The West Point Museum.*

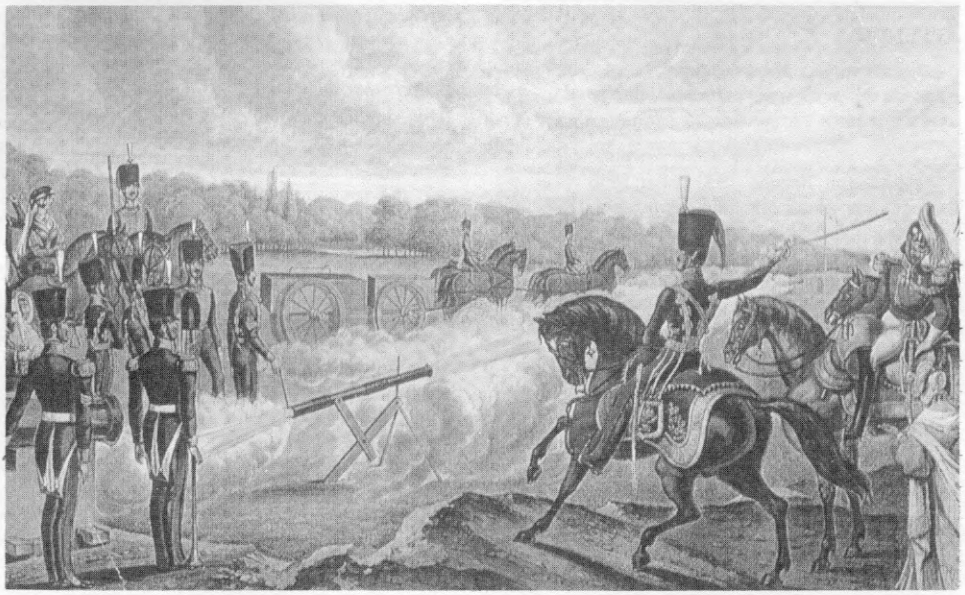


Figure 29 Gunners of the Royal Horse Artillery at practice on Plumstead Marsh c. 1840 from a contemporary print. The simple launching tube is the variation seen in plate 28. In the background stands a two-piece rocket cart. After the Napoleonic wars, the R.H.A. Rocket Troops were disbanded and, for a while, a rocket section was attached to each regular troop of horse artillery.

the casing, doing away with side-mounted sticks, and improving accuracy[41]. He then introduced interchangeable war heads that screwed into the projectile allowing rocket gunners to vary the war head as required and allowing more war heads to be carried.

Despite these improvements, Congreve's rockets never enjoyed widespread use in the British service although the armies of France, Russia and the United States included them in their artillery inventories. One of the problems with the rocket was that there was no reliable information on their accuracy and this omission was not modified until 1842 when Colonel Dansey of the Royal Artillery conducted extensive trials that established primitive but accurate range tables for the weapon.[42] The other problem was the rocket's inaccuracy and this shortcoming was never really overcome although in 1852, Captain Edward Boxer produced an improved rocket with greater accuracy and longer range. Another inventor, Hale, developed a rocket that had no stick which was adopted by the United States in 1846 and produced in Britain in 1854-55.[43] Both Hale's and Boxer's rockets were in service with the Royal Artillery in the 1860's.[44] By this time, however, the rocket's best target — the massed formations of infantry and cavalry of the Napoleonic period — had disappeared from the battlefield and the weapon had no useful role, nevertheless, rockets were used in colonial wars. Perhaps the last combat use of the rocket in the nineteenth century was at the battle of Isandhlwane in 1879 when a small unit equipped with Hale's rockets was overrun after failing to stop an attacking Zulu Impi.[45] By the end of the nineteenth century, the military rocket had been relegated to the role of a signalling device and was only to come into its own again during the Second World War. To Sir William Congreve, however, goes the credit for the introduction of the rocket as a weapon in modern warfare.

APPENDIX I

Major Actions in which Congreve Rockets were used, 1805-1815

Europe

Boulogne, France	8 October 1806
Copenhagen, Denmark	2-6 September 1807
Flushing, Belgium	13-15 August 1809
Santarem, Spain	3 November 1810
Leipzig, Germany	18 October 1813
Ft. Frederick, Germany	19 December 1813
Glueckstadt, Germany	5 January, 1814
Wittenberg, Germany	15 January 1814
Adour River, Spain	27-28 February 1814
Quatre Bras, Belgium	16 June 1815
Waterloo, Belgium	18 June 1815

North America

Lewistown, Del.	6 April 1813
Havre de Grace, Md.	2 May 1813
Fredericktown, Del.	6 May 1813
Georgetown, Del.	6 May 1813
Craney Island, Va.	22 June 1813
Hampton, Va.	24 June 1813
LaColle Mill, L.C.*	30 March 1814
Oswego, N.Y.	6 May 1814
Wareham, Mass.	13 June 1814
Lundy's Lane, U.C.*	25 July 1814
Stonington, Conn.	9-11 August 1814
Benedict, Va.	22 August 1814
Bladensburg, Va.	24 August 1814
Ft. Washington, Va.	27 August 1814
Hampden, Maine	2 September 1814
Potomac River†	1-6 September 1814
Plattsburgh, N.Y.	11 September 1814
North Point, Md.	12 September 1814
Ft. McHenry, Md.	13-14 September 1814
New Orleans, La.	24 Dec. 1814/19 Jan. 1815

*L.C. (Lower Canada), now Quebec; U.C. (Upper Canada), now Ontario.
†Below Alexandria, Va.

APPENDIX II

A Partial Bibliography of the Publications of Sir William Congreve, the Younger.

The bibliography which follows was primarily compiled from the holdings of the Royal Artillery Institution, Woolwich, and is published with the permission of that Institution. I am grateful to Mrs. Bridget Timbers of the R.A.I. for her guidance, Joyce Eakin Gooding of Museum Restoration Service, Capt. Adrian B. Caruana R.A. (Ret.) and Mr. Keith Crouch of the Royal Military College of Canada for their assistance in its compilation.

As this bibliography illustrates, William Congreve was a prolific author and thinker who published on a wide variety of subjects.

1806

Memoir on the possiblity, the means, and the importance of the destruction of the Boulogne flotilla, in the present crisis; with the outline of a general system for the attack of all the enemy's naval depots and arsenals. Including an appendix entitled: "A short account of the attempt made on Boulogne in November, 1805," and "Proofs of the practicability of an invasion." London: J. Whiting, 1806.

1807

A concise account of the origin and progress of the rocket system. With a view of the apparent advantages both as to the effect produced, and the saving of expence, arising from the peculiar facilities of application which it possesses, as well for naval as military purposes. London: J. Whiting, 1807.

1808

Postscript to the concise account of the origin and progress of the rocket system. London: J. Whiting, 1808.

The different modes of use and exercises of rockets; both for bombardment and for the field, with explanatory plates. 2nd edition, London, 1810.

1809

Detail of a plan for attaching to cavalry regiments a proportion of rocket artillery with case shot; containing the same number of balls as the six-pounder spherical case, and ranging 2500 yards. London: J. Whiting.

1810

A concise account of the origin and progress of the rocket system; with a view of the apparent advantages both as to the effect produced, and comparative saving of expence, arising from the peculiar facilities of application which it possesses, as well for naval as military purposes. London, 1810; 2nd edition, Dublin: A. O'Neill, 1817.

1811

A statement of facts relative to the savings which have arisen from manufacturing gunpowder at the Royal powder-mills; and the improvements which have been made in strength and durability since the year 1783. Finsbury Place: J. Whiting, 1811.

An elementary treatise on the mounting of naval ordnance: shewing the true principles of construction for the carriages of every species of ordnance, so as to obtain the power of working the heaviest metal with the fewest hands; with the least possible strain to the ship; and with reference to every other desideratum which can possibly enter into the combination; demonstrated by a variety of diagrams & copper-plates. London: J. Egerton, 1811; London: W.H. Wyatt, 1811. Reprinted by Museum Restoration Service, Ottawa, 1970.

1813

Concise account of the origin and principles of the new class of 24 pdr. medium guns, of reduced length and weight, proposed by Colonel Congreve for the arming of frigates. London: n.p., 1813; another edition, London: 1814.

1814

The details of the rocket system, shewing the various applications of this weapon, both for sea and land service and its different uses in the field and in sieges. Illus. by plates of the principal equipments, exercises and cases of actual service, with general instructions for its application and a demonstration of the comparative economy of the system. London: J. Whiting, 1814; revised edition, see 1827. Reprinted by Museum Restoration Service, Ottawa, 1970, with the addition of a paper by Capt. Edward Boxer entitled "The Congreve Rocket" originally published in 1860. Also reprinted by R.A. Printing Press, Woolwich, n.d. [mid 1970's] and British Aero-Space, London, 1984.

Description of the construction, properties and varieties, of the hydro-pneumatic lock, invented by Colonel Congreve, shewing the principle of its action, with introductory observations on locks in general; and a supplement containing the demonstrations of the spontaneous adjustments of which it is capable. London: J. Egerton, 1814.

1818

Short account of the improvements in gunpowder made by Sir William Congreve, comptroller of the Royal Laboratory: being the substance of the specification of a patent granted to him the 3d of July, 1815. London: T. Egerton, 1818.

A description of the sights, or instruments for pointing guns; prepared by Major General Sir William Congreve for the use of the navy, and now adopted in that service, with an account of the practice made with them on board H.M.S. Liffey. To which is added a short review of the proceedings relative to these sights and a series of instructions for the use of them. London: T. Egerton, 1818; 2nd edition, London: T. Egerton, 1819; 3rd edition, London: T. Egerton, 1828.

1819

Principles, on which it appears that a more perfect system of currency may be formed either in the precious or non-intrinsic metals; so as to produce a representative coin or token, the genuineness of which may be instantly determined by a separate gauge, or an intrinsic self-gauging coin. London: T. Egerton, 1819.

A short account of a patent lately taken out by Sir William Congreve, bart. for a new principle of steam engine; and also of a new mode which he has adopted for the saving of fuel & the consumption of smoke in the production of steam, the generation of gas, and in various other operations; being also the subject of a patent. London: T. Egerton, 1819.

Of the impracticability of the resumption of cash payments; of the sufficiency of a representative currency in this country, under due regulations; and of the danger of a reduction of the circulating medium, in the present state of things. London, J. Hatchard, 1819; London: J. Whiting, 1819; London: The Pamphleteer, 1820.

1820

An analysis of the true principles of security against forgery; exemplified by an enquiry into the sufficiency of the American plan for a new bank note; with imitations of four of the most difficult specimens of those notes, made by ordinary means; by which is proved that there is no adequate security in fine colour, in the present state of the arts, and the true basis of security is in the due application of relief engraving, and printing in two or more colours. London: T. Egerton, 1820.

A concise account of the origin & principles of the new class of 24-pounder medium guns, of reduced length and weight, proposed by Sir William Congreve, in 1813, and adopted in His Majesty's Navy. With a variety of experiments & other documents proving the excellence of that construction of ordnance. London: R. Egerton, 1820.

1822

Detail of the different models, arms, trophies and military machines . . . of the Royal Military Repository. London: n.p., 1822.

Syllabus of the exercises and other operations connected with the service of artillery taught in the Royal Military Repository. London: n.p., 1822.

1823

Memoire on the recoil of naval ordnance. London: n.p., 1823.

1827

A treatise on the general principles, powers and facility of application of the Congreve rocket system as compared with artillery, showing the various applications of this weapon, both for sea and land service and its different uses in the field and in sieges. Illustrated by plates of the principal exercises and cases of actual service. With a demonstration of the comparative economy of the system. London: Longman, Rees, Orme, Brown and Green, 1827. Reprinted as *Traite des fusees de guerre comparees a l'artillerie,* Paris, 1841.

1972

William Congreve and his clock. A reprint of the patent granted to Congreve in 1808, with an introductory note and a portrait. London: Turner & Devereux, 1972.

NOTES

1. Francis Scott Key quoted in Harold I. Lessem and George C. Mackenzie, *Fort McHenry. National Monument and Historic Shrine,* Washington, 1954, p. 19. The account of the bombardment of 13-14 September is from this work and Walter Lord, *The Dawn's Early Light,* New York, 1972, pp. 277-300.
2. The words here are taken from the first printing of "The Star Spangled Banner" printed in hand bill form in Baltimore on 15 September, 1814.
3. Details of Congreve the elder's career are from

John Kane, *List of Officers of the Royal Regiment of Artillery, as they stood in the Year 1763, With a Continuation to the Present Time . . .*, Greenwich, 1815, p. 4.

4. At this time, Hanover was the personal fief of the British royal family and commissions in the Hanoverian list were often used as a means of rewarding favourites who did not qualify for pensions based on service in the British forces. The *Dictionary of National Biography* (D.N.B.) entry for Congreve the younger states that he attended Woolwich and was appointed a second lieutenant in the Royal Artillery in 1791. The author can find no proof for this statement. Many of the details in the D.N.B. entry for Congreve the younger are incorrect and it should be used with great caution.

   Congreve may have held a half pay appointment for a time in the British Army. The *Army Lists* of 1806 to 1811 show a William Congreve on half pay as a quartermaster in the Princess Royal's Own (McDowall's) Fencible Cavalry from 1806 to 1817. This regiment, which existed only briefly from 1795 to 1800, was under the control of the Prince Regent, a friend and patron of Congreve the younger. In 1813 he was granted a "special annual pension for his inventions" of 1,000 pounds. (P.R.O. WO.44, Vol. 516).
5. See *Sir William Congreve and his Clock*, London, 1972.
6. William Congreve, *An Elementary Treatise on the Mounting of Naval Ordnance*, London, 1811, p. ix.
7. *Ibid.*, p. 3.
8. *Ibid.*, p. 47-49.
9. *Abridgements of the Specifications Relating to Fire-Arms and Other Weapons, Ammunition, and Accoutrements*, London, 1859, Reprinted 1960, pp. 46, 51, 57, 66.
10. See William Congreve, *Concise Account of the Origin and Principles of the New Class of 24 Pdr. Medium Guns*, London, 1813 and *A Description of the Sights, or Instruments for Pointing Guns . . .*, London, 1818.
11. Richard Glover, *Peninsular Preparation*, Cambridge, 1963, pp. 68-69.
12. Details of Congreve's career are from the D.N.B. and *The Museum of Artillery. The Rotunda*, Woolwich, 1976, n.p.
13. This paragraph is based on the following sources: Richard J. Hobbs, "The Congreve War Rocket: 1800-1815," *United States Naval Institute Proceedings*, 94, March 1968, pp. 81-88; W. Y. Carman, *A History of Firearms: From the Earliest Times to 1914*, London, 1955; J. Scoffern, *Projectile Weapons of War and Explosive Compounds*, London, 1858, Reprinted 1971; A. B. Caruana, *British Artillery Ammunition, 1780*, Bloomfield, Ont., 1979 and R. W. Adye, *The Little Bombardier & Pocket Gunner*, London, 1801.
14. Carman, *op. cit.*, p. 192; Hobbs, *op. cit.*, pp. 81-82.
15. Carman, *op. cit.*, pp. 192-193.
16. William Congreve, *A Treatise on the . . . Congreve Rocket System . . .*, London, 1827, pp. 15-16.
17. Christopher Lloyd and Harden Craig, eds., "Congreve's Rockets, 1805-1806," *Publications of the Navy Records Society*, XCII, London, 1952, pp. 424-467; Carman, *op. cit.*, p. 193.
18. *Ibid.*
19. Hobbs, *op. cit.*, p. 86.
20. Glover, *op. cit.*, p. 70; Hobbs, *op. cit.*, p. 86; David Yarrow, ed., "A Journal of the Walcherne Expedition, 1809," *Mariner's Mirror*, 61, 1975, pp. 183-189.
21. Michael Glover, *Wellington as Military Commander*, London, 1973, p. 225.
22. *Ibid.*, p. 71.
23. Francis Duncan, *History of the Royal Regiment of Artillery*, 2 Vols., London, 1872, II, pp. 392-395; Edwardd Fraser and L. G. Carr-Laughton, *The Royal Mariane Artillery*, 2 Vol., London, 1930, pp.47-50.
24. Duncan, *Ibid.*, II, pp. 311, 376, 390, 393.
25. Fraser and Carr-Laughton, *op. cit.*, pp. 47-52.
26. *Ibid.*, pp. 237-259.
27. *Ibid.*, p. 266.
28. *Ibid.*, pp. 265-267.
29. *Ibid.*, pp. 266-274.
30. *Ibid.*, pp. 272-273; Armistead to the Secretary of War, 24 September, 1814, contained in *Niles Weekly Register*, VII, pp. 23-30.
31. Alexander Dickson, "Artillery Services in North America in 1814 and 1815," *Journal of the Society for Army Historical Research*, VIII, 1929, pp. 79-227; Duncan, *op. cit.*, II, pp. 399, 406-410.
32. Unless otherwise noted, the description of the rocket system of 1814-1815 is taken from William Congreve, *The Details of the Rocket System*, London, 1814.
33. Hobbs, *op. cit.*, p. 85.
34. Yarrow, *op. cit.*, p. 188.
35. R. W. Adye, *The Pocket Gunner and Bombardier*, London, 1813, p. 331.
36. G. Larpent, ed., *Private Journal of Judge Advocate Larpent*, London, 1854, pp. 354-355.
37. Cavalier Mercer, *Journal of the Waterloo Campaign*, 2 Vols., London, 1870, I, pp. 278-280.
38. Larpent, *op. cit.*, p. 355.
39. J. C. Fredriksen, ed., "Chronicle of Valor: The Journal of a Pennsylvania Officer in the War of 1812," *Western Pennsylvania Historical Magazine*, No. 3, p. 275. McFeely was fired upon by an R.M.A. unit equipped with rockets during the battle of LaColle Mill in 1814.
40. Hobbs, *op. cit.*, p. 87.
41. *Catalogue of the Museum of Artillery*, London, 1963, p. 55.
42. Hew Strachan, *From Waterloo to Balaclave: Tactics, Technology, and the British Army, 1815-1854*, Cambridge, 1985, p. 136.

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