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Chapter 3

THE SWEDISH FIRE ARROW THE OLDEST ROCKET SPECIMEN EXTANT*

Å. Ingemar Skoog† and Frank H. Winter‡

In the Collection of the Royal Army Museum (Kungl. Armémuseum) in Stockholm is a rare 16th Century rocket specimen, the "fire arrow", which is probably the oldest existing rocket specimen in the world. A study of this unique 400 year old rocket is of great value not only because it is the oldest remaining rocket artifact, but also because it enables a better understanding of early rocket technology during its first major development cycle in Europe in the 15th through 17th Centuries. It may also provide some clues as to the general development and spread of the rocket up to that time.

DESCRIPTION OF THE FIRE ARROW

The "fire arrow" (Figure 1), with an overall length of 2.08 meters and a total weight of 6.8 kg, consists of basically three different parts significant to its use and function: the pole, the incendiary ball with the three rockets and the iron arrow-head. The arrow-head (Figure 2) served the traditional purpose of penetrating the targets and impeding the removal of the fire arrow due to the barbs.

The ball at the upper end of the fire arrow (Figure 2) contains an incendiary and is covered by a canvas-type of material. During the 16th and 17th Centuries incendiary charges consisted of two parts of gun-powder, two parts of salpeter and one part of sulfur plus some train oil formed into a ball and wrapped in a canvas and painted with pitch. Partly embedded in the ball are three rockets, 265 mm long and 46 mm in diameter. The rocket casings are wrapped with a paper of muslin type material. A restricted exhaust outlet (Figure 3) is achieved by strapping the case with a string, a manufacturing method known from the 16th and 17th Century literature (e.g. Schmidlap and Simienowicz). All three rockets are charged with black powder in the common cylindrical propellant configuration.

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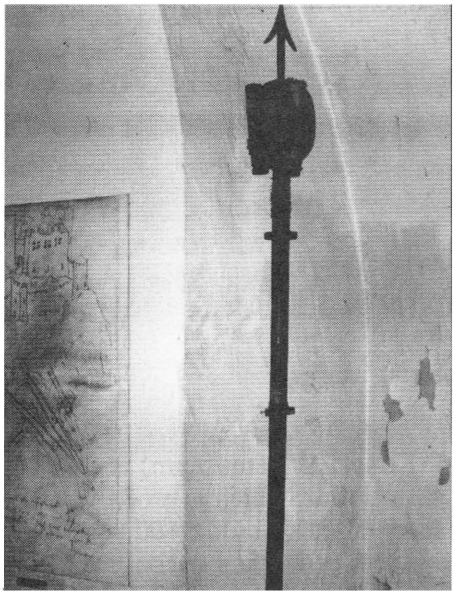

Figure 1 The Fire Arrow in the Royal Army Museum (photo by Å. I. Skoog)

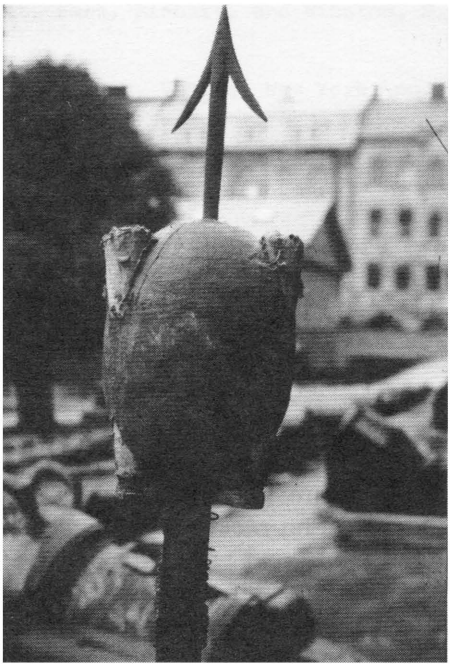

Figure 2 The incendiary ball and rockets (photo by Å. I. Skoog)

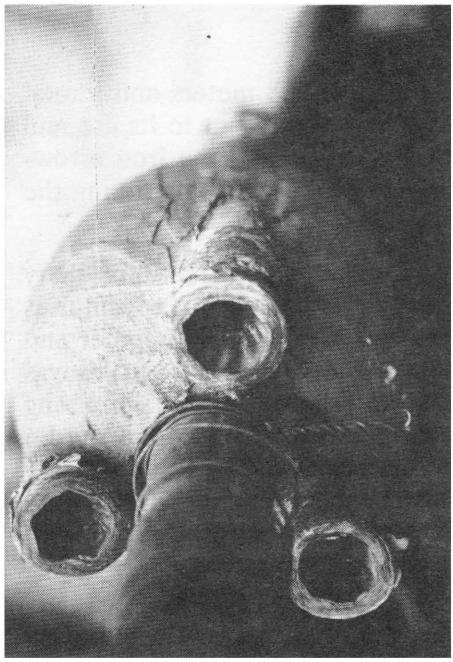

Figure 3 The exhaust outlet of the rockets (photo by Å. I. Skoog)

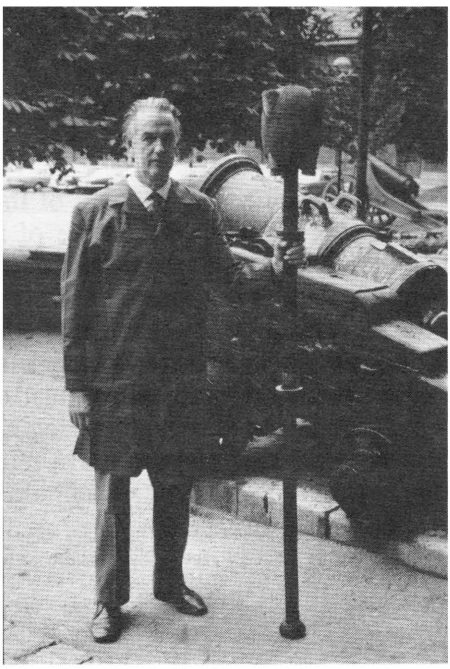

Figure 4 The pole with discs and endplate (photo by Å. I. Skoog)

Figure 5 The endplate of the Fire Arrow (photo by Å. I. Skoog)

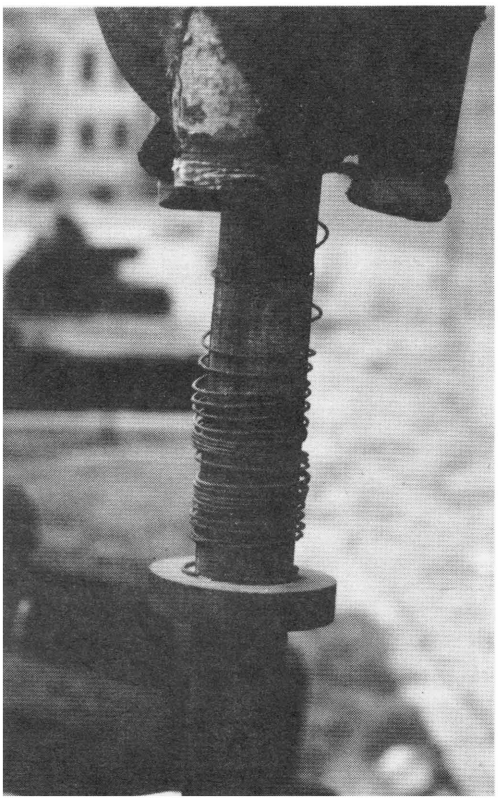

Figure 6 The grooves for fuses and the steel-wire (photo by Å. I. Skoog)

The wooden pole (Figure 4) is 52 mm in diameter and fitted with two wooden discs (0.71 and 1.205 meters from the arrow tip) along the pole and an expanded semispherical end-plate (Figure 5). Along the whole length of the pole are three grooves placed in front of each one of the three rockets and running through the two discs. Above each of the discs is a steel-wire wound around the stick (Figure 6). The end-plate bears traces of having been covered by sheet-metal or similar material. The diameter of the discs is 9.2 cm.

The grooves supported the fuses to the rocket and/or the incendiary of the ball. These fuses must have been kept in place by some wrapping held together by the steel-wire.

HISTORICAL BACKGROUND

The fire arrow first came into the possession of the Royal Army Museum in 1879 (inventory No 1029 F: II) when handed over by the Stockholm Ammunition Depot; but no explicit records exist on this particular artifact.

As the military inventory records from 1520 and later are preserved in the Royal Swedish Military Record Office and often contain additional materials such as contracts for manufacturing of guns and records of tests and military engagements, a good picture of the introduction and use of the fire arrow is achievable.

In Swedish, the word for fire arrow is *fyrpil*. An archaic word for gun in the Swedish language is *stycke*. This is of importance going through the old inventories, as in the year 1565 four *fyrpilstycken* or fire arrow guns are registered for the first time. During the next five years the following number of *fyrpilstycken* were manufactured:

1565	4
1566	25
1567	61
1568	18
1569	6
1570	8
Total	122

It is unclear whether any further manufacturing occurred after 1570, but in 1594 thirty-three *fyrpilstycken* were still available. Between 1611 and 1632 a few of these fire arrow guns were still registered, the last one in 1632. Of particular interest in the possible use of the fire arrow is the record of 1569 which shows the following distribution:

- Fortifications in Sweden 7
- Fortifications in Finland 2
- Fortifications in Baltic Provinces 2
- The field artillery 3
- The Navy 63

These "fyrpilstycken" were made primarily of copper and a few out of iron. They weighed on the order of 200 - 700 kg.[1] None of these *fyrpilstycken* are known to exist today. Sweden participated in the Reformation during the first half of the 16th Century; at the same time, King Gustav I Vasa also tried to consolidate and expand the Swedish Baltic Empire. The inventory records show the *fyrpilstycken* were spread to the Swedish provinces of the Baltic east coast during this time. In order to build up his Baltic Empire the King needed to modernize and strengthen the army. For this purpose he hired fireworkers and gunsmiths from the continent, mainly Germany.

The most famous of these gunsmiths, and who had the strongest influence in the development of the Swedish 16th Century artillery, was Gilius Packett. Packett came to Sweden from Danzig in 1554. In a contract of 24th November 1564 (Fig-

ure 7) between Packett and the Swedish King the manufacture of large fire arrows was to be used against ships and buildings to set fire. Furthermore, Packett had the obligation to teach six Germans and six Swedes in the art of artillery and pyrotechnics.[2] This was one year before the first fire arrow gun shows up in the inventory records.

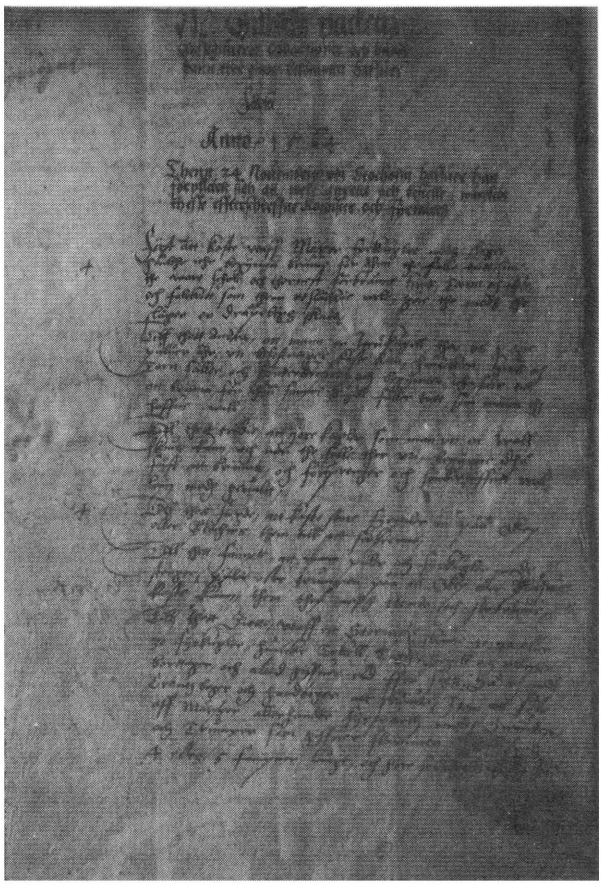

Figure 7 Gilius Packett's contract with the Swedish King, dated 24 November 1564 (The Royal Swedish Military Record Office).

The inventory records for 1565[3] list test-firings of fire arrows in six instances, for a total of 23 fire arrows. In addition, the records show that 33 fire arrows were launched against the town and castle of Varberg in southern Sweden during the Swedish siege in August and September 1565, and that a total of 407 fire arrows were manufactured that year.

ROCKETS IN THE 15TH - 17TH CENTURY LITERATURE

Following this description and historical background of the fire arrow, the contemporary literature on artillery and pyrotechnics must be analyzed in order to gauge the significance of the artifact, and the state-of-the-art of rocketry in general during that period.

First, there is ample evidence to show that rockets were well known in Europe by the end of the 13th Century. Thus, recipes for "flying fire" found in the *Liber Iqnium ad Comburendos Hostes* (*Book of Fires for Burning Enemies*) attributed to Marcus the Greek in the 13th Century are found duplicated--sometimes word for word--in manuscripts of the 14th Century. Mark the Greek (Marchus Graecus) provides at least four formulas for rockets. The one most often copied is recipe No. 13:

> "Take 1 libre (pound) of native sulpher, 2 libra of charcoal of linde or willow, 6 libra of sla petrosum (saltpeter or potassium nitrate) which are all three well mixed on a marble stone. Afterwards place the powder at pleasure in an envelope for flying (i.e. as a rocket) or for making thunder (as a fire-cracker). Note that the envelope for flying should be long and slender and filled with powder well packed. But the envelope for making thunder should be short and thick and half-filled with the said powder and strongly tied at both ends with iron wire".[4]

In Albertus Magnus' book *De Mirabulus Mundi* (*On the Wonders of the World*), written sometime between 1250 and 1280 A.D., essentially the same receipt is found. The following comes from the 1637 English translation of this work, entitled *Of the Vertues of Herbes, Stonses, and Certaine Beasts. The Secrets of Albertus Maqnusi*:

> "Make flying fire after this manner. Take one pound of Brimstone ("burn-stone" or sulfur), two pounds of the coales of Willow or (should be and) with six pounds of Stony salt (saltpeter), these three thinges must be mayed very small on a Marble Stone: afterward thou maist put soone at thy pleasure in a coot (cartridge) of paper, flying or casting thunder. A coot to fly, should be long, small and Fall (sic., full) of that best pouder: but a coot to make thunder, should be short, grosse and halfe full. Here endeth the secrets of Albertus Magnus."[5]

Once established that the rocket was known in Europe by the end of the 13th Century, its use and relative popularity vis-à-vis other weapons must be determined. Some of the earliest known instances of the rocket are found in Italy, where this device derived its name; "rochetta" is a Latin word meaning "spindel" after the shape of the rocket. Rochettas are recorded to have been used by the city of Bologna against the rival city state of Forli, in Emilia, in 1281. The town of Chiogga was also struck with rockets in 1379. Several engagements in France are known. According to the 19th Century leader of French rocketry. General Louis Auguste Susané:

> "...The use of rockets as weapons became most frequent. We can cite the celebrated defense of Orléans in 1428, where the towers and machines of the English were burned by rockets; the siege of Chavency, in 1436, where the fire was by rockets in the great bastion; at Pont-Audemer in 1449, where a fire was lit by rockets, causing the fort to fall at the first assault; the siege of Bordeaux by Count Dunois, in 1451; and the attack on Gand (i.e. Ghent, now in Belgium), by the Duke of Bourgone [Bourgogne] in 1453; twelve years later, in 1465, at the siege of Corbeil, one saw in combat a company of rocketeers, called the Company of Serpents (perhaps Sappers, or firework 'serponts'), which was commanded by a Breton artificer named Master John, known as the 'Fireband'"[6].

Likewise, war rockets frequently appear in inventories of armories and castles, like the Swedish fire arrow appearing on the lists of stores in the late 16th and early 17th Century in Sweden. They show up in the Bologna Inventory of 1381, with and without iron.[7] In Spain, they are found in the Aragon Inventory of 1488.[8] At the same time, however, war rockets become exceedingly scarce in military records and

treatises. While war rockets appear to have had a brief heyday in the 14th through 15th Centuries, they already had been clearly eclipsed by vastly more efficient, and reliable, conventional firearms and artillery. Though war rockets still lingered, they seem to have remained experimental, especially in these early years. In the various inventories of castles and armories they are always guns, war rockets being few and far between. The Swedish fire arrow may thus likewise be classed as a rarity and probably experimental. Although several were made and proved successful enough to have been deployed in at least one engagement, as shown by the old records already cited.

In the early 15th Century a pyrotechnic literature developed and served as the basis for the art for the next two centuries. The *Feuerwerkbuch* (Fireworkbook) of 1420[9] is one of the earliest of these works. It was rewritten and copied as a hand-written manuscript for over a century until printed for the first time in 1529. A second work of this period which had great influence was the *Bellifortis* written by Conrad Kyeser in 1405.[10] The influence of these two manuscripts can be found in most of the pyrotechnical and artillery manuscripts and books of the 15th and 16th Centuries, e.g. by Schmidlap, Conrad Haas, Franz Helm and later, by Simienowicz.[11]

Early war rockets were launched by leaning them up against trees or rocks or by means of simple wooden tripods or trestles. The earliest known picture of a rocket and rocket launcher appears in Conrad Kyeser von Eichstätt's *Bellifortis* finished in 1405 (Figure 8). Kyeser's launcher is a simple open trestle aimed upward to impart a long trajectory to the rocket toward its target. Standard firework launchers of wood are found in such works as John Babington's Pyrotechnia, 1635.

The *Feuerwerkbuch* was not only the standard work to be copied and rewritten by many pyrotechnicians during the 15th and 16th Centuries, it also contained very specific technical information of great relevance for the Swedish fire arrow. The incendiary is here described as consisting of six parts of saltpeter, two parts of sulfur and 1 part of charcoal mixed with oil and spirits and formed to a ball around a stick and finally covered by canvas. The *Feuerwerkbuch* also describes how to launch a pole or an arrow out of a gun (Figure 9). Finally, it provides details of manufacturing fuses.[9]

Another source of information on gun-launched rockets dates back to as early as the late 15th Century. Indeed, a proposal for a gun-launched rocket was found in the recently discovered *Codex Madrid I*, of Leonardo da Vinci and dates to approximately 1495. It shows not only another remarkable invention by the great universally acclaimed genius, but also the earliest known mating of the gun and the rocket in order to achieve far greater range for both:

> "To fire a rocket to great altitude, proceed this way: Set your cannon upright, as you see; load the cannon with a ball connected to a rocket by a chain, leaving the rocket on the outside, as shown in the figure. Then, secure a small board, with gunpowder, level with the touchhole of the cannon. Having done this, fire the rocket, and the rocket's fire, falling on the board and the touchhole, will fire the cannon. The cannonball will drive the rocket more than three miles (5 km) high and a flame half a mile (800 m) long will be seen trailing the rocket." (Figure 10).

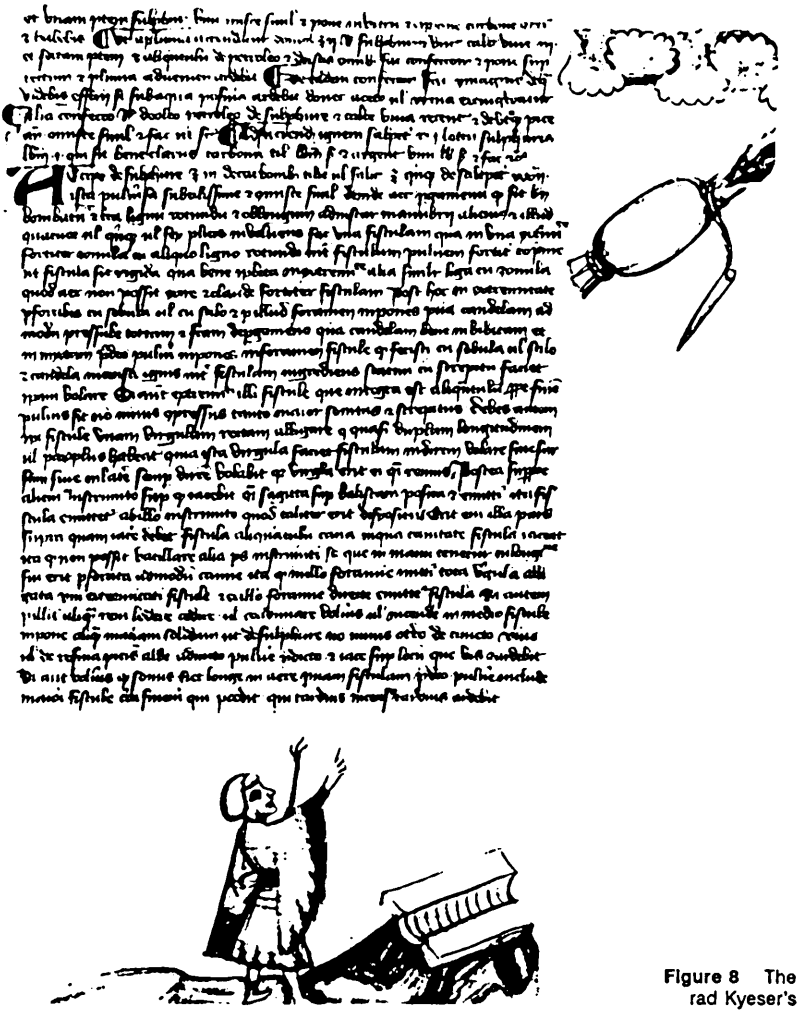

Figure 8 The rocket and launcher in Conrad Kyeser's Bellifortis.

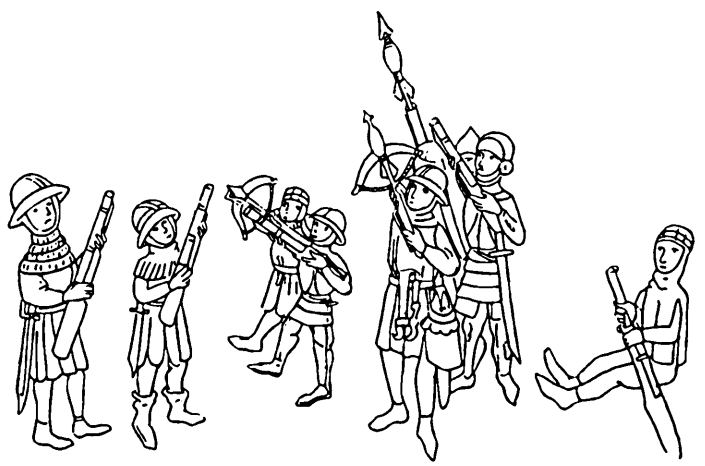

Figure 9 Fire arrows launched from crossbow and handgun around 1430 in Das Feuerwerkbuch von 1420.

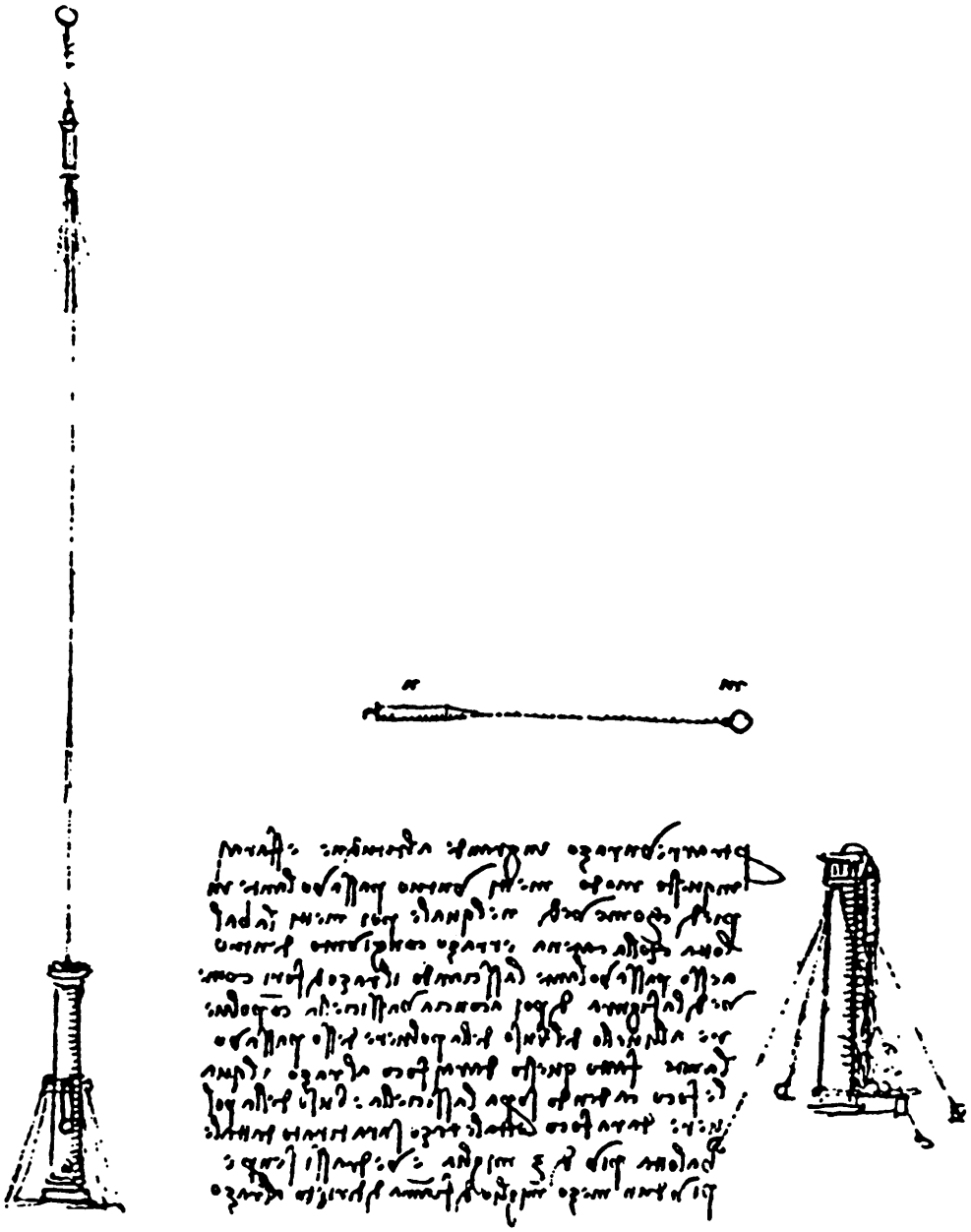

Figure 10 Leonardo da Vinci's rocket gun of 1495.

It is not known if Leonardo da Vinci tried this idea or why it was really intended for the rocket-cannonball to soar to such a high altitude. Leonardo da Vinci also speaks of other rocket weapons, including lances "of considerable length fitted with short rockets which should be placed within thé edges of the ships, and these may be set on fire by means of a thin cord which comes down the length of the pole as far as the hand." The suggestion of lances is thus very much akin to rocket arrows with barbs.[12]

Mostly, rockets functioned from the 16th Century on as amusing firework pieces or as naval signals. Vannoccio Biringuccio's *Pirotechnia* of 1540 represents one of the earliest works dealing with, in part, firework rockets. Apart from the information that recreational pyrotechnics featuring rockets and rocket-propelled devices were fairly well established by the mid-16th Century, Biringuccio's work shows that by that date the making of multiple rockets was an established art; and so were "master fuses". It also contains some of the varied ingredients available for pyrotechnics. Much the same mixtures were also found in pyrotechnics for war.[13]

Biringuccio's book represents the beginning of the flowering of the art of pyrotechnics and pyrotechnic rockets. At the same time, European war rockets were becoming used less and less. By 1700 technological advances in artillery were such that European war rockets were then unheard of, until the early 19th Century. Thus, the Swedish fire arrow may be said to fit into the middle of the first period of general use of the war rocket in Europe (i.e. ca. 1600). This period also represents an innovative time for all weapons and technology.

COMPARISON WITH 16TH - 17TH CENTURY ROCKETS

Following this brief history of the rocket with an emphasis on the place of the Swedish fire arrow we can examine that technology in greater detail. First, the incendiary arrows described and depicted in Biringuccio's *Pirotechnia* should be noted (Figure 11). This was the simplest and most common form of incendiary weapon and can be found in many other early works on military art and science such as *The Gunner Shewing the Whole Practise of Artillery* by Robert Norton 1628 and *La Pyrotechnie* 1630 of Jean Appier who also took the name of Hanzelet Lorraine.[14] The standard incendiary arrow, or incendiary darts as they were sometimes called, were shot from bows and arbalests (cross-bows). Their heads consist of iron-barbs, much like the head found on the Swedish fire arrow. The purpose of the standard, non-rocket propelled incendiary arrows was to convey incendiary mixtures to the gates of earthworks, wooden bridges, carts, munitions, ramparts, defending batteries, ships hulls and rigging and the like. The barbs were to insure that the arrow would stick to the target. Biringuccio's suggested compositions of pure pork fat, petroleum oil, oil of sulfur, doubly refined saltpeter, aquae vitae, Grecian pitch, turpentine, and "some coars gunpowder".[15]

Figure 11 Biringuccio's fire arrow from 1540.

Assuming that the barb on the Swedish specimen was likewise meant for attaching itself to the surface of a target for spreading incendiary fires, it may be said that the concept of an incendiary arrow represents an advance on a very old idea, to overcome the shortness of range of the standard incendiary arrow. The use of multiple rockets and also the possibility of a gun launcher represent even more interesting innovations. The Chinese of the Sung Dynasty and later periods are also known to have employed rocket arrows. But these were crude devices which were generally propelled only by small rockets. Multiple rocket arrangements and gun-assisted launchers were unknown.[16]

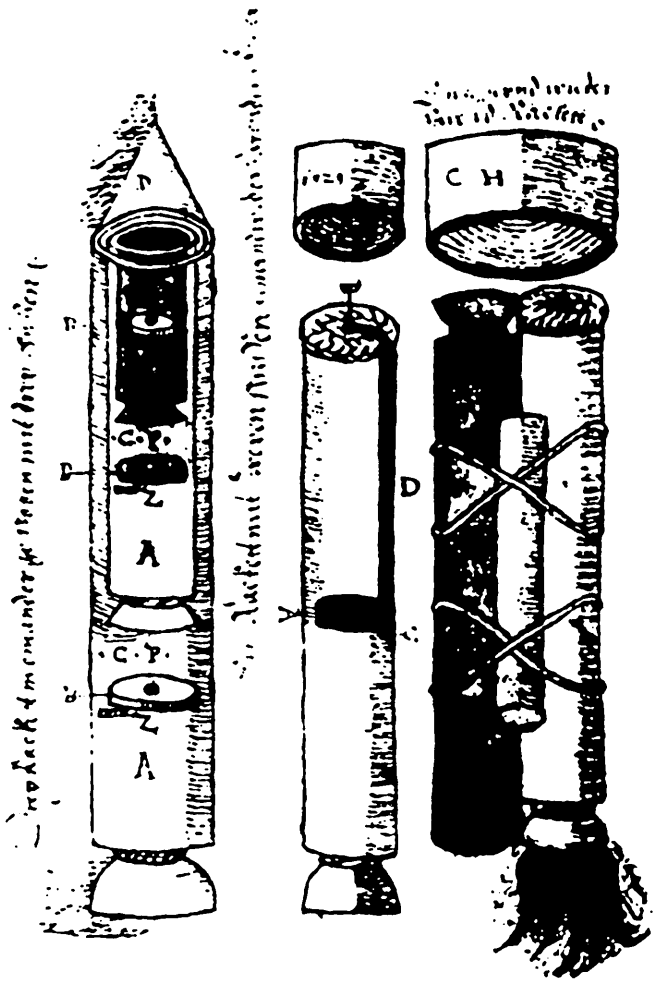

Figure 12 Conrad Haas' multistage rocket from 1529.

In addition to Biringuccio, several other early references to multiple rockets exist. Perhaps the earliest example may be found in the Sibiu Manuscript of Conrad Haas of Dornbach near Vienna. The Haas manuscript is dated to the period 1529-1569 and was written while Haas was a foreman in the arsenal of Sibiu, Transylvania, in what is now Romania. The particular drawings (Figure 12) showing the multiple rockets are dated 1529. Whereas the multiple rockets described by Birin-

guccio were very small and burst forth as a payload rather than as propelling means, the multiple arrangements of Haas were clearly larger and meant for additional rocket boost. Some of his multiple rockets were step arrangements, with one rocket placed in tandem upon the other. This form was later copied by the pyrotechnists and artillerists Johann Schmidlap (1560), Casimir Simienowicz (1650), and others. Conrad Haas' design of multiple rocket lashed together is rare, especially as three units are thus adjoined in some designs. This is the configuration found in the Swedish fire arrow and was definitely designed to achieve maximum lifting force, or thrust. The Swedish fire arrow thus represents not only the oldest known rocket specimen but the oldest known example of a multiple, but not step or stage, rocket.[17,18]

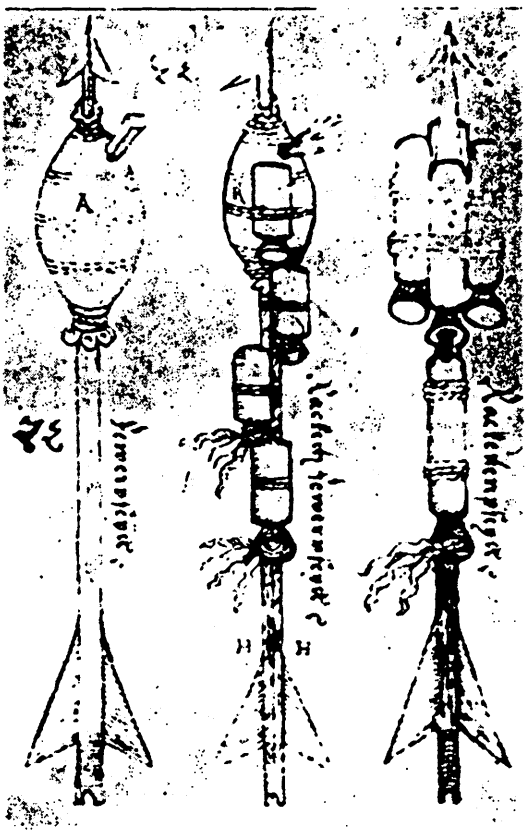

Figure 13 Conrad Haas' fire arrows from 1555.

It is not necessary to dwell upon the question of priority of the stage or compound rocket in any form. What is more important in the Haas manuscript for the study of the Swedish fire arrow is that on leaf 287, dated 1555, is found a picture of three different fire arrows (Figure 13) all with a barbed head and boosted by up to four rockets. At the rear of the arrow shafts are what can be regarded as normal tails. The purpose of these fearful-looking contrivances are for spreading incendiaries. The payload sections in two of the arrows depicted are placed just under the flukes of the barbs. The Swedish fire arrow in its purpose, and in particular in

its design, is a remarkable duplication of the Haas principle. The main difference is found in the exterior of the Swedish fire arrow. Haas' rocket arrows do not contain the peculiar wooden discs and suggestion of gun-launching. Rather, the Haas' arrows are initially launched by bows. Regardless of this difference, it is significant that Todericiu's diligent researches lead him to believe that the Conrad Haas manuscript was copied verbatim in many parts by Johann Schmidlap. Thus, while Schmidlap's *Künstliche und rechtschaffene Feuerwerk* of 1560 and 1591[19] deals only with pleasure fireworks and does not include the deadly fire arrow, there is no question that Schmidlap had access to rocket fire arrow technology. Franz Helm in his *Buch von den probierten Künsten* of 1535, also described the fire arrow and the configurations shown in one copy of the manuscript from 1591 indicate that the fire arrows might have been gun-launched (Figure 14) and fitted with rockets. The fact that the exhaust outlet is turned 90 degrees to the trajectory is most likely an artistic error in an attempt to accentuate the rocket.[20] The fire arrow was therefore generally known in northern Europe by the mid-1500's. In fact, the Swedish specimen now establishes the spread of this technology as far north as Sweden and indicates that it had developed to a high art.

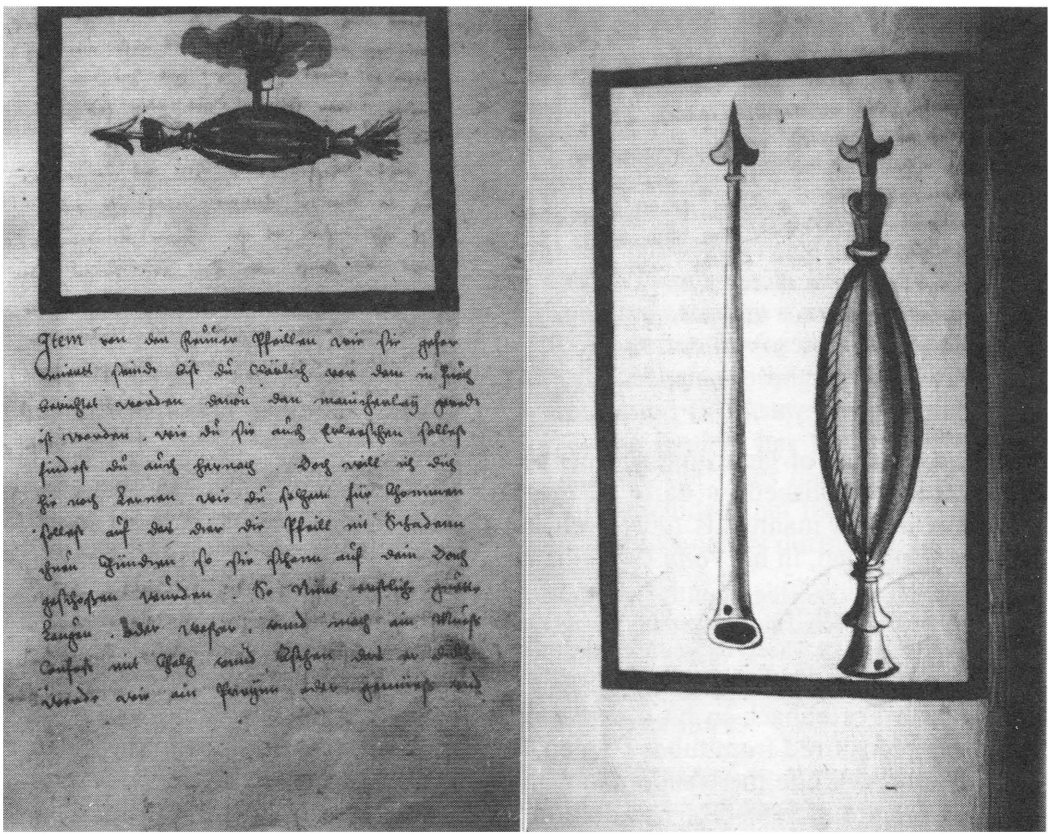

Figure 14 Various stages of manufacturing of a fire arrow according to Franz Helm 1591.

The fire arrow must have been especially popular in the northern countries as yet another example of it appears in the *Praxis Reczna Dziala* (*Practical Manual of Artillery*), written in Poland between 1622 and 1623 by Andrea dell'Aqua, an Italian in the service of the Polish artillery under Sigismund III. Dell'Aqua was a Venetian military engineer who had seen extensive service throughout Europe. His book, therefore, did not confine itself to amusements. Dell'Aqua also did not confine himself to bow-launched fire arrows, they are fire-arrows fired from guns. These projects are found in Chapters IV-VI. He also mentioned another, non-incendiary use of the barb:

> "For the purpose of injuring the enemy, when the rockets will have fallen to the ground (i.e. the barb falls into the bodies of the enemy), mount on the rockets hook D and arrow point F."

And furthermore:

> "If you want that the rocket reach higher altitudes than those fired from by hand, make a wooden tube N open on both ends, and mount the rocket by means of a regular cannon pin O (inside a cannon breech)."

Formulas are also provided as well as dell'Aqua's prejudices as in Chapter V:

> "Some of the arrows may be modified and ejected the way the Tartars do it. However, they have no knowledge of how to make a rocket of incendiary materials... Apparently they never learned any art or science which would be dangerous to us, Christians. In order to spur the progress and teach you artillarymen all the professional art, I will show you a small thing: shell A must be made of linen (canvas?) and filled with the mixture of 16 parts of good (gunpowder), 3 parts of sulphur and 1 part of charcoal. You do not have to grind these ingredients into a fine powder, nor a careful mixing is needed. Next take arrow B with a hollow tube which has to be filled with the (incendiary) mixture: 8 part of good powder, 1 part of charcoal, 1 part of sulphur. Grind all this well, mix, and do not forget to sprinkle the mixture with brandy. Mount a short cord coated with powder, that would not burn too long, as shown in D."

In Chapter VI of the *Praxis Reczna Dziala* the instruction is given that rockets may be fired from a mortar, but these were not fire arrows. Rather, they were simple rocket bodies, without sticks, for carrying explosives and incendiary compositions amongst the enemy. Mainly, dell'Aqua's fire arrow rockets were for the serious business of war.[21,22]

The practice of launching rockets by guns, either for war or pleasure, had already been established as early as the late 15th Century. The firing of festive fireworks in this manner is more well known. Leonhart Fronsperger, a friend of Johann Schmidlap, in his *Vonn Geschütz vnnd Feuerwerk* of 1557,[23] typically said:

> "Roget is the simplest of all the fireworks... And while the roget is of small power and does not last long, many beautiful fireworks can be made from it, when several are combined in balls or wheels or are shot from mortars; they are an ornament and propulsion to other fireworks and rise into the air from their own fire, without shooting."

Joseph Furtenbach in his *Architectura Navalis* of 1629 described war rockets with iron heads fired from tubes ("holen Teuchel") mounted on ships in the defense against pirates. While the Neapolitan Gambattista della'Porta in his *Magia Naturalis* (*Natural Magic*) of 1558 (English edition 1658), described at length how to make a rocket that will fit in brass or iron guns for shipboard use.[24]

Another example of naval use of gun-fired rockets fired by Dutch ships against the English is from the 17th Century. These were "invented" by the "State's fireworker and engineer Adolf Sleevocht" about 1653. They were fired from blunderbusses with the special purpose of setting fire to the sails of enemy ships.[25] The mode of launching these rockets is emphasized here because of the possibility that the Swedish fire arrows were likewise fired in this manner.

Finally, the quality of the rockets in the Swedish fire arrow should be investigated. To judge their caliber, the Polish artillerist Casimir Simienowicz *Great Art of Artillery* of 1650 and 1676 will be used, based on its wide spread circulation and several translations. While Simienowicz spoke of 100-pounder rockets, these must have been theoretical only as this size is almost unheard of save for the gigantic, and exceedingly expensive, 50 lb (25 kg) and 120 lb (60 kg) experimental rockets of Colonel Christoph Friedrich von Geissler, field artillery commander of the Elector of Saxony in 1668. Rather 6 lb (3 kg) rockets with an external diameter of 2 5/8 inches (67 mm) and a body length of 20 inches (500 mm), were considered the norm for large skyrockets. Babington, and many other 17th Century pyrotechnists, generally give recipes only for rockets up to 1 lb (0.5 kg) in caliber. The material for the rocket units of the Swedish specimen thus conform to normal standards of the time and are manufactured from standard materials used by all pyrotechnists, rolled pasteboard.[26]

THE FUNCTION OF THE FIRE ARROW

Based on the analysis of the fire arrow and the available 15th through 17th Century literature on pyrotechnics and artillery, the function of the fire arrow can be established. This despite the fact that no fire arrow gun has been preserved. The fire arrow of the Royal Army Museum in Stockholm was most likely designed to be gun-launched. The pole with its circular discs, the endplate and the groove design as well the contemporary literature provide the rationale for this assumption. The three rockets served the purpose of increasing the range by giving the fire arrow additional thrust. Whether the rockets were ignited in the trajectory by the fuses retained in the grooves along the pole or at the launch, has not yet been finally determined. If the rockets were ignited at launch, the fuses must have served the purpose of igniting the incendiary. It cannot be excluded that the fuses might have had the dual purpose of igniting both rockets and incendiary during the flight.

By the middle of the 16th Century the pyrotechnical skill and knowledge had advanced so that igniting the rockets by fuses during the flight must have been achievable. This, of course, would give the maximum performance for the fire arrow. The rockets themselves seem to have been of a standard type when compared with the descriptions in the contemporary literature.

The purpose of the fire arrow was to set fire and to spread fear, as documented by the engagement of 1565. It is of particular interest that a great number of fire arrow guns were manufactured for the Swedish Navy. Naval use is also confirmed by the literature, although no Swedish naval engagement with fire arrows is documented.

CONCLUSIONS

The fire arrow as a rare 16th Century specimen, has enabled us to compare an artifact with the general descriptions in the 15th through 17th Century literature. Although no picture of a fire arrow with the same configuration as the preserved artifact has yet been found, the general descriptions in the literature and the design of the artifact clearly indicate a gun-launched fire arrow. Limited success when used in action has also been documented.

Based on the information in the 16th Century inventory records, there is a strong possibility that the manufacturer of this fire arrow was the fireworker and gunsmith Gilius Packett, who would have brought the idea to Sweden from Germany. With an X-ray examination as well as a chemical analysis of the interior of the Swedish fire arrow, a more complete determination of its nature might be secured. For the Swedish fire arrow of the mid-16th Century is the rarest glimpse we have into the fascinating history of early rocket technology.

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