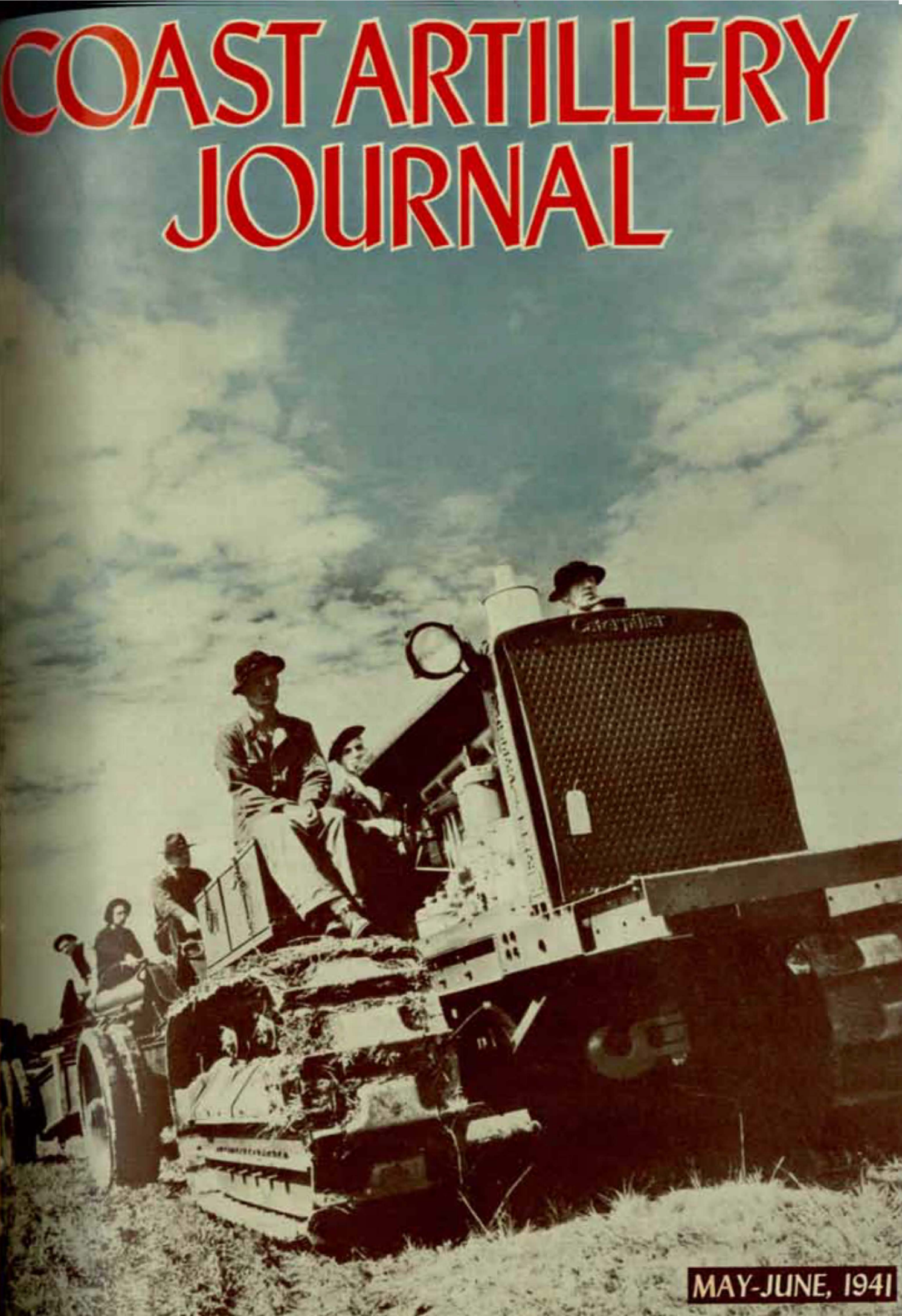
COAST ARTILLERY JOURNAL



MAY-JUNE, 1941

War Rockets of the Past

By Willy Ley

Rockets as a weapon of war are nowadays about as obsolete as catapults and crossbrows. Their once important rôle—especially in amphibious operations—and the fact that rockets are still in use not only for amusement but also for the more serious purposes of serving as distress signals, or as a line-throwing apparatus for the rescue of the crews of stranded vessels, warrants some interest in their history.

Historians, however, have always treated the powder rocket as a stepchild. The volume of the literature about the early history of guns and gunpowder is enormous but more than seventy per cent of all the books and treatises ever written on the history of gunpowder fail even to mention the fact that rockets constitute one of the three early applications of gun powder. The other two were Roman candles and bombs; guns do not appear until almost a full century later.

Neglecting a few rather doubtful and unreliable reports it seems that the oldest source about the application of gun*powder* is the Chinese chronicle T-hung-Lian-Kang-Mu which speaks about new weapons used in the battle of Kai-fung-fu (Pien-king) against the Mongols. This battle took place in 1232 A.D. and the new weapons used were the Tchin-tien-lui (heaven-shaking thunder) and the Fe-ec-ho-tsiang (arrows of flying fire). The former were bombs that were dropped from the city's walls while the latter were rockets.

One passage has been translated as follows:

"In addition the defenders had 'arrows of flying fire.' They attached an inflammable substance to the arrow. The arrow suddenly flew away and spread its fire over an area measuring ten steps. The Mongols dreaded those arrows of fire very much."

The term "fire arrow" tends to be misleading but the statement that these "arrows" began to fly away suddenly and the lack of mention of a bow or other instrument capable of throwing arrows suggests that they were rockets. The French Jesuit Pater Amiot succeeded in finding drawings of such fire arrows in ancient Chinese chronicles. They look exactly like powder rockets, save for a pointed tip attached to the front end of the guiding stick and for feathers attached to the other end. The latter feature can be found on hand-made Chinese sky rockets even nowadays.

J. von Romocki, a German historian of military arts and sciences, held the theory that the early Chinese powder rockets slowly "evolved" from fire bearing arrows. He believed that the Chinese, while experimenting with various kinds of "salt" accidentally used saltpetre with the result that the fiercely-burning incendiary mixture acquired explosive properties. If it is assumed that the Chinese habitually wrapped those incendiaries that were to be attached to fire bearing arrows in paper tubes instead of parcels—as is likely—the reaction of a quickly burning saltpetre mixture must have been noticed. It was probably found that fire arrows flew much farther than was to be expected or else that they were greatly retarded, depending upon whether the fire mixture had been ignited from one or the other end. Finally some such arrows may have departed "on their own volition" after igniting without being shot from a bow.

At any event it seems to be certain that saltpetre mixtures really were concocted first in the Far East. In the occident mention of saltpetre made its first appearance in the writings of Arab savants and they adorn not only saltpetre but also other pyrotechnic implements with the term "from China." Abdallah Ibn Baithar, for example, writing about 1240 A.D., said that "the flower of the stone of Assos" is called "Snow from China" by the Egyptians. Strangely enough Ibn Baithar does not mention the qualities of saltpetre at all and since it seems unlikely that he should not have known about them we might conclude that he wanted to keep them secret.

The next Arabic manuscript, entitled *Fighting on Horse Back and with War Machines* has an entirely different attitude. It contains fairly accurate recipes for rockets, gunpower, Roman candles and even for a rocket driven torpedo. The latter was called a "self-transporting and self-combusting egg" and consisted of two large convex pieces of some material forming a hollow lens shaped body, two large rockets for propulsion and a central beam with a pointed tip which was to penetrate the hull of an enemy vessel. The hollow lens-shaped body was probably to be charged with incendiary mixtures for setting fire to enemy vessels. The author of this book and possibly the inventor of the first torpedo about which we have knowledge was one Hassan Alrammah, a hunchback of great brilliance. He died "at an age between 30 and 40 in the year 695 of the Hegira" which dates his book as having been written between 1275 and 1295, probably during the first half of that period.

Hassan Alrammah used an Arabic term for saltpetre but he did call rockets "Chinese arrows" and scattered

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Willy Ley was born in Berlin, and came to this country in 1935. He studied at the universities of Berlin and Koenigsberg, and became interested in rocket research in 1925. He was one of the founders of the German Rocket Society; was co-editor of the Society's monthly journal, and took part in many rocket experiments. Mr. Ley is now with the research department of the newspaper PM. He has his first papers for naturalization, and hopes to acquire full citizenship late this year.

a few "from China's" around in other places of his manuscript.

At that time explosive saltpetre mixtures and rockets were already known in Europe. The first certain mention of a rocket in Europe dates back to 1258, the locality being Cologne. Latin manuscripts of the period immediately following that date always refer to rockets as "*ignis volans*" or "flying fire." The Cologne MS uses a German term, but not "Flugfeuer" as should be expected as a translation of the Latin. Instead the term used is "Windfeuer"[1] or "wind fire" which may have to be read "wildfire," soon to become a common term for rockets in all Germanic languages.

The history of gunpowder, rockets, and pyrotechnics in general emerged from comparative obscurity soon after that first mention. The three main sources are the writings of Roger Bacon, Albertus Magnus (Albert von Bollstädt) and Hanns Hartlieb, a rarely mentioned German plagiarist of the same period. All three are based upon the mysterious *Liber Ignium* or *Fire-Book* written by one otherwise unknown Marcus Graecus.

The *Liber Ignium* of which Roger Bacon and Albertus Magnus seem to have known more complete copies than the two Paris manuscripts now in existence has been a source of never-ending speculation.

The Fire Book applies the term *ignis volans* to two different things, Roman candles and rockets. The recipe for the driving charge of a rocket begins as follows:

"Take one pound of live sulphur, two of charcoal and six of saltpetre"—a fairly weak mixture, especially with the impure saltpetre of that time, but sufficient for the purpose, as I found out by experiment.

In Alberti Magni's book *De Mirabilibus Mundi* the rocket charge recipe reads the same as does also the German text of Hanns Hartlieb. Both these books date from the same period, the period during which Hassan Alrammah wrote his own book. The writings of Roger Bacon, much discussed on account of the deliberately mysterious language he used, also fall into the same period. Without joining the controversy about the proper meaning of Bacon's famous anagram I state that Hime translated it as meaning: "Take 7 parts of saltpetre, 5 of young hazelnut wood and 5 of sulphur" a mixture that would also be rather weak.

Rockets, then, were fairly well known in intellectual and military circles in 1280 and after. They were apparently used as self-propelling fire arrows, fired at the enemy—and especially against the rigging of enemy vessels—in the hope that they would set the target afire. The extensive use of rockets as a weapon of pirates (and against pirates) is mentioned as late as the sixteenth century by Italian authors.

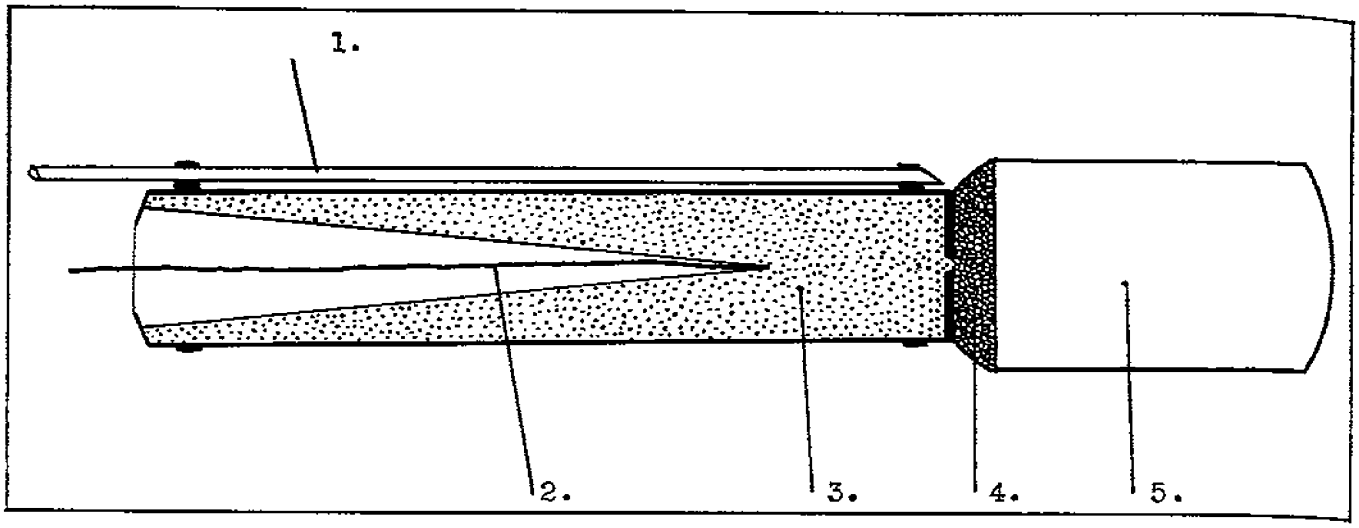
Firearms throwing solid bullets and not lumps of burning powder (as is characteristic for "Roman candles") appeared early in the 14th century. The oldest known picture of a gun is still the famous miniature in the Oxford manuscript *De Officiis Regum* of 1326. Unfortunately the manuscript, which deals with the duties of a monarch, does not mention guns or gunpowder at all. The year 1313 as date of the invention of firearms seems to be generally accepted now after a long and bitter controversy that dragged on for decades in historical journals of all countries. This date was claimed by the so-called *Memorieboek* of the City of Ghent which shows among the entries for the year 1313 the following sentence: "By the way, during this year the use of *bussen* was found for the first time by a monk in Germany." There is no doubt that the term *bussen* means "portable guns," the word still survives in modern High German in the form *Büchse* which means a hunting rifle or a smooth bore rifle in general. This entry is corroborated by other entries in the *Memorieboek* speaking about *bussen met kruyd* (shotguns with powder); by the fact that the first guns in England came with Flemish soldiers; and by the legend about *Bertholdus niger*, a lengendary German monk and supposed inventor of artillery.

Firearms throwing solid bullets slowly replaced not only bows and arrows and crossbows and darts but rockets as well. Rockets, however, had an important advantage: they bore fire. The historian Muratori emphasized that in 1379, in the battle about the island of Chiozza an otherwise invincible tower was fired by this means which decided the outcome.

The book *Bellifortis* by the German military engineer Konrad Kyeser von Eichstädt, finished in 1405, described three varieties of rockets; ordinary sky rockets, swimming rockets and rockets running along taut strings. The latter type was presumably used to carry messages. An approximate contemporary of Konrad Kyeser, the Italian engineer Joanes de Fontana, is known to have written an apparently comprehensive book on the weapons and the armament of his time. The manuscript of this book is said to be in the library of Milan but not even excerpts have ever been published. The same de Fontana, however, jotted down many of his ideas in a kind of sketchbook which can be dated as having been finished in 1420 and which was later called the *Bellicorum Instrumentorum Liber*.

In this book Joanes de Fontana made drawings of flying rockets disguised as pigeons, swimming rockets disguised as fish and ground rockets camouflaged as running hares. All these forms were supposed to carry fire to the enemy's camp or to his fortifications. De Fontana also designed a rocket driven torpedo, consisting of a powder filled roughly triangular wooden vessel with a long drawn-out and sharply pointed bow, propelled by two large powder rockets. The hollow of the vessel was to be charged with powder, of course. Two huge eyes were painted on top of the contraption to make it look like the head of a sea monster. Another idea of his was a heavy wooden car, moving not on wheels but on two large wooden rolling pins to be serv-

[1] The spelling is that of modern High German.



PROPAGANDA ROCKET, SPANISH CIVIL WAR, MADRID, 1938
1—Guiding stick. 2—Fuse. 3—Driving charge. 4—Small explosive charge. 5—Container for propaganda leaflets printed on tissue paper

iceable on rain soaked terrain or on poor roads. The propelling force was three large rockets, working through a common exhaust nozzle. The purpose for which this first rocket car had been conceived was not so much the battering of heavy stone walls, but to confuse enemy cavalry or enemy foot soldiers advancing in solid formations.

Probably closer to actual practice than these designs were the pictures of barrels filled with rockets and tied to the masts or bowsprits of ships to be fired against other vessels in solid volleys. Such pictures can be found frequently in books of the period from 1550-1650.

That rockets might be used to give signals seems to have been a fairly late discovery. Count Reinhart von Solms was apparently the first to describe rockets equipped with small parachutes. At about the same time (1550) rockets with stabilizing fins instead of stabilizing sticks were described for the first time; the first underwater rockets were mentioned in 1610.

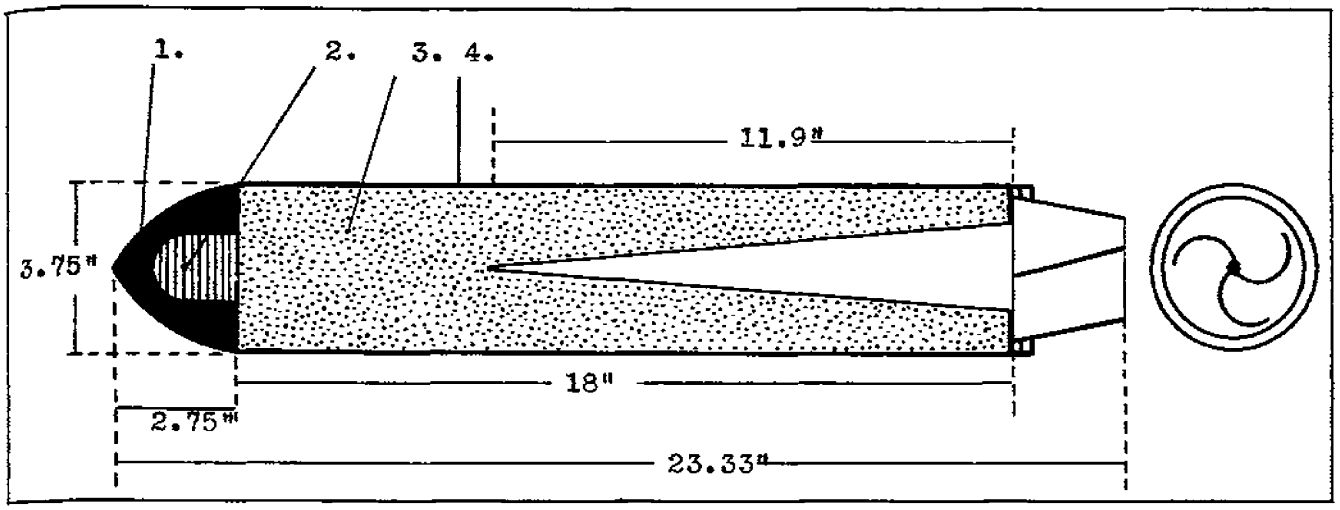
Save for special applications like pirate fighting and signal shooting, guns had replaced rockets as a weapon of war completely by 1550. A once-famous book, written by one Leonhart or Linhart Fronsperger in 1557, gave detailed directions for the manufacture of various kinds of rockets, but emphasized that "this most common piece of fireworks" would serve for amusement only and had no serious applications. It has to be borne in mind, however, that Fronsperger lived far inland in Europe and was discussing land warfare only; it is doubtful whether he ever even saw the sea.

There exists a very conspicuous gap in the history of rockets, reaching from about 1550 to 1800. This gap is not apparent but real; it was caused by lack of activity, not by lack of records.

It is true that during this period Sir Isaac Newton established his Third Law of Motion which provides the scientific explanation for the motion of rockets, stating that every action has an equal but opposite reaction. It is also true that one of his disciples, the Dutch professor Jacob Willem s'Gravesande, experimented with a simple apparatus to produce steam reaction and that he proposed a "steam car" based on his invention. And it is finally true that at least one man was trying to revive the war rockets of the late Middle Ages during that "dull season" lasting two and a half centuries. He was the Prussian colonel Christoph Friedrich Geissler who constructed rockets weighing not less than 120 pounds. They were equipped with rather heavy bombs, but it seems that those bombs were a bit too heavy because Geissler reported that his rockets burned for "quite some time" until they finally rose and that they did not go very far.

The revival of the ancient war rockets really came around the year 1800 and, curiously enough, it again came from the East. In 1789 there appeared in London a book by one Innes Munro, Esq. It was entitled: *A Narrative of the Military Operations on the Coromandel Coast Against the Combined Forces of the French, Dutch and Hyder Ally Cawn from the Year 1780 to the Peace in 1784.* In this book Munro related that the Indians possessed war rockets, "not unlike those our boys are playing with," but consisting of an iron tube, filled with powder and incendiary matter, weighing between six and twelve pounds and fastened to a stick of bamboo between eight and ten feet long. The range of these rockets was estimated to be around one and a half miles. Munro stated that it was very difficult to aim these rockets but reported that they did much damage nevertheless, especially among the cavalry of the British.

It was probably this report that caused the French "Citizen Chevalier" to experiment with war rockets near Paris in 1799. The rockets were fired against a large square of canvas which served as a target. Some of them missed and a few tore through the fabric without doing any further damage. But those that stuck to the



ROCKET, WAR, 24-pr. MARK VII (c)
1—Cast iron. 2—Hardwood. 3—Driving charge. 4—Steel tubing. All measurements in English Imperial inches. (From *Treatise on Ammunition*, British War Office, 1905)

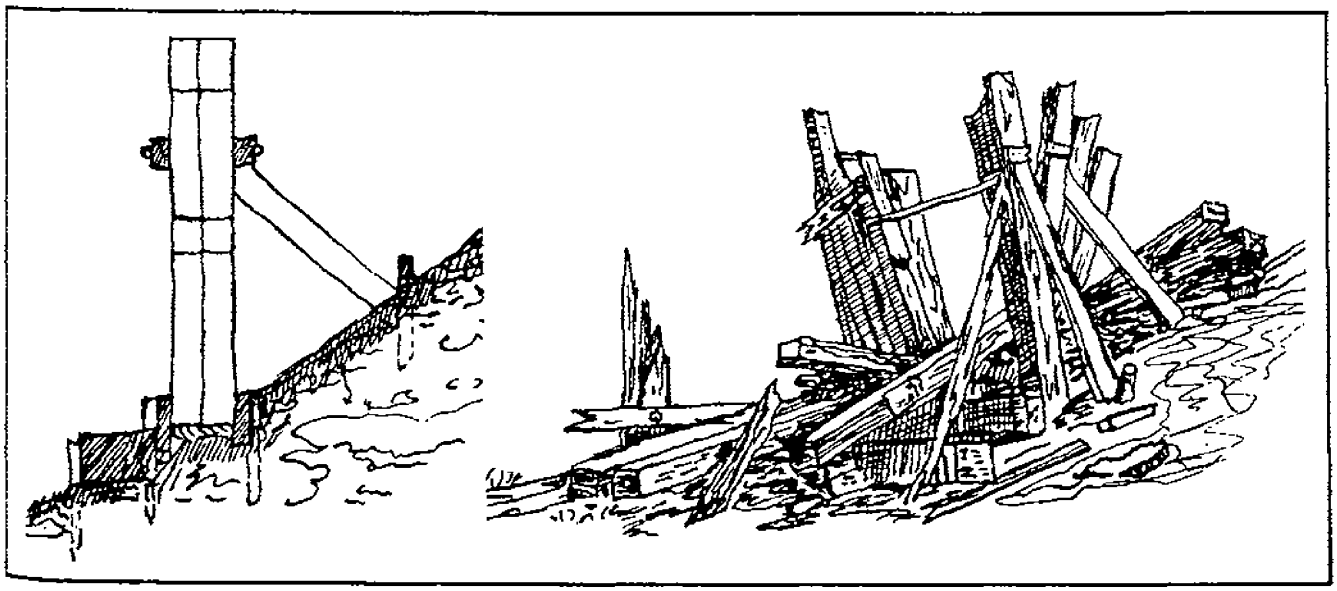
target—they were covered with some kind of sticky resin—ignited it immediately.

When the British troops attacked Seringapatam in 1792 they were again greeted with war rockets and Colonel Dirom of the British Force had to report that there were "a good many wounded, though in general but slightly, chiefly by rockets."

The Indian potentate responsible for the creation of a special corps of rocket throwers in his private army was Hydar Ali, Prince of Mysore. His rocket corps numbered 1,200 men, but his son Tippoo Sahib increased the number to 5,000. It seems that the rockets had been improved also, at the siege of Seringapatam in 1799 the Indian war rockets proved quite destructive and must have carried an explosive charge. An eye-witness, Lord Egerton of Tatton, spoke of "rockets of uncommon weight" and another eye-witness, Colonel Gerrard, saw three British soldiers killed and four others wounded by the explosion of a single rocket.

The news caused much excitement in England and a British officer, Colonel William Congreve, (later General and Sir) conceived the idea of duplicating this "new" weapon in England and of improving it with the superior science and better technological methods of the Western world. Contrary to common belief Congreve never saw the Indian war rockets in action, because he never went to India.

In a treatise published in 1807 Colonel Congreve wrote that he had conceived the idea of his war rockets in 1804. "I knew that rockets were used for military purposes in India; but their magnitude was inconsiderable and their range not exceeding 1,000 yards. . . . I immediately procured, at my own cost, the largest rockets I could get made in London, but found, on trial,



Effect of a Congreve rocket with explosive charge on a target wall erected of planks of oakwood about six inches thick

that none of them was capable of more than five or six hundred yards range."

After trying out various methods he eventually obtained ranges of 1,500 yards "from the same class of rocket which at first would range only 600." He then applied for permission to use the Royal Laboratory and soon a range of 2,000 yards was obtained. One year later, in 1805, he demonstrated the use of his new weapon to the Prince Regent. Later in the same year he accompanied Sir Sidney Smith in a naval attack on Boulogne, France.

What actually happened during that first trial of his rockets and what results were obtained is somewhat mysterious. The Encyclopedia Britannica says that "the weather prevented the use of the rockets." French and German history books claim that about 200 rockets were fired but without results worth mentioning. Only three houses were set afire by the 200 missiles, French sources claim, and those fires were quickly extinguished by French soldiers who carried the empty shells of burned out rockets through the streets of the town, laughing and joking about the "English fireworks." It may be, however, that these claims refer to the second attack on Boulogne in 1806 which was termed "very effective" by the British.

There is no disagreement whatever about the effects of the next attack with Congreve rockets, during the siege of Copenhagen in 1807. The British discharged large numbers of Congreve rockets—estimates vary from 20,000 to 25,000—and the greater part of the city burned to the ground. Incendiary missiles were terribly effective against the average structures of that time. Congreve had other than incendiary rockets made early in the course of his experimentation, as the following table, taken from his "Concise Account etc. . . ." proves. In that book the table is headed: *List of the different Species of Rocket-Ammunition hitherto made:*

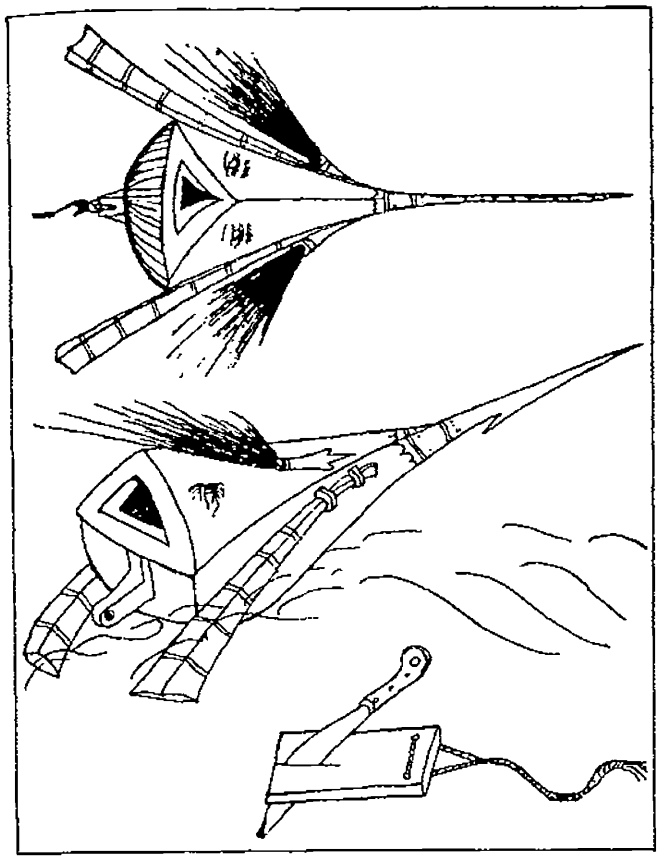
Nature of Ammunition	Armed With	Extreme Range	Elevation for Extreme Range Not Less Than
	Carcasses:		
42 lbs. Carcass Rocket	large 18 lbs. small 12 lbs.	3,000 yards	60°
42 lbs. Shell Rocket	Shells 5½ lbs. or 12 lbs. spherical	3,000 yards	60°
	Carcasses:		
32 lbs. Carcass Rocket	large 18 lbs.	2,000 yards	60°
	medium 12 lbs.	2,500 yards	55-60°
	small 8 lbs.	3,000 yards	55°
32 lbs. Shell Rocket	9 lbs. spherical shell (bomb)	3,000 yards	50°
32 lbs. Case Shot Rocket	large 200 carbine balls	2,500 yards	55°
	small 100 carbine balls	3,000 yards	50°
32 lbs. Expl. Rocket	strong iron cones 5-12 lbs. of powder	2,500-3,000 yards	55°
12 lbs. Case Shot	large 72 carbine balls	2,000 yards	45°
	small 48 carbine balls	2,500 yards	45°
Rocket Light Balls	(Flare Rockets equipped with Parachute.)		

Congreve himself had hoped from the outset that his war rockets would replace artillery completely, especially for land warfare. The British authorities, however, while watching his experiments and considering his proposals made up their minds that this was an excellent weapon for naval battles. It must be remembered that naval engagements were close range encounters at that time and that the high masts and the huge spread of canvas were towering, easy and inflammable targets. Consequently Congreve's rockets were first used from small boats and barges. Congreve liked to term his rockets the "soul of artillery without the body" since they needed no ordnance to project them; thus, naval men said, they were excellent artillery for vessels too small to carry real artillery.

The launching mechanism was as simple as possible on those "rocket boats." It consisted of an extra mast with a ring of iron to accommodate the guiding stick of the rockets. This ring could be adjusted in varying heights to determine the elevation of fire.[2] The equivalent of the "launching mast" for land warfare was a wooden rack looking somewhat like a very wide stepladder, later cannon like launching tubes of copper were employed and found to be very satisfactory.

The rockets themselves consisted of an iron shell containing the driving charge to which the "head" (incendiary carcass or explosive bomb) could be attached. The long and heavy guiding stick was at first fastened to the driving shell in the customary manner of sky rockets. When it was found in the course of experi-

[2]Later this design was greatly improved in attaching a launching device resembling a very narrow stepladder to the launching mast. The rocket rested on the rungs of the ladder the head of which could be fastened to the mast at varying heights. This design was ready in 1816. British "rocket boats" (or "rocket flats") played an important rôle in the bombardment of Algiers on August 27th, 1816 where the Dey's forces were bombarded into submission. Five gun boats, ten mortar boats (launches belonging to the fleet), eight rocket boats (flats belonging to the fleet) and thirty-two gun boats (barges, yawls, etc.) took part in the bombardment; the rocket boats were equipped with 2,500 rockets, not all of which were used.



Torpedo from the Sketchbook of Joanes de Fontana about 1420. Top and side view. The painted eyes are plainly visible. The small picture at the bottom apparently refers to a trailing "tail" like that of a kite; the dagger stuck into it is to signify that the whole structure is built of wood.

mentation that the off-center weight of the guiding stick impaired accuracy too much the center line stick was introduced. This was accomplished in attaching to the upper end of the guiding stick a two pronged fork with prongs about five or six inches long. The two prongs in turn were attached to a ring which fitted around the exhaust nozzle of the rocket shell. Since it was found that a two-pronged fork failed to keep the heavy stick in perfect alignment three- and four-pronged forks were built, the three-pronged variety seems to have been the most common form.

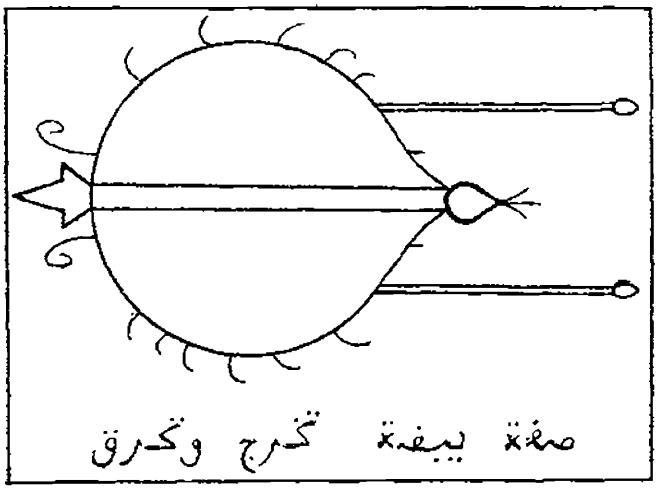
"In September, 1811," to quote from H. B. Latham's article on the history of the British Rocket Brigade,[2] "Congreve's experiments had so far impressed the Board of Ordnance, that they placed at his disposal a detachment from the Horse Artillery at Woolwich commanded by Second Captain Richard Bogue and consisting of one N.C.O. and thirty men. His experiments now continued both at Woolwich and Bagshot until the middle of May, 1813, when a select committee of artillery officers reported that 'they were unable to offer any opinion as to their utility and recommended that a trial should be made with them upon actual service.' The Master-General of the Ordnance concurred in this recommendation. By this time the original small detachment had grown considerably. Lieutenant Thomas Strangways had joined it in October, 1812, and now with the order to proceed on 'Active Service' immediately, it was granted the right to style itself 'The Rocket Brigade.' "

The "active service" consisted at first of participation in the battle of Göhrde (September 16th, 1813) where the Congreve rockets made a rather bad showing. They proved inaccurate and scored only a few direct hits, much impressing the French commander of the opposing forces, however.

Things were different at Leipzig (October 16th to 19th, 1813) where the Rocket Brigade joined in the second attack on the village of Paunsdorf in the afternoon of October 18th. Bogue opened fire at a very close range, scoring very many direct hits. The French fell back, but Bogue's assault at the head of the dragoons escorting his Rocket Brigade proved premature and it was not until after Strangways brought up the rockets for close support that French resistance collapsed. The village of Sellerhausen was the next objective, but Bogue was killed by a bullet before the attack started. Strangways took command and directed fire so effectively that the Allied troops took this village away from Napoleon's soldiers after a fairly short fight. However, the French retook the village with a counter-attack performed by the Old Guard of Napoleon's army.

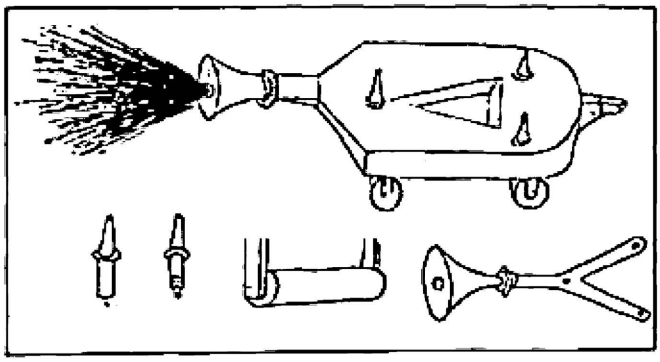
The Rocket Brigade took no part in the actual taking of Leipzig, but was granted the right to bear the word "Leipzig" on their appointments.

Another famous battle of the same year where rockets were used is that of Danzig. English transport ships that arrived in July—during an armistice—brought artillery and other war material, including 3,500 Congreve rockets of the incendiary type. After the armistice had



The "self-propelling and combusting egg" of Hassan Alrammah. The short curly lines are to indicate that the torpedo is to swim on the surface

[2] "The Rocket Service and The Award of the Swedish Decorations for Leipzig," by Captain H. B. Latham, R.H.A. *The Journal of the Royal Artillery*. Vol. LVI, No. 4, January, 1930, pages 419-452.



Rocket-propelled car. From Joanes de Fontana's sketch-book

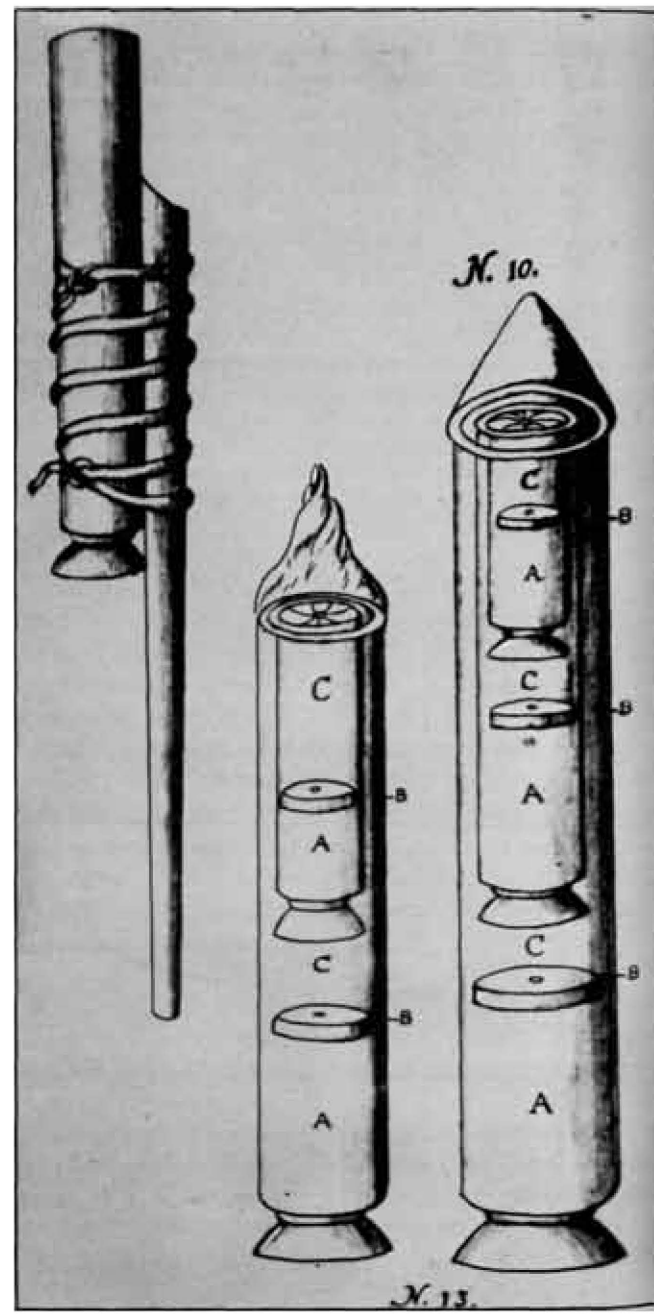
expired the first bombardment of the city was ordered on August 26th. But the rockets did not do any harm; as in Boulogne they were carried around in the streets and a few business-minded people secured them for "semi-permanent" exhibits. The next bombardment on September 10th was more effective; twenty-three buildings were set afire, among them the hospital of the Dominican monks with 700 beds, occupied mostly by Russian prisoners of war. On October 20th Duke Alexander of Württemberg ordered another bombardment which meant the end of the siege. The rockets fired the food storage buildings so that the city was forced to surrender on November 27th.

It is not surprising that the commands of all other European armies were striving desperately to learn the secret of Congreve's rockets after these conspicuous applications. Experimental laboratories were established in virtually all European countries by their respective governments. The experience gathered by those laboratories must have been fairly much alike everywhere because the final results differed only slightly, but it seems just the same as if the British succeeded in keeping their original designs secret. In 1817, when many other nations already boasted war rockets of their own manufacture and about as effective as those of Great Britain Sir William Congreve still wrote in the introduction to his *Concise Account*: "I have cautiously avoided any disclosure which might lead to a discovery of the interior structure and combination of the Rocket."

This book was, incidentally, mainly a political-military pamphlet instead of what the term Account seems to indicate, i. e. an engineering description. Congreve had apparently been attacked by artillery officers as to the efficiency of his rocket system and he violently defended its superiority as compared with the artillery of his time. He always put emphasis on the superior mobility of rocket equipped bombardment groups and when mentioning the fact that the 32-pound rocket contained about seven pounds of carcass composition he did not forget to add that the ten-inch mortar fired bombs with the same weight of carcass composition. But the range of the ten-inch mortar was only 2,000 yards at the very best and it was "the most ponderous piece of ordnance."

Somebody must have said that the incendiary rockets lost most of their terror as soon as the enemy got acquainted with them and that soldiers, after having learned that there was no immediate danger to them, could easily extinguish incendiary rockets that fell close to them. Congreve's reply was very definite:

"A certain portion of the rockets have a 6-pounder shell or a cylinder, holding nearly one pound of powder, contained in the carcass which bursts during the combustion; nor can the enemy distinguish the one sort from the other, and will, therefore, avoid all. But in addition to the above precaution, every rocket contains a certain quantity of smoke-ball composition; and the suffocating quality of this matter is well known to



Multiple powder rockets as pictured in a book on fireworks, printed in Austria about 1625

be such, that no person can exist in the room where it has burnt but a few seconds."

The question which type of weapons, rockets or artillery, was the more expensive was answered by a little expense account for either sort.

Rockets

	£	s.	d.
Case complete	0	5	0
Cone	0	2	11
Stick	0	2	6
Rocket charge	0	3	9
Carcass charge	0	2	3
Labour, paint etc.	0	5	6
	£1	1	11

Ten Inch Mortars

	£	s.	d.
Carcass charge	0	15	7
Powder charge	0	1	0
Cartridge, etc.	0	1	0
	£1	2	7

(Plus the cost of the mortar.)

It was Congreve's dream to construct rockets weighing 500 or even 1,000 pounds and drawings for 8-inch rockets were found later among official reports. They were never built.

In the meantime army experts of other countries were furiously at work. The Dutch army started experimentation in 1816, at first with Congreve rockets of British make. But the results were so unsatisfactory (probably because the rockets had been stored for more than a year) that the experiments were discontinued as soon as the supply was used up. Ten years later, in 1827, stickless rockets with three stabilizing vanes were proposed by the Dutch Captain de Boer. They were made and tested, but two years later British rockets were ordered again for renewed experiments. The Dutch seem to have had particularly bad luck, they finally decided not to use rockets at all, except in colonial warfare. Actually Dutch rockets won (in 1825) a seemingly hopeless battle against about 5,000 native warriors in Celebes.

Another army where much attention was paid to rockets was the Polish. They did not rely on British rockets but made their own experimental rockets from the start. In charge of the work was Captain Joseph Bem. He compared his rockets to a light Russian field piece (the so-called *unicorn*) and stated that they had a slightly longer range, that they were at least as mobile and much cheaper.

The French army experts were doubtful at first and the *Aide-mémoire à l'usage des officiers d'artillerie de France* of the year 1819 came pretty close to stating that everything ever said in favor of war rockets had to be regarded as imaginative exaggeration. But the French did create a special commission for rocket research and various types of rockets were constructed and tested. They strove to develop a rocket as short and as heavy as possible, their largest model had a weight of close to twenty kilograms. Its range was two miles. Military books—secret at that time—stated that those rockets penetrated between three and six feet of sand at a distance of 100 yards. The explosive force of the bombs carried by those rockets was very high, their destructive effect surpassed that of comparable artillery shells by far.

The Danish army assigned the development of war rockets to Captain Schuhmacher. It seems that Captain Schuhmacher, who worked on a lonely island in the Baltic in a specially equipped laboratory (all his workers were convicts) was very successful, but nothing was ever published. We know about these experiments only through a few notes made by the French Captain Brulard who visited Schuhmacher's island with the special permission of both governments, his own and that of Denmark. The Danish experiments were surpassed in secrecy by the Swedish, all that is known is that the officer in charge of the laboratory had the name of Schrïderstjerna.

The most extensive use of war rockets, however, was made by the Austrian army. They used only the stickless rockets originally invented by William Hale near the end of the first half of the last century and proudly recorded a long list of battles and minor engagements in Hungary and in Italy that were decided in favor of the Austrians by the rocket batteries. In Switzerland everything was organized down to the smallest detail for the creation of an independent rocket corps, but it was never actually formed.

None of all these rocket corps was very long lived, in 1860, only that of Austria was left. It was dissolved seven years later, after it had failed in the war against Prussia. The Prussian *Feuerwerks-Abteilung* served only as a commission for the study of rockets for military purposes. When after the war against Napoleon III in 1870-71, the Prussian Army underwent complete reorganization the rocket department quietly disappeared from history.

There has been a revival of interest in rockets during the present war. Major General J. F. C. Fuller, British Army, Retired, in an article in *The Gunner*, quoted in part in the January-February, 1941, issue of the Coast Artillery Journal, mentions the rocket as the possible "secret weapon." He indicates that directional control is all that is needed to make rockets effective weapons. Controls similar to the clever ones for controlling naval torpedoes are possible for use in bombing large targets.

If defense against the night bomber becomes more effective, as recent developments hint that it might, there is even greater possibility that some form of rocket may be evolved to take the place of night bombardment aviation.