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## Chapter 1

## ANALYSIS OF ROCKET CONSTRUCTION, DESCRIBED IN MANUSCRIPTS AND PRINTED BOOKS DURING THE 16TH AND 17TH CENTURIES\*

Mieczyslaw Subotowicz<sup>†</sup>

The earliest authors before the 15th Century who dealt with rockets and rocket techniques are: Marcus Graecus [1], Ibn Albaithan [2], Albertus Magnus [3], Roger Bacon [4], Hassan Alrammah [5], and Muratori [6]. Also mentioned in the literature is the Silesian monk, Severinus [7], who used gun powder to accelerate "pipes", which probably refer to rockets. More detailed descriptions of the military rockets and fireworks appear in European writings of the 15th Century.

The first use of rockets in Europe was probably in 1241 in Legnica (Silesia), during the battle between the Polish prince Henryk Pobozny and the Tartars (Figure 1). At the beginning of the 15th Century Konrad Kyeser von Eichstädt [8] wrote a widely-known manuscript that described rocket and powder production. He wrote about the three types of rockets and produced sketches of typical powder rockets (seen in Figure 2) as well as double-direction rockets.

The Italian engineer, Joannes de Fonana [10], presented prototype projects of an aerial torpedo able to produce a blast and of a reaction airplane -- a kind of rocket with the wings. Also known is a sketch of a double-direction rocket of Regionmontanus [12].

Very important achievements in non-standard rocket construction are contained in a manuscript by Konrad Haas [16] found in the library of the city Sibiu in Rumania [53]. The manuscript consists of three parts, probably written by three different authors living in the years 1380-1569. In the third part, techniques for production and some applications of one- and multi-step rockets are described. The unknown author of the first part may be Hans Haasenwein. The author of the third part, Konrad Haas, was born in Dornbach near Vienna and served as chief of the artillery arsenal of the town Sibiu/Herrmannstadt. A relationship appears to exist between Konrad Kyeser's *Bellifortis* with the manuscripts of the later technicians, including Haas. His manuscript contains some sketches of the two-stage rocket,

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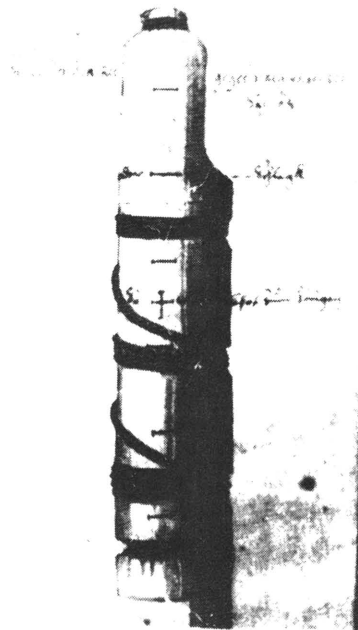
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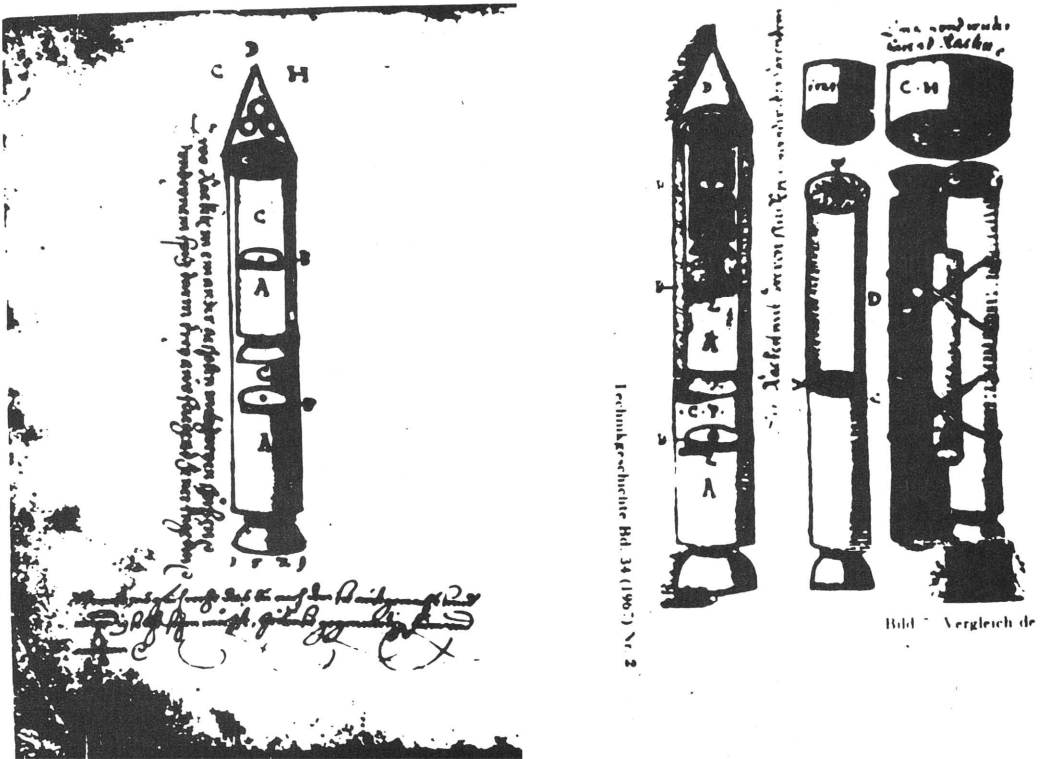
seen in Figure 3, a three-stage rocket, a double-direction rocket, a rocket battery, a combined two-step rocket, and delta-shaped stabilizers used in rocket flight. Haas also dealt with primitive ballistics and flight theory.



**Figure 1** Fresco in the abbey built on the battle place by Legnica, Silesia, of the Polish army against the Tartars in 1241. The fresco shows the drake fire head that could be propelled by rocket action.



**Figure 2** Sketch of rocket from the book of Konrad Kyesser von Eichstädt [8], 1405.



**Figure 3** Sketch of two-step rocket from book by K. Haas [16], 1529-1569 (left); and sketch of Haas three-step rocket and double-direction rocket (right) [16]

An author who dealt with non-standard rocket design, Vanuccio Biringuccio [17], described a combined two-stage rocket whose second stage was the rocket battery. Reinhard von Solms [19] wrote on rockets with parachutes. In Leonhard Frönsperger's book [21] are sketches of a two-step rocket and of a double-direction rocket (shown in Figure 4). Frönsperger had probably seen [53] the Haas manuscript [16].

Especially well-known was the book of Johann Schmidlap [24], published in 1561 and republished in 1590, 1591 and 1608. It contains sketches (Figure 5) of two-stage and double-direction rockets. It is highly probable that some parts of the Haas' manuscript were copied by Schmidlap in his book [24, 53].

Details of rocket technology were first published in Poland by Marcin Bielski [25], Figure 6, and by S. Sarnicki [26].

Many technicians and artillery specialists [27-51] dealt with rockets in books or manuscripts. Only non-standard rocket construction is noted in the following paragraphs.

It appears that in the early years of the 17th Century the manuscript of Walenty Sebisich [31], was written. He was the military architect of the town Wrocław. The

manuscript contains sketches of rockets with the delta-type stabilizers, Figure 7a; rocket batteries, Figure 7b; and something like a two-stage rocket, Figure 7c.



Figure 4 Sketch of two-stage rocket and of double direction rocket from L. Frönsperger [210], 1557.

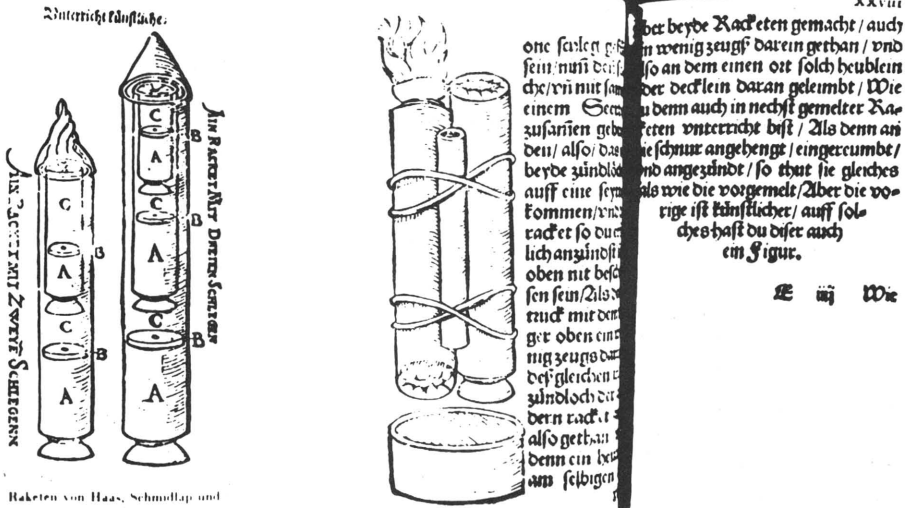


Figure 5 Sketch of the two-stage and three-stage rockets of J. Schmidlap [24], 1561 (left); and sketch of his double-direction rocket (right) [24].

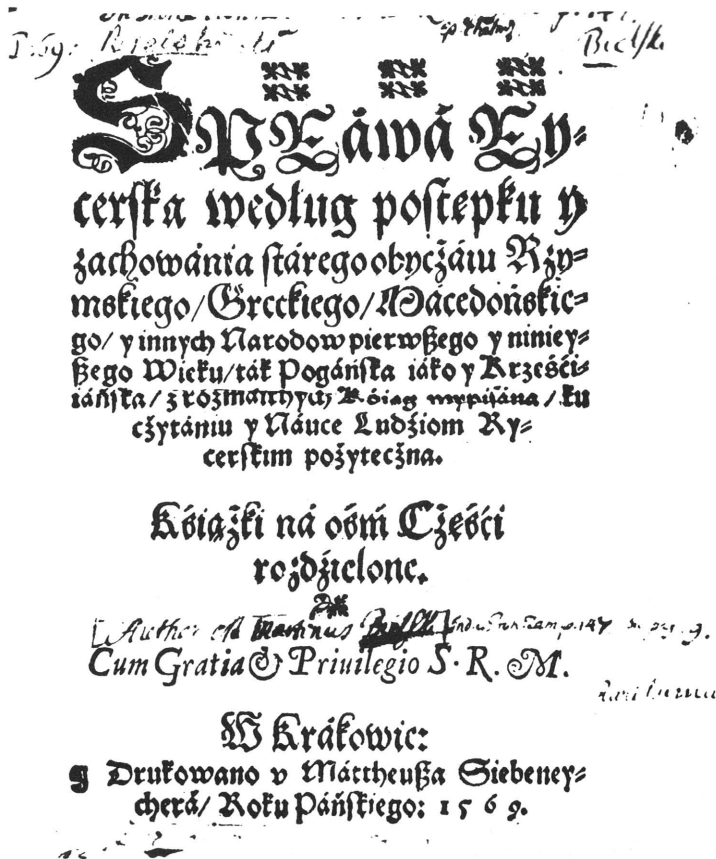
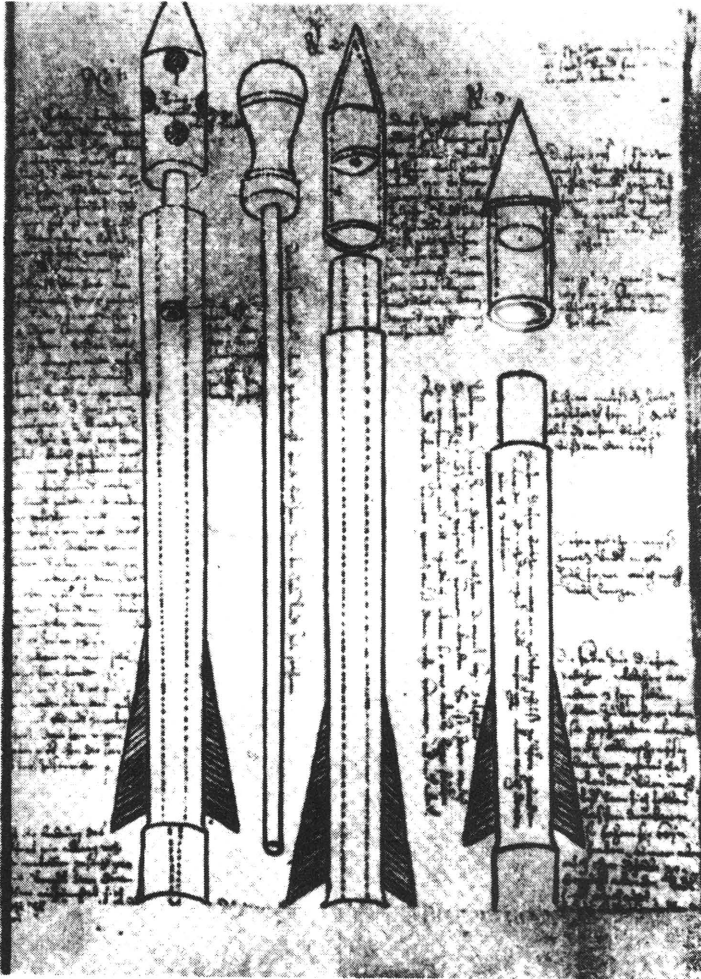


Figure 6 Title page of work by M. Bielski, 1569, written in Polish [25] in which details of rocket production are described.

Another manuscript is that of A. dell Aqua [41], an artillery specialist of Italian origin who served in the armies of Polish kings and princes. His book was written between in 1630 and 1635 and contains a sketch of a two-stage combined rocket (Figure 8). The second stage of the rocket is a rocket battery, which consists of five small rockets.

Kazimierz Siemienowicz [43] occupies a special place among authors of non-standard rocket concepts and designs. Serving as artillery general of the Polish king Władysław IV during the first half of the 17th Century, he wrote an excellent book [43] that was translated into English and other European languages (Figure 9a). Siemienowicz incorporated excellent sketches in his book of various rocket configurations, as noted in Figures 9b and 9c. They included multi-stage rockets, rocket batteries, conical nozzles, delta-type stabilizers, double-direction rockets and combined rockets, wherein one or more multi-stage rockets form the rocket battery. Similar rocket concepts appeared in books and manuscripts prepared by many authors during the second half of the 17th Century, and later.

When analyzing non-standard rocket designs by the above-mentioned authors, it is usually not possible to find connections between them. But there are two exceptions, namely, Frönsperger's work [21], and that of Schmidlap [24]. Both are believed to be connected [53] with the Haas' manuscript [16]. When we examine the military and entertainment applications of these rockets, some construction solutions appear quite obvious. Fireworks were in common use for a long period in courts of kings and princes. Therefore, it is highly probable that all the designs and concepts already described were proposed quite independently by different authors, even up to the 20th Century [52].



**Figure 7a** Delta-type rocket stabilizers by Sebisch [31] about 1600.



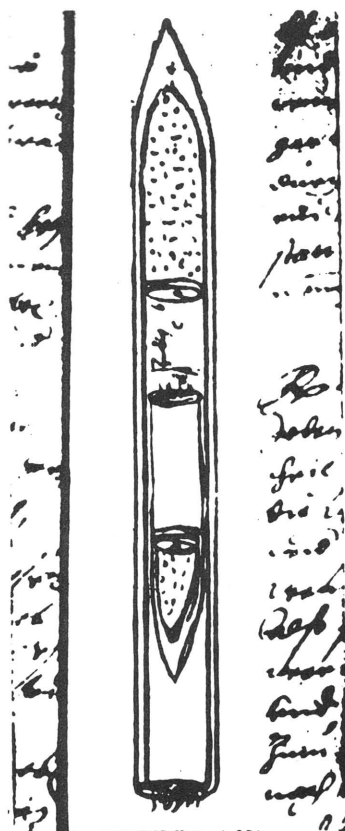


Figure 7b & 7c Sketch by Sebisch of rocket battery, about 1600 (left); and of his two-stage rocket (right) [31].

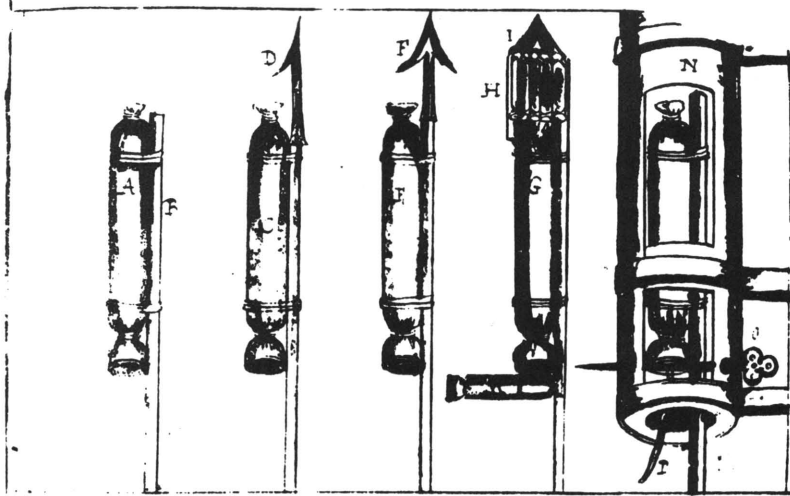


Figure 8 Sketch of two-stage combined rocket by A.dell Aqua [41], 1630-1635.

THE  
**GREAT ART**  
*of Ruzh*  
**ARTILLERY**  
 OF  
**CASIMIR SIMIENOWICZ,**  
 Formerly LIEUTENANT-GENERAL of the  
 Ordnance to the King of Poland.

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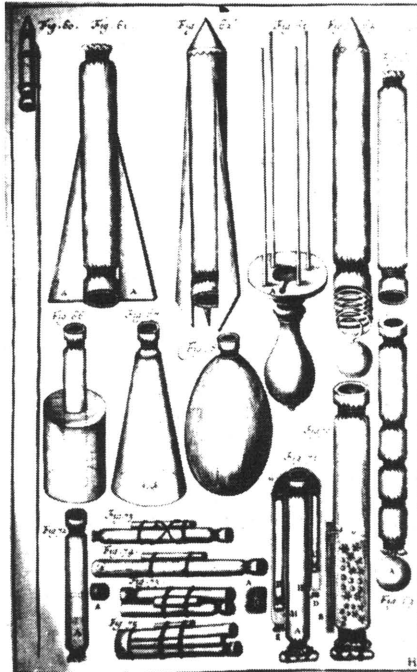
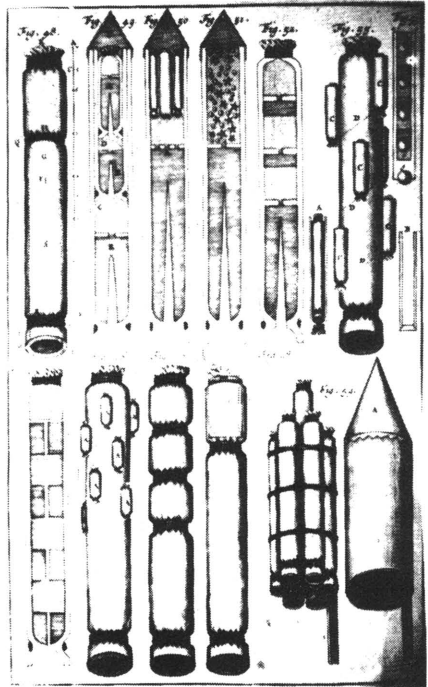
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**Figure 9** Title page of the English translation, 1729, of the Siemienowicz book [43], 1650 (top left); sketches of his [43] three-stage rocket, two-stage combined rocket and of the rocket battery (top right); of his double-direction rockets and of the delta-type rocket stabilizers, 1650 (bottom).

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