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NOT ONLY BARRELS – EQUIPMENT FOR FIREARMS IN THE STATE OF THE TEUTONIC ORDER IN PRUSSIA

Keywords
Firearms equipment; projectiles; gunpowder; Late Medieval Prussia; Teutonic Order; Middle Ages

Introduction

The history of research on firearms in the state of the Teutonic Order in Prussia (fig. 1) is already about 150 years long. One of the first works was a paper by M. Toeppen[1], worth mentioning are also works by M. Baltzer[2],

[1] M. Toeppen, *Die älteste Nachrichten uber das Geschützwesen in Preussen*, Archiv für Offiziere des Königlichen Preussischen Artillerie- und Ingenieure Corps 63 (1868), pp. 123–168, 211––236.

[2] M. Baltzer, *Zur Geschichte des Danziger Kriegswesens im 14. und 15. Jahrhundert. Ein Beitrag zur Säcularfeier der Vereinigung Danzigs mit der preussischen Monarchie*, *Wissenschaftliche Beilage zum Programm des Königlichen Gymnasiums zu Danzig*, Danzig 1893.

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B. Engel[3], extensive and to some degree still valid publications by B. Rathgen[4], papers by M. Grodzicka[5], or a book by V. Schmitdchen.[6] The latter was intended to comprehensively discuss the problem of firearms in the Order's state in the period to 1410. Of great value are also works by A. Nowakowski[7], M. Woźniak[8], M. Arszyński and I. Sikorska-Ulfik[9], W. Świętosławski[10], A. R. Chodyński[11],

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3 B. Engel, *Nachrichten über Waffen aus dem Tresslerbuche des Deutschen Ordens von 1399–1409*, Zeitschrift für Historische Waffenkunde 1 (1897–1899), pp. 195–199, 228–233; idem, *Waffengeschichte-Studien aus dem Deutschordensgebiet*, Zeitschrift für Historische Waffen- und Kostümkunde 4 (1906–1908), pp. 118–125.

4 B. Rathgen, *Die Pulverwaffe im Deutschordensstaate von 1362 bis 1450*, Elbinger Jahrbuch 2 (1922), pp. 1–116; idem, *Die Faule Grete*, Elbinger Jahrbuch 4 (1924), pp. 45–76; idem, *Das Geschütz im Mittelalter*, Berlin 1928.

5 M. Grodzicka, *Zabytkowe działa spiżowe w zbiorach polskich*, Studia i Materiały do Historii Wojskowości 6 (1960), 2, pp. 358–415; eadem, *Bombarda z zamku w Kurzętniku (Najstarszy spiżowy okaz artylerii krzyżackiej)*, Studia do Dziejów Dawnego Uzbrojenia i Ubioru Wojskowego 1 (1963), pp. 7–13.

6 V. Schmidtchen, *Die Feuerwaffen des Deutschen Ritterordens bis zur Schlacht bei Tannenberg 1410: Bestände, Funktion und Kosten, dargestellt anhand der Wirtschaftsbücher des Ordens von 1374 bis 1410*, Lüneburg 1977.

7 A. Nowakowski, *Some Remarks about Weapons stored in the Arsenals of the Teutonic Order's Castles in Prussia by the End of the 14th and early 15th Centuries,* in: *Das Kriegswesen der Ritterorden im Mittelalter*, ed. Z. H. Nowak (Ordines Militares. Colloquia Historica Torunensia VI), Toruń 1991, 75–88; idem, *Źródła zaopatrzenia w uzbrojenie wojsk krzyżackich w Prusach w XIV–XV w.*, in: *Pamiętnik XIV Powszechnego Zjazdu Historyków Polskich*, ed. D. Bednarska-Pituła, 2 vols, here vol. 2, pp. 333–337, Toruń 1994; idem, *Arms and Armour in the Medieval Teutonic Order's State in Prussia* (Studies in the History of Ancient and Medieval Art of Warfare 2), Łódź 1994; idem, *Arsenał zamku krzyżackiego w Toruniu*, in: *Materiały z VII sesji naukowej Uniwersyteckiego Centrum Archeologii Średniowiecza i Nowożytności*, ed. J. Olczak (Archaeologia Historica Polona 14), pp. 223–231, Toruń 2004.

8 M. Woźniak, *II. 2. 23. Bombarde*, in: *800 Jahre Deutscher Orden. Ausstellung des Germanischen Germanisches Nationalmuseums Nürnberg in Zusammenarbeit mit der Internationalen Historischen Kommission zur Erforschung des Deutschen Ordens*, hrsg. v. U. Arnold, G. Bott, Gütersloh–München 1990, p. 70,

9 M. Arszyński, I. Sikorska-Ulfik, *II. 2. 24. Büchsenkugeln*, in: *800 Jahre Deutscher Orden* (as n. 8), pp. 70–71.

10 W. Świętosławski, *Koszt broni palnej i jej użycia w państwie krzyżackim w Prusach na początku XV wieku*, Studia i materiały do historii wojskowości 35 (1993), pp. 19–31.

11 A. R. Chodyński, *Zbrojownie malborskie*, Malbork 1978; idem, *Habsburg artillery at the close of the 15th and the beginning of the 16th centuries*, Fasciculi Archaeologiae Historicae 9 (1996), pp. 51–59; idem, *The stores of arms in the town hall of Elbląg at the beginning of the 15th century*, Fasciculi Archaeologiae Historicae 9 (1996), pp. 15–24; idem, *Inwentarz broni palnej w ratuszu elbląskim z 1413 roku*, Rocznik Elbląski 15 (1997), pp. 69–79; idem, *Bombarda krzyżacka z Kurzętnika*, in: *Imagines potestatis. Insygnia i znaki władzy w Królestwie Polskim i Zakonie Niemieckim. Katalog wystawy w Muzeum Zamkowym w Malborku 8 czerwca – 30 września 2007 roku*, ed. J. Trupinda, Malbork 2007, pp. 388–389; idem, *I.9.2. Bombarda krzyżacka*

B. Możejko[12], P. Strzyż[13], S. Jóźwiak and J. Trupinda[14], or M. Dąbrowska[15]. An extensive and enormously valuable popular-scientific book on the military of the Teutonic Order in Prussia has been recently been published by K. Kwiatkowski.[16] This work also contains numerous valuable observations concerning firearms. Some remarks on firearms in the Order's state were also made by the author of the present paper[17], in some cases with co-authorship of other scholars.[18] Numerous interesting pieces of information can also be retrieved from publications dealing

z Kurzętnika, pocz. XV w., in: *Fundacje artystyczne na terenie państwa krzyżackiego w Prusach. Katalog wystawy w Muzeum Zamkowym w Malborku 25 czerwca – 12 września 2010 roku*, ed. B. Pospieszna, 2 vols, here vol. 1, Malbork 2010, pp. 126–127; idem, *Magazyny broni na zamku w Malborku w średniowieczu i w czasach nowożytnych. Muzealne zbiory militariów w XIX i XX w.*, in: *Materiały z sesji naukowej z okazji 60lecia Muzeum Zamkowego w Pszczynie, 11–12 maja 2006 r.*, ed. M. Kluss, Pszczyna 2010, pp. 181–200.

12 B. Możejko, *Ikonograficzne źródło do historii artylerii w drugiej połowie XV wieku*, Kwartalnik Historii Kultury Materialnej 48 (2000), 3–4, pp. 171–176.

13 P. Strzyż, *Zespół kamiennych kul działowych z zamku w Reszlu*, Komunikaty Mazursko-Warmińskie 4/258 (2007), pp. 461–470; see also P. Strzyż, P. Czubla, A. Mackiewicz, *Cannonballs from the Olsztyn turret*, Fasciculi Archaeologiae Historicae 28 (2015) (*From the Problems of Historical Archaeology*), pp. 123–131.

14 S. Jóźwiak, J. Trupinda, *Organizacja życia na zamku krzyżackim w Malborku w czasach wielkich mistrzów (1309–1457)*, Malbork 2007.

15 M. Dąbrowska, *Proces odlewania dział w lejni malborskiej w XV wieku*, Archaeologia Historica Polona 18 (2009), pp. 21–44; eadem, *Badania archeologiczno-architektoniczne na terenie Zamku Niskiego w Malborku w latach 1998–2004*, in: *XV Sesja Pomorzoznawcza. Materiały z konferencji 30 listopada – 2 grudnia 2005 r.*, ed. G. Nawrolska, Elbląg 2007, pp. 303–316.

16 K. Kwiatkowski, *Wojska Zakonu Niemieckiego w Prusach 1230–1525. Korporacje, jej pruskie władztwo, zbrojni, kultura wojny i aktywność militarna* (Dzieje Zakonu Niemieckiego 3), Toruń 2016.

17 G. Żabiński, *Das Marienburger Ämterbuch as a source for the Teutonic Order's arms and armour resources*, in: *Non sensistis gladios. Studia ofiarowane Marianowi Głoskowi w 70. rocznicę urodzin*, ed. O. Ławrynowicz, J. Maik, P. A. Nowakowski, Łódź 2011, pp. 505–514; idem, *The Grose bochse – a Teutonic Supergun from 1408*, Fasciculi Archaeologiae Historicae 25 (2012), pp. 31–40; idem, *Das Grosse Ämterbuch des Deutschen Ordens – remarks on its value for arms and armour research,* in: *Weapons Bring Peace? Warfare in Medieval and Early Modern Europe*, ed. Lech Marek (Wratislavia Antiqua 18), Wrocław 2013, pp. 199–212; idem, *Ways of acquisition of firearms and related equipment in the state of the Teutonic Order in Prussia*, Acta Militaria Mediaevalia 10 (2014), pp. 119–142; idem, *Technology of manufacture of firearms in the Teutonic Order's state in Prussia – gun barrels and metal projectiles*, Fasciculi Archaeologiae Historicae 28 (2015), pp. 83–110.

18 G. Żabiński, P. Muntowski, *Średniowieczne i wczesnonowożytne militaria z wału von Plauena na Zamku w Malborku*, in: *XVIII Sesja Pomorzoznawcza*, 2 vols, ed. E. Fudzińska, here vol. 2: *Od późnego średniowiecza do czasów nowożytnych. Materiały z konferencji 16–18 listopada 2011*, Malbork 2013, pp. 37–58; J. Stępiński, G. Żabiński, P. Strzyż, *The light field cannon from Kurzętnik – a unique example of medieval artillery (against the background of development of firearms in the Teutonic Order's state in Prussia)*, Acta Militaria Mediaevalia 9 (2013), pp. 155–202.

with firearms in what is now Poland and in Central Europe.[19] Of enormous value are two books by P. Strzyż[20], which are based on a very broad assemblage of archaeological finds and also make some use of Teutonic written sources.

In spite of the fact that equipment accompanying firearms has also been dealt with in many of these works, it seems that our state of knowledge on this issue is still far from perfect. An attempt at partially filling this gap has already been undertaken by the author, with support from J. Stępiński and P. Strzyż.[21] Although the main focus of the paper was to discuss the technology of the cannon from Kurzętnik (Germ. Kauernick)[22], it was also attempted at offering some remarks on the firearms' equipment.

Concerning the source basis, the most significant are these which are directly related to the Teutonic Order itself. Of enormous importance is the account book of the Order's Treasurer[23], which covers the years 1399–1409. Relevant pieces of information can also be extracted from the book of the Marienburg (Pol. Malbork) Convent[24], which records expenses for the years 1399–1412. Numerous expenses on equipment for firearms can be found in the expense book of the House Commander of Marienburg[25] for the years 1410–1420. A great deal of data is available from the Order's inventories and visitation reports.[26] The nature

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[19] See e.g. K. Konieczny, *Ręczna broń palna w Polsce w XV i XVI w.*, Muzealnictwo Wojskowe 2 (1964), pp. 167–237; M. Głosek, *Broń palna*, in: *Uzbrojenie w Polsce średniowiecznej 1350–1450*, ed. A. Nadolski, Łódź 1990, pp. 155–164; M. Mielczarek, *Ręczna broń palna*, in: *Uzbrojenie w Polsce średniowiecznej 1450–1500*, ed. A. Nowakowski, Toruń 1998, pp. 60–64; idem, *Artyleria*, in: *Uzbrojenie w Polsce średniowiecznej 1450–1500* (as above), pp. 65–72; J. Szymczak, *Początki broni palnej w Polsce 1383–1533*, Łódź 2004; L. Klimek, J. Stępiński, P. Strzyż, G. Żabiński, *Late medieval wrought iron firearms from the Museum in Biecz*, Fasciculi Archaeologiae Historicae 26 (2013), pp. 83–98.

[20] P. Strzyż, *Średniowieczna broń palna w Polsce. Studium archeologiczne*, Łódź 2011; idem, *Broń palna w Europie Środkowej w XIV–XV w.*, Łódź 2014.

[21] Stępiński, Żabiński, Strzyż (as n. 18).

[22] In this paper historical local names from the 14th–16th centuries are used first, while later names are given in parentheses, therefore e.g.: Danzig (Pol. Gdańsk), and Marienburg (Pol. Malbork).

[23] *Das Marienburger Tresslerbuch der Jahre 1399–1409* (henceforth: MTB), ed. E. Joachim, Königsberg 1896.

[24] *Das Marienburger Konventsbuch der Jahre 1399–1412* (henceforth: MKB), ed. W. Ziesemer, Danzig 1913.

[25] *Das Ausgabebuch des Marienburger Hauskomturs 1410–1420* (henceforth: ABMH), ed. W. Ziesemer, Königsberg 1911.

[26] *Visitationen im Deutschen Orden im Mittelalter*, Part 1 (*1236–1449*) (henceforth: *Visitationen* 1), ed. M. Biskup, I. Janosz-Biskupowa, red. U. Arnold (Quellen und Studien zur Geschichte des Deutschen Ordens 50,1), Marburg 2002; *Visitationen im Deutschen Orden im Mittelalter*, Part 2 (*1450–1519*) (henceforth: *Visitationen* 2), ed. M. Biskup, I. Janosz-Biskupowa, red. U. Arnold

and value of these sources have recently been discussed.[27] Furthermore, numerous significant pieces of information are contained in an anonymous register of the Order's firearms and related equipment from c. 1523.[28] The researcher's situation, on the other hand, is much worse with regard to firearms in Prussian towns. One of the most important sources are the account books of the Old Town of Elbing (Pol. Elbląg)[29] and of Thorn (Pol. Toruń)[30]. Accounts produced for the needs of the Prussian Confederacy during the Thirteen Years War (1454–1466) against the Order are also of use.[31] Apart from that, in some cases it is possible to find relevant data in narrative sources, for instance the *Ältere Hochmeisterchronik*[32], the *Jüngere Hochmeisterchronik*[33], the *Preussische Chronik* of Simon Grunau[34], the continuation of the chronicle of Johann von Posilge[35], the *Hanseatische Chronik* of Bernt

(Quellen und Studien zur Geschichte des Deutschen Ordens 50,2), Marburg 2004; *Das grosse Ämterbuch des Deutschen Ordens* (henceforth: GÄDO), ed. W. Ziesemer, Danzig 1921; *Das Marienburger Ämterbuch (1375–1442)* (henceforth: MÄB), ed. W. Ziesemer, Danzig 1916.

27 See e.g. Żabiński, *Das Marienburger Ämterbuch* (as n. 17); idem, *Das Grosse Ämterbuch* (as n. 17); Stępiński, Żabiński, Strzyż (as n. 18), pp. 164–165.

28 M. Biskup, *Wykaz sprzętu artyleryjskiego Zakonu Krzyżackiego w Prusach z około 1523 roku*, Komunikaty Mazursko-Warmińskie 1–2/167–168 (1984), pp. 97–103.

29 *Nowa księga rachunkowa Starego Miasta Elbląga*, Part I (*1404–1410*) (henceforth: NKRSME I), ed. M. Pelech (Towarzystwo Naukowe w Toruniu. Fontes 72), Warszawa 1987; Part II (*1411––1414*) (henceforth: NKRSME II), ed. M. Pelech (Towarzystwo Naukowe w Toruniu. Fontes 73), Warszawa 1989.

30 *Księga kamlarii miasta Torunia z lat 1453–1495 / Kämmereibuch der Stadt Thorn von 1453 bis 1495* (henceforth: KKMT), ed. K. Kopiński, K. Mikulski, J. Tandecki (Źródła do dziejów średniowiecznego Torunia / Quellen zur Geschichte des mittelalterlichen Thorn 3), Toruń 2007.

31 *Księga żołdu Związku Pruskiego z okresu wojny trzynastoletniej 1454–1466* (henceforth: KŻZP), ed. A. Czacharowski (Towarzystwo Naukowe w Toruniu. Fontes 61), Toruń 1969; *Księga Theudenkusa* (henceforth: KT), ed. L. Koczy (Towarzystwo Naukowe w Toruniu. Fontes 33; Źródła do dziejów wojny trzynastoletniej I), Toruń 1937; M. Biskup, *Wykaz broni palnej i innego sprzętu wojennego wysyłanego przez Toruń w okresie wojny trzynastoletniej (1454–1466)*, Zapiski Historyczne 31 (1966), 1, pp. 81–94.

32 *Die Ältere Hochmeisterchronik*, ed. M. Toeppen, in: *Scriptores rerum Prussicarum. Die Geschichtsquellen der preussischer Vorzeit bis zum Untergange der Ordensherrschaft*, 5 vols., ed. Th. Hirsch, M. Toeppen, E. Strehlke, Leipzig 1861–1874, here vol. 3, pp. 519–709.

33 *Die Jüngere Hochmeisterchronik*, ed. T. Hirsch, in: *Scriptores rerum Prussicarum* (as n. 32), vol. 5, pp. 1–172.

34 S. Grunau, *Preussische Chronik*, vol. 1, in: *Die Preussischen Geschichtsschreiber des XVI. und XVII. Jahrhunderts*, ed. M. Perlbach, 5 vols. Leipzig 1876–1998, here vol. 1; vol. 2, ed. M. Perlbach, in: *Die Preussischen Geschichtschreiber*, vol. 2; vol. 3, ed. P. Wagner, in: *Die Preussischen Geschichtschreiber*, vol. 3.

35 *Johanns von Posilge, Officials von Pomesanien, Chronik des Landes Preussen (von 1360 an, fortgesetzt bis 1419) zugleich mit des auf Preussen bezuglichen Abschnitten aus der Chronik Detmar's von Lübeck*, ed. E. Strehlke, in: *Scriptores rerum Prussicarum* (as n. 32), vol. 3, pp. 13–399.

Stegmann[36], and others.[37] Of certain value are also extracts of sources from the Ordensbriefarchiv.[38]

Concerning sources which can be use for comparative purposes, one must mention a series of Late Medieval and Early Modern Period treatises and manuals on firearms, such as the famous *Bellifortis* from c. 1405 by Konrad Kyeser[39], a mid-15th century work by Johannes Bengedans[40], the *Kriegsbuch* by Ph. Mönch[41] from 1496, the München copy of the *Zeugbuch* of the Roman King Maximilian I[42] from c. 1502, *Memoires d'artillerie* by Surirey de Saint Remy[43] from 1697, or Józef Jakubowski's *Nauka Artyleryi* (*Teaching of Artillery*)[44], published in 1781–1783.

The present paper is divided into the following sections:

– stocks, trestles, stands and carriages,
– gun instruments,
– tools for the manufacture of projectiles,
– equipment related to gunpowder,
– conclusions and suggestions for further research.

Eventually, some information should be offered about the monetary and weight system which existed in the Teutonic Order's state in Prussia in the discussed period. This data is given on the basis of sources and scholarship which

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36 *[Bernt Stegmann's] Hanseatische Chronik*, ed. T. Hirsch, in: *Scriptores rerum Prussicarum* (as n. 32), vol. 5, pp. 492–528.

37 *Geschichten von wegen eines Bundes von Landen und Steten wider den Orden unser Lieben Frawen und die Bruder desselben Ordens*, ed. M. Toeppen, in: *Scriptores rerum Prussicarum* (as n. 32), vol. 4, pp. 71–211; *Johann Lindaus Geschichte des dreizehnjaehrigen Krieges*, ed. M. Toeppen, in: *Scriptores rerum Prussicarum* (as n. 32), vol. 4, pp. 490–675; *Liborius Nakers Tagebuch über den Kriegszug des Hochmeisters Johann v. Tiefen gegen die Türken im J. 1497*, ed. M. Toeppen, in: *Scriptores rerum Prussicarum* (as n. 32), vol. 5, pp. 289–314.

38 *Regesta historico-diplomatica Ordinis S. Mariae Theutonicorum 1198–1525*, Pars 1, 3 vols., ed. W. Hubatsch, E. Joachim, Göttingen 1950–1973, here vol. 1 (*1198–1454*), ed. W. Hubatsch; vol 3 (*1511–1525*), ed. W. Hubatsch.

39 *Conrad Kyeser aus Eichstätt Bellifortis*, c. 1405 (henceforth: Kyeser), ed. G. Quarg, Dusseldorf 1967.

40 *Krigskunst og kanoner / Kriegskunst und Kanonen. Das Büchsenmeister- und Kriegsbuch des Johannes Bengedans* (henceforth: Bengedans), ed. H. Blosen, A. R. Olsen, Aarhůs 2006.

41 Ph. Mönch, *Kriegsbuch*, 1496, Universitätsbibliothek Heidelberg, Cod. Pal. Germ. 126.

42 *Zeugbuch Kaiser Maximilians I*, c. 1502, Innsbruck, Bayerische Staatsbibliothek München, Cod. Icon. 222.

43 S. de Saint Remy, *Memoires d'artillerie. Recueillis par le Sr Surirey de Saint Remy, Commissaire Provincional de l'Artillerie, et l'un des Cent et un Officiers Privilegiez de ce Corps*, Paris 1679.

44 J. Jakubowski, *Nauka Artyleryi. Zebrana z naypóźnieyszych Autorów napisana dla pożytku korpusu Artyleryi narodowey z Rozkazu i Nakładem Jego Królewskiej Mci. Pana Naszego Miłościwego*, Warszawa 1781–1783.

were consulted for the needs of this paper. Summarical data on this issue can also be found in several works of other authors.[45]

Currency:
1 Mark – 4 Ferto (Vierdung) – 24 Scots – 60 Schilling (shillings) – 720 Denars

Weights:
1 Last – 12 Tonnen (barrels) – 12 Schiffspfund (skippounds) – 36 Zentner – 240 Lispfund (lispounds) – 4320 Pfund (pounds)
1 Stein (stone) – 34 Pfund in Gdańsk (Danzig) and Elbing (Elbląg), 24 Pfund in Toruń (Thorn)
1 pound – c. 0.405 kg

Stocks, trestles, stands and carriages

In order to discuss the issue of stocks, stands and carriages for firearms in Teutonic Prussia, it seems prudent to offer a general overview of types of firearms which were used in the Order's state. It must be of course remembered that in many cases the terminology used in written sources is far from precise.[46] A division into *steynbuchsen* (stone projectile guns) and *lodbuchsen* (lead bullet guns) can be roughly (but not always!) equivalent to artillery and hand-held firearms with very light cannons. However, it tells us nothing closer on construction details of firearms. Furthermore, such a division is of much less use at the turn of the 15th and 16th centuries, due to the spread of cast iron projectiles for artillery.[47] It was therefore decided to disregard such mentions in written sources and focus on those from which more information can be gained. Concerning hand-held firearms, the most often used term was *handbuchse*. This term first appears in written sources in the early 15th century and is in use up to the end of the existence of the Order's state in Prussia.[48] Weapons which can be interpreted as *handbuchsen* can be seen in

[45] See e.g. Kwiatkowski (as n. 16), pp. 142–143, Scheme 1; p. 255, Scheme 4; Schmidtchen (as n. 6), 27; NKRSME I (as n. 29), p. xxxi.

[46] See e.g. Szymczak (as n. 19), pp. 30–35.

[47] Cf. Żabiński, *Technology of manufacture*, (as n. 17), p. 87.

[48] GÄDO (as n. 26), pp. 60, 68–69, 70–71, 73–74, 87–88, 91, 97, 105–106, 109–110, 112–114––115, 117–118, 120, 122, 147–148, 174–175, 184–185, 188, 189–190, 198, 199–200, 207––208, 234, 247, 250–252, 254, 297, 314, 335, 339, 340, 348, 352, 358–359, 390–395, 481–482, 523, 549, 551–552, 554, 578, 616; MÄB (as n. 26), pp. 143–144, 147–148; *Visitationen* 1 (as n. 26), No. 90, p. 111; No. 120, p. 250; No. 123, p. 261–262; No. 124, p. 276; No. 134, p. 322; *Visitationen* 2 (as n. 26), No. 147, pp. 21, 31, 38, 40; No. 176, pp. 152–153; Grunau, vol. 2 (as

a painting (c. 1480) depicting the siege of Marienburg (Pol. Malbork) in 1460[49] (figs. 2 and 3).

Another term, i.e., *handror*, is used much more sporadically and it appears only in the early 16th century records.[50] Regrettably, although the sources sometimes say more about guns themselves (e.g., *mesingks handror* or brass hand-held guns around 1523 at Preußisch Mark (Pol. Przezmark)[51]; *alte hantroer* and *toppelt handtroer* in 1524 at Rhein (Pol. Ryn)[52]), they do not provide any data on their stocks. In can be supposed that stocks for *handbuchsen* and *handroren* underwent a more or less the same evolution as everywhere else, i.e., from simple wooden shafts on which gun barrels where mounted (or shafts inserted into sockets in rear parts of barrels, see fig. 4) to fully developed gunstocks with properly shaped butts (figs. 5 and 6).[53]

An archaeological example of such an early *handbuchse* from the territory of the Teutonic Order's state is an early 15th century find from the Curonian Spit near the locality of Schwarzort, discovered during dredging works in 1871 (fig. 7). The gun is provided with a 5.9 cm long socket, into which an oak wood shaft was inserted. The shaft, being perhaps a late 19th century reconstruction (although survival of original wood in waterlogged environment cannot be completely excluded), was octagonal in cross-section and its length was 54 cm. Its diameter in the socket was 3.8 cm while in its end part it was 4.05 cm thick. Interestingly, there was a cavity in the end part of the stock. It accommodated a c. 39.3 cm long and 1.1 cm thick oak wood ramrod.[54] Another gun of such type and chronology (of

n. 34), pp. 399, 420, 551–552; Nanker (as n. 37), p. 298; see also Stępiński, Żabiński, Strzyż (as n. 18), pp. 178–179.

49 Konieczny (as n. 19), pp. 199–201, fig. XIIIa; Szymczak (as n. 19), 310; Strzyż, *Broń palna* (as n. 20), pp. 45–46, fig. 3; idem, *Średniowieczna broń palna* (as n. 20), p. 20.

50 GÄDO (as n. 26), pp. 76, 149, 187, 204, 206; Biskup (as n. 28), pp. 101–102.

51 Biskup (as n. 28), p. 102; Szymczak (as n. 19), 45.

52 GÄDO (as n. 26), p. 204.

53 Strzyż, *Broń palna* (as n. 20), pp. 25–34, 38–46, 67–72; S. McLachlan, *Medieval handgonnes. The first black powder infantry weapons* (Osprey Weapon 3), Oxford 2010, pp. 28–31, 37; R. D. Smith, K. DeVries, *The Artillery of the Dukes of Burgundy, 1363–1477*, Woodbridge 2005, pp. 217–218; E. Oakeshott, *European Weapons and Armour. From the Renaissance to the Industrial Revolution*, Woodbridge 2000, pp. 31–33; Mielczarek, *Ręczna broń* palna (as n. 19), p. 61; L. K. Makovskaya, *Ručnoe ognestelnoye oruže russkoy armii konca XIV–XVII v.*, Moskva 1992, pp. 28–29, 42–43, 121–122, figs. 18–24; pp. 123–125, figs. 26–37; p. 128, fig. 44; Głosek (as n. 19), p. 158; Konieczny (as n. 19), pp. 188–192, figs. VII-IX; pp. 199–211, figs. XIIIa-XXII; Rathgen, *Das Geschütz* (as n. 4), pp. 72–74, 129, 535–537; K. Górski, *Historia artyleryi polskiej*, Warszawa 1902, pp. 30–31.

54 Strzyż, *Broń palna* (as n. 20), pp. 38–40, 43, table 1; p. 289, plate IX.7–9, cat. No. 95; idem, *Średniowieczna broń palna* (as n. 20), pp. 18, 124, cat. No. 8; p. 218, plate II.1–3, cat. No. 8;

unknown provenance, but possibly related to the Order's state) is stored in the Museum in Lębork (Germ. Lauenburg). The barrel is 51.1 cm long and the calibre is 1.65 cm.[55]

Another type of hand-held firearms was hackbut (*hakenbuchse*), i.e., a gun with a hook it its front part, which could be supported against a wall or a shield.[56] Interestingly, first mentions of hackbuts in written sources appear only in the mid-15th century and they are more numerous in the early 16th century[57] It could be supposed that in earlier sources hackbuts may have been simply recorded under *handbuchsen*. Also in this case the sources sometimes provide more information. Extra small or extra large hackbuts were sometimes referred to as half-hackbuts (*halbehacken*)[58] or double hackbuts (*dhoppelthacken*)[59] respectively. In some cases the sources say that some hackbuts stored in a given locality are old (in 1521 at Preussisch Mark (Pol. Przezmark): *hogkenbuchszen* and *alde hogken*[60], *alte hocken* in 1524 at Rhein (Pol. Ryn)[61]). In 1524 at Rhein *boehemysch hocken* were recorded.[62] Analogously to *handbuchsen*, hackbuts with brass barrels (*mesigkes* or *mesingks hacken*) (figs. 8 and 9) are sometimes mentioned, e.g., about 1523 at Königsberg (Russ. Kaliningrad) and at Preußisch Mark (Pol. Przezmark).[63] On the other hand, a hackbut with an iron barrel (fig. 10) was explicitly mentioned in 1518 at Preußisch Holland (Pol. Pasłęk).[64] As in the case of *handbuchsen*, nothing closer was said on hackbut stocks. Based on data provided by P. Strzyż, it is possible to say that hackbut stocks also underwent a considerable evolution from

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Szymczak (as n. 19), pp. 36, 38, fig. 4; Konieczny (as n. 19), p. 185, fig. V; Rathgen, *Das Geschütz* (as n. 4), pp. 73–74; M. Thierbach, *Über die erste Entwickelung der Handfeuerwaffen*, Zeitschrift für Historische Waffenkunde 1 (1897–1899), 6, pp. 130–131.

55 Strzyż, *Broń palna* (as n. 20), pp. 42, 290, plate X.1–3, cat. No. 96; idem, *Średniowieczna broń palna* (as n. 20), pp. 18–19, 123, cat. No. 6; p. 219, plate III.1–3; cat. No. 6.

56 Szymczak (as n. 19), pp. 41–45; Mielczarek, *Ręczna broń palna* (as n. 19), pp. 62–63; Głosek (as n. 19), p. 158; Rathgen, *Das Geschütz* (as n. 4), pp. 62–67.

57 Biskup (as n. 28), pp. 101–102; GÄDO (as n. 26), pp. 50, 60, 65–71, 73–74, 79, 109–111, 113–115, 117–118, 120–123, 147–149, 174–175, 177, 654, 184–185, 187–191, 199–200, 202, 204, 206–209, 247, 250–251, 254, 256, 297, 314, 338–340, 342, 348, 353, 355–356, 358–359; Grunau, vol. 3 (as n. 34), pp. 483, 520, 534, 541; KKMT (as n. 30), No. 15; *Regesta*, vol. 3 (as n. 38), No. 23137, p. 217; No. 23192, p. 220; see also Stępiński, Żabiński, Strzyż (as n. 18), p. 179.

58 GÄDO (as n. 26), p. 123; Biskup (as n. 28), pp. 101–102.

59 Biskup (as n. 28), pp. 101–102; on this issue see also Szymczak (as n. 19), p. 41.

60 GÄDO (as n. 26), p. 149.

61 GÄDO (as n. 26), p. 204.

62 GÄDO (as n. 26), p. 204.

63 Biskup (as n. 28), p. 101–102.

64 GÄDO (as n. 26), p. 111.

simple straight beds or rods inserted into barrels' sockets to well-profiled stocks with ergonomically shaped butts (fig. 11).[65]

A very interesting record concerning firearms' stores at the capital castle in Marienburg (Pol. Malbork) comes from the year 1448. It mentions *22 hantbuchsen mit 39 kamern*[66], i.e., hand-held veuglaires with detachable powder chambers. In this case, the construction of their stocks must have been quiter sophisticated.[67] P. Strzyż mentions numerous examples of small calibre veuglaires and supposes that such weapons may have sometimes been mounted on trestles with the use of rotating Y-shaped holders.[68]

In 1414 in Elbing (Pol. Elbląg) 13 *cleine lotbuchsen* were recorded, apart from 10 large ones.[69] Although it is rather obvious that the former were hand-held firearms[70], it seems impossible to say anything closer about them. An inventory from Christburg (Pol. Dzierzgoń) from 1434 mentions "small short guns" (*cleyne kurcze buchsen*).[71] It can be tentatively proposed that this concerns a very primeval form of hand-held firearms, which consisted of very short barrels mounted on simple wooden stocks or shafts.[72] It could also be supposed that a mention of "rod guns" (*rutebuchsen*) from Ortelsburg (Pol. Szczytno) from 1520[73] may concern such ear-

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[65] Strzyż, *Broń palna* (as n. 20), pp. 34–36, 46–66, 286, plate VI, cat. Nos. 21–22; p. 292, plate XII.5–7, cat. No. 57; p. 295, plate XV.2, cat. No. 16; p. 296, plate XVI, cat. No. 24; p. 297, plate XVII.1–3, cat. No. 25; p. 298, plate XVIII.5–7, cat. No. 28; p. 305, plate XXV.1–3, cat. No. 38, plate XXVI.5–6, cat. No. 41; p. 333, plate LIII.6–7, cat. No. 139; p. 334, plate LIV, cat. No. 2; p. 339, plate LIX.1–4, cat. No. 141; p. 343, plate LXIII, cat. No. 50; p. 360, plate LXXX.4, cat. No. 65, cat. Nos. 2, 16, 21–22, 24–25, 28, 38, 41, 50, 57, 65, 139, 141; see also idem, *Średniowieczna broń palna* (as n. 20), pp. 21–26 and Szymczak (as n. 19), p. 42, Fig. 8.

[66] MÄB (as n. 26), pp. 143–144; Chodyński, *Magazyny broni* (as n. 11), p. 188; Rathgen, *Das Geschütz* (as n. 4), pp. 398–399; idem, *Die Pulverwaffe* (as n. 4), p. 13.

[67] On possible hand-held veuglaires in Köln in the mid-15th century see Rathgen, *Das Geschütz* (as n. 4), p. 317.

[68] Strzyż, *Broń palna* (as n. 20), pp. 94–95, 367, plate LXXXVII, cat. Nos. 110–111; idem, *Średniowieczna broń palna* (as n. 20), pp. 30–32, 124, cat. Nos. 13–14; p. 224, Plate VIII.1–7.

[69] NKRSME II (as n. 29), p. 78.

[70] Cf. Rathgen, *Das Geschütz* (as n. 4), p. 396.

[71] GÄDO (as n. 26), p. 142.

[72] Strzyż, *Broń palna* (as n. 20), pp. 25–34: for the most representative examples see p. 281, plate I, cat. No. 17; p. 282, plate II.4–7, cat. No. 20; p. 283, plate III, cat. No. 125; p. 284, plate IV, cat. Nos. 14, 18, 47, 48; p. 285, plate V, cat. No. 94; p. 290, plate X.4–6, cat. Nos. 14, 17, 18, 20 47, 48, 94, 125, 193; idem, *Średniowieczna broń palna* (as n. 20), pp. 15–21, 123–124, cat. Nos. 3, 6, 8; p. 217, plate I, cat. No. 3; p. 218, plate II, cat. No. 8; p. 219, plate III, cat. No. 6; see also Szymczak (as n. 19), pp. 36–41.

[73] GÄDO (as n. 26), p. 122.

ly hand-held firearms. Furthermore, from 1477 comes a mention of "key guns" (*schlusselbuchszen*) from Osterode (Pol. Ostróda).[74]

Concerning artillery, in the period up to the end of the 15th century there is a variety of terms which cannot always be precisely linked to a given type of cannon. It is only in the early 16th century that the terminology becomes more precise.[75] For Central Europe this seems to have been first of all caused by reforms of Maximilian I, who attempted at dividing artillery into clearly defined types using standardised ammunition. It is also this ruler who is believed to have introduced a new type of artillery carriages (so-called double bracket carriages) on a mass scale. These replaced carriages of old type, so-called *Burgunderlafetten*. The latter were composed of two parts – the lower one and the upper one, on which the barrel rested and which could be raised or lowered to change the angle of fire.[76] This significant change was possible due to the invention of trunnions. It simplified the construction of carriages and made it possible to change the angle of elevation without the need to raise or lower the entire barrel.[77]

Concerning light artillery, guns using lead ammunition should be discussed first. Guns referred to as *grosse lotbuchsen* are mentioned in sources only in the first half of the 15th century.[78] It could be suggested that such guns may have been mounted on various kinds of stands or trestles (fig. 12).[79] V. Schmidtchen shows an example of a heavy (94 kg) *lotbuchse* mounted on a trestle provided with an aiming bracket.[80] There are mentions of lead bullet guns on such trestles from 1416 and 1421 in inventories of weaponry at Nessau (Pol. Wielka Nieszawa). Interestingly, these sources mention 7 *lotbochsen* and 3 stands (*gestellen*) only (in 1416 – 7 *lot-*

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74 GÄDO (as n. 26), p. 340.

75 Cf. Świętosławski (as n. 10), p. 20, n. 6; on standarisation of artillery and its terminology at the turn of the 15th and 16th centuries see also Szymczak (as n. 19), pp. 65–69.

76 Rathgen, *Das Geschütz* (as n. 4), p. 130; W. Boeheim, *Studien über die Entwickelung des Geschützswesens in Deutschland*, Zeitschrift für Historische Waffenkunde 1 (1897–1899), 3, p. 58; on Maximilian's artillery see also e.g. Chodyński, *Habsburg artillery* (as n. 11), pp. 51–59; D. Goetz, *Die Anfänge der Artillerie*, Berlin 1985, pp. 33–34; on the new type of carriage see Szymczak (as n. 19), p. 70.

77 Strzyż, *Broń palna* (as n. 20), pp. 77–78; idem, *Średniowieczna broń palna* (as n. 20), p. 38; Szymczak (as n. 19), pp, 15–17, 71; Mielczarek, *Artyleria* (as n. 19), p. 71; H. Müller, *Deutsche Bronzegeschützrohre 1400–1750*, Berlin 1968, p. 41; Rathgen, *Das Geschütz* (as n. 4), pp. 130–131, 526; Górski (as n. 53), p. 33.

78 GÄDO (as n. 26), pp. 105–106, 369, 370, 744, 746, NKRSME II (as n. 29), p. 78; *Visitationen* 1 (as n. 26), No. 92, p. 119; *Visitationen* 2 (as n. 26), No. 176, pp. 152–153.

79 Schmidtchen (as n. 6), pp. 20–22; Rathgen, *Das Geschütz* (as n. 4), p. 396.

80 Schmidtchen (as n. 6), p. 21, fig. 13.

buchsen czu gestellen)[81]; in 1421 – *7 lotbochsen und 3 gestellen*.[82] From 1411 there comes a mention of a large gun to be brought with its trestle to the Town Hall in Elbing (Pol. Elbląg) (*de grote bussen up dat Rathus to bringen mit dem stellen*).[83] Furthermore, in 1441 a large lead bullet gun in a wooden stock was recorded at Althaus (Pol. Starogród) (*grosse lotbuchse in einer holczladen*[84]; *bochsen in holczen laden* were also mentioned at Birgelau (Pol. Bierzgłowo) in 1440 and 1441[85]). A trestle-gun (*bockpuchsel*) was also mentioned at Königsberg (Russ. Kaliningrad) about 1523.[86] Perhaps at that time this type of cannon was already rather old-fashioned.

Analogous stands and trestles may have also been used for terrace-guns (*tarrasbuchsen*), i.e., light cannons deployed on castle terraces (fig. 13).[87] On the other hand, examples of terrace-guns on wheeled carriages are also known. B. Rathgen mentions a purchase of a pair of wheels for a terrace-gun in Naumburg an der Salle in 1449; however, he believes that this gun was actually a field cannon.[88] Such guns could fire both metal and stone projectiles. A majority of mentions concerning them is known from the first half of the 15th century, although they also sporadically occur in later sources.[89]

Another kind of cannons which appears in sources were small guns launching stone projectiles (*cleyne steynbochsen*). Such guns are mostly mentioned in

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[81] GÄDO (as n. 26), p. 481.

[82] GÄDO (as n. 26), p. 482.

[83] NKRSME II (as n. 29), 31; Chodyński, *Inwentarz broni* (as n. 11), p. 72; Chodyński, *The stores of arms* (as n. 11), p. 17.

[84] GÄDO (as n. 26), p. 511.

[85] GÄDO (as n. 26), pp. 455, 457; see also Stępiński, Żabiński, Strzyż (as n. 18), p. 177.

[86] Biskup (as n. 28), p. 100; on such guns see also Szymczak (as n. 19), pp. 58–59, idem, *Broń palna w arsenałach zamkowych i miejskich w Polsce XV wieku*, in: *Szlachta, starostowie, zaciężni*, ed. B. Śliwiński (Gdańskie Studia z Dziejów Średniowiecza 5), Gdańsk–Koszalin 1998, p. 285; and idem, *Die Feuerwaffenvorräte in den Schloß- und Stadtarsenalen in Polen in der 2. Hälfte des 15. und am Anfang des 16. Jahrhunderts*, Fasciculi Archaeologiae Historicae 9 (1996), p. 10.

[87] Strzyż, *Broń palna* (as n. 20), pp. 72–84; Szymczak (as n. 19), pp. 53–55; Mielczarek, *Artyleria* (as n. 19), pp. 67, 69; Goetz (as n. 76), pp. 29–30; Schmidtchen (as n. 6), p. 19; Rathgen, *Das Geschütz* (as n. 4), pp. 57, 129–130, 332–335; Górski (as n. 53), pp. 16–19.

[88] Rathgen, *Das Geschütz* (as n. 4), pp. 156, 159, 287; on wheeled carriages for terrace-guns see also Szymczak (as no. 19), p. 70; and idem, *Broń palna* (as n. 86), p. 294.

[89] GÄDO (as n. 26), pp. 30, 45, 50, 88, 92, 104–106, 108, 188, 234, 281, 285, 287, 306, 309, 312, 314, 335, 339, 353, 355–356, 390, 424, 434–435, 445, 447–448, 450, 453, 456, 460, 483, 485–486, 519, 521–522, 531–533, 600, 603, 605, 608, 610, 616, 634–635, 640, 643–644, 694, 697, 699, 701, 703, 705–706, 708–709, 729–730, 742; MKB (as n. 24), p. 282; *Visitationen* 1 (as n. 26), No. 90, p. 111; No. 116, p. 211; No. 120, p. 249; No. 122, p. 259–260; No. 123, p. 261–262; No. 125, p. 278; *Visitationen* 2 (as n. 26), No. 176, p. 152–153; see also Stępiński, Żabiński, Strzyż (as n. 18), 176.

the period from the late 14th to the mid-15th century, while only one record is known from the first quarter of the 16th century.[90] Only in a few cases the sources provide more information on stands of such guns. In 1409 at Marienburg (Pol. Malbork) 2 small stone cannonball guns composed of two parts were mentioned. The one had one screwed-in powder chamber, while the other had three insertable powder chambers (*2 cleyne steynbochsen ycliche von 2 stocken, eyne geschruwete mit eyme polfergehuse, dy ander nicht geschruwet mit 3 polferhusen*).[91] This means that these guns were veuglaires, and their stands must have been properly shaped to accommodate removable powder chambers. It is unknown, however, whether stands for these guns were wheeled or not. On the other hand, an explicit reference to small stoneball cannons on wheeled stands is known from the same year from the Order's capital castle, where *cleyne steynbochsen of den karren* were recorded.[92] Furthermore, there is a series of records from the years 1431–1438 concerning stores of firearms at Schlochau (Pol. Człuchów). They mention stone cannonball guns in iron-fitted stands, or in fully iron-fitted stands (*steynbuchsen in laden beslagen* or *steynbuchsen in wol beslagen laden*).[93] Obviously, the size of these cannons was not specified, but these records are anyway a valuable mention concerning the construction of stocks.

As far as wheeled stands are concerned (fig. 14), there is a series of records which directly mention guns on some sort of wheelbarrow-like carriages (*carrenbuchsen*).[94] Interestingly, such records are sporadic in the first half of the 15th century and it is first in the early 16th century that they become much more numerous.[95] This may be in line with a belief that wheeled carriages became more

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[90] *Ältere Hochmeisterchronik* (as n. 32), p. 675; GÄDO (as n. 26), pp. 7, 16, 86, 92, 104, 127, 132, 236, 238, 240, 306, 314, 353, 412, 436, 438, 447–448, 450, 453, 456, 548–549, 593, 603, 608, 610, 616, 640, 641–644, 650, 656, 694, 697, 699, 701, 705–706, 742, 749–751, 756, 758, 760, 768; MÄB (as n. 26), pp. 14–15, 19–20, 143; MTB (as n. 23), pp. 558, 573; *Visitationen* 1 (as n. 26), No. 91, p. 111; No. 120, p. 249; No. 133, p. 305; *Visitationen* 2 (as n. 26), No. 147, pp. 28, 107.

[91] MTB (as n. 23), p. 558; Żabiński, *Technology of manufacture* (as n. 17), p. 90; Stępiński, Żabiński, Strzyż (as n. 18), p. 173; Świętosławski (as n. 10), p. 22; Schmidtchen (as n. 6), p. 60; Rathgen, *Das Geschütz* (as n. 4), p. 406; Rathgen, *Die Pulverwaffe* (as n. 4), p. 29; Górski (as n. 53), p. 26; Engel, *Nachrichten über Waffen* (as n. 3), p. 231; Toeppen (as n. 1), p. 152.

[92] MTB (as n. 23), p. 573; Rathgen, *Das Geschütz* (as n. 4), pp. 407, 420.

[93] GÄDO (as n. 26), pp. 658, 660, 663, 665, 668–669.

[94] See e.g. Schmidtchen (as n. 6), p. 19; Müller (as n. 77), p. 39, fig. 20; Rathgen, *Das Geschütz* (as n. 4), p. 130, 238–239, 243, 245–246.

[95] GÄDO (as n. 26), pp. 50, 112, 123, 147–148, 184–185, 189–190, 199–200, 207–208, 344––345, 348–349, 358–359; *Geschichten* (as n. 37), p. 132; *Johann Lindaus* (as n. 37), pp. 509, 516, 618; MTB (as n. 23), pp. 573, 579; *Regesta*, vol. 1 (as n. 38), No. 3861, p. 243.

popular in the first half of the 15th century.[96] On the other hand, there are several mentions of wheeled carriages from as early as the late 14th century.[97] Also in this case almost nothing is said on the construction of these carriages. Only in 1409 at Marienburg (Pol. Malbork) a payment for a blacksmith Swenkenfeld for fitting one gun on a carriage was recorded (*Swenkenfelde dem smede vor 1 bochse of eyme karren zu beslohen*).[98] "Carriage guns" varied with regard to their size. Small "carriage guns" were recorded in 1409 at Marienburg[99], in 1516 at Osterode (Pol. Ostróda)[100], in 1518 at Preußisch Holland (Pol. Pasłęk)[101], or in 1521 at Ortelsburg (Pol. Szczytno).[102] Large guns of that kind were mentioned in 1516 at Osterode.[103]

Another not quite precise term which is used in reference to light and perhaps also some medium-sized cannons is field gun (*hawfnitz*) (fig. 15), i.e., a gun accompanying troops in the field.[104] Such guns are mentioned in written sources only in the second half of the 15th and the first quarter of the 16th century,[105] which obviously does not mean that they were not used in earlier times. Guns of this kind were mounted on various types of stands, also including wheeled ones.[106]

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96 See e.g. Głosek (as n. 19), p. 157.

97 R. Heś, *Początki broni palnej w Zgorzelcu (Görlitz) 1393–1420*, Acta Militaria Mediaevalia 5 (2009), p. 141; Szymczak (as n. 19), p. 70; Goetz (as n. 76), p. 37; Rathgen, *Das Geschütz* (as n. 4), pp. 19, 39–40, 52, 169, 174, 238–239, 243, 245–247, 323, 325, plate 3.8.

98 MTB (as n. 23), p. 579; Żabiński, *Ways of acquisition* (as n. 17), p. 130; Rathgen, *Das Geschütz* (as n. 4), p. 408; idem, *Die Pulverwaffe* (as n. 4), p. 31; Toeppen (as n. 1), p. 235; Engel, *Nachrichten über Waffen* (as n. 3), p. 230.

99 MTB (as n. 23), p. 573.

100 GÄDO (as n. 26), pp. 348–349.

101 GÄDO (as n. 26), p. 112.

102 GÄDO (as n. 26), p. 123.

103 GÄDO (as n. 26), pp. 348–349.

104 See Strzyż, *Broń palna* (as n. 20), pp. 84–92; Szymczak (as n. 19), pp. 60–61; Mielczarek, *Artyleria* (as n. 19), p. 70; Głosek (as n. 19), p. 157; Górski (as n. 53), p. 20–21.

105 GÄDO (as n. 26), pp. 109–110, 188, 341–342; Grunau, vol. 3 (as n. 34), pp. 466, 553–555, 654; KŻZP (as n. 31), p. 103.

106 See e.g. Strzyż, *Broń palna* (as n. 20), pp. 89, 91–92, fig. 13; Szymczak (as n. 19), p. 61; Müller (as n. 77), p. 33, fig. 13; p. 35; It is interesting that the only surviving cannon which can be related to the Order, that is, the early 15th century gun from Kauernick (Pol. Kurzętnik) can actually be classified as a light field cannon. Regrettably, only the barrel of the gun (c. 42.28 kg) survived, see Strzyż, *Broń palna* (as n. 20), pp. 85–87, 364–365, plates LXXXIV-LXXXV, cat., No. 102; Stępiński, Żabiński, Strzyż (as n. 18), pp. 155–161, figs. 1–9; Strzyż, *Średniowieczna broń palna* (as n. 20), pp. 34–35, 123, cat. No. 5; p. 225, plate IX, cat. No. 5. A good example of a wheeled carriage for light field cannons is that of a wrought iron gun from the collection of the Zeughaus in Berlin. The cannon itself may be of Burgundian origin and it is dated to the second half of the 15th century. The barrel is mounted on a two-part bed with a split-trail elevation, with the use of iron fittings. The cannon's wheels are iron-fitted, too, see Strzyż, *Broń palna* (as n. 20), p. 89, fig. 12; Smith, DeVries (as n. 53), pp. 310–311, No. 25.

With regard to medium-sized cannons, in written sources from the period of 1408–1454 there are such terms as *mittelbochse*, *mittelmessige bochse*, *mittelmessige steynbuchze* or *mittelsteynbuchsen*.[107] Only in one case it is possible to say more on their size – 2 *mittelbochsen* recorded in 1408 at Marienburg (Pol. Malbork) weighed 9.5 Zentners (i.e., over 450 kg) each.[108] The earliest guns of that size may have rather been mounted on immovable stands, but wheeled carriages must also be taken into consideration for later periods.

A very ambivalent term which appears in written sources is no doubt "large guns" (*grosse buchsen*). It seems that this term may have been used both in reference to very heavy artillery (including the heaviest cannons), as well as to cannons which were simply larger than other ones which were stored in a given arsenal when an inventory or visitation report was written. This may especially be true in the case of earlier records. Chronologically, the term *grosse buchse* appears throughout the entire period in question, but is used rather exceptionally in records which are later than 1466 (i.e., the end of the Thirteen Years War between the Order and Kingdom of Poland).[109] An interesting example is the Teutonic Order's record from c. 1523, mentioning one huge cannon (*das grosse hawptstugk* – see below with fig. 25).[110] It is only sporadically that the actual or even approximate sixe of such guns can be assessed (e.g., heavy cannons cast at Marienburg (Pol. Malbork) in 1408–1409, including the *Grose Bochse* – a veuglaire weighing perhaps over 13 tons).[111] The situation is not much clearer concerning another similar term

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[107] GÄDO (as n. 26), pp. 86, 88, 436, 438; *Geschichten* (as n. 37), pp. 138–139; MTB (as n. 23), pp. 511, 558.

[108] MTB (as n. 23), p. 511; Rathgen, *Das Geschütz* (as n. 4), p. 406; idem, *Die Pulverwaffe* (as n. 4), p. 27.

[109] ABMH (as n. 25), pp. 17, 21; *Ältere Hochmeisterchronik* (as n. 32), p. 699; Biskup (as n. 28), p. 100; GÄDO (as n. 26), pp. 7, 16, 97, 112, 130, 217, 219, 226–228, 240, 306, 314, 318, 329, 429–430, 435–436, 456, 460, 480–481, 614–615, 648–649, 658, 672, 685–686, 688, 690, 699, 767–768; *Geschichten* (as n. 37), pp. 118, 136, 138–139, 145; *Jüngere Hochmeisterchronik* (as n. 33), pp. 139–140; KKMT (as n. 30), No. 32; *Johann Lindaus* (as n. 37), p. 509; MÄB (as n. 26), pp. 14–15; MTB (as n. 23), pp. 479–480, 483, 496, 497, 501, 502, 506, 510–511, 515, 557, 558; NKRSME II (as n. 29), pp. 10, 31; *Visitationen* 1 (as n. 26), No. 107, pp. 183–184; No. 111, p. 187; *Visitationen* 2 (as n. 26), No. 147, pp. 24, 31.

[110] Biskup (as n. 28), p. 100.

[111] MTB (as n. 23), pp. 479–480, 483, 496, 497, 501, 502, 506, 510–511, 515, 557, 558; Posilge (as n. 35), p. 292; Żabiński, *Technology of manufacture* (as n. 17), pp. 89–92, 99–100, 102, tab. 3; p. 103; Strzyż, *Broń palna* (as n. 20), pp. 108, 217, 223–224; Stępiński, Żabiński, Strzyż (as n. 18), pp. 166–167, 169, tab. 1; pp. 173–174; Żabiński, *The Grose bochse* (as n. 17), pp. 31–41; Strzyż, *Średniowieczna broń palna* (as n. 20), p. 38; Szymczak (as n. 19), pp. 108, 185; Nowakowski, *Źródła zaopatrzenia* (as n. 7), p. 334; Schmidtchen (as n. 6), pp. 46–47, 56–62; Rathgen, *Das Geschütz* (as n. 4), pp. 405–415, 419–420, 464–465; idem, *Die Faule Grete* (as

"large stoneball cannons" (*grosse steynbuchsen*). As in the previous case, its use is chiefly limited to the end of the 14th and the first half of the 15th century[112] Another term for large guns – in this case, with extraordinarily long barrels – was "long gun" (*lange bochse*). It first appears only in 1409 in reference to guns cast in Danzig (Pol. Gdańsk) (*cleyne lange bochse* [...] *mit 3 polfergehusen*, i.e., a veuglaire[113]; *lange bochse*[114]). *Lange steynbochsen* were also recorded in 1428 at the farm in Alt-Thorn (Pol. Stary Toruń).[115] As far as the heaviest guns are concerned, it seems obvious that such cannons were mounted on immobile stands or beds (fig. 16), and wheeled carriages went into use only in the end of the 15th century, as sizes of the largest cannons became significantly diminished, due to the use of cast iron projectiles (fig. 17).[116]

Yet another type of cannons which appears in written records are veuglaires.[117] Such guns are known from the period between the early 15th century and the first two decades of the 16th century, but most mentions concern times up to the mid-15th century[118] This may imply that in later period these cannons were considered obsolete. P. Strzyż stressed the fact of a gradual abandonment of veuglaires in the

n. 4); idem, *Die Pulverwaffe* (as n. 4), pp. 25–41; Engel, *Nachrichten über Waffen* (as n. 3), pp. 230–231; Toeppen (as n. 1), pp. 145–152, 228–229.

[112] *Ältere Hochmeisterchronik* (as n. 32), p. 675; Biskup (as n. 28), p. 100; GÄDO (as n. 26), pp. 16, 60, 86, 88, 90, 92, 97, 104–106, 127, 132, 236, 353, 403, 434, 438, 447–448, 450, 453, 460, 483, 548–549, 603, 605, 608, 610, 616, 626, 630, 640–644, 650, 656, 660, 663, 665, 668, 694, 697, 701, 703, 705–706, 708–709, 742, 749–751, 756, 758, 760; *Jüngere Hochmeisterchronik* (as n. 33), pp. 139–140; MÄB (as n. 26), pp. 19–20, 22–24; *Visitationen* 1 (as n. 26), No. 91, p. 111; No. 120, pp. 249–250; No. 125, p. 278; No. 133, p. 305; *Visitationen* 2 (as n. 26), No. 147, p. 28; No. 176, pp. 152–153.

[113] MTB (as n. 23), pp. 554, 559, 573.

[114] MTB (as n. 23), pp. 590–591; on such guns see also Świętosławski (as n. 10), p. 23; Rathgen, *Das Geschütz* (as n. 4), pp. 407–408; Rathgen, *Die Pulverwaffe* (as n. 4), p. 33.

[115] GÄDO (as n. 26), p. 443.

[116] See e.g. Strzyż, *Broń palna* (as n. 20), pp. 109–110, fig. 18; Smith, DeVries (as n. 53), p. 209; Szymczak (as n. 19), pp. 15–17, 64, 71, 152; A. R. Williams, A. J. R. Paterson, *A Turkish bronze cannon in the Tower of London*, Gladius 17 (1986), p. 187; Goetz (as n. 76), pp. 27–28, 43; Schmidtchen (as n. 6), pp. 18–19, fig. 8; Müller (as n. 77), pp. 19, 29, fig. 11; Rathgen, *Das Geschütz* (as n. 4), pp. 227–228, 235; Górski (as n. 53), pp. 24–25, 33.

[117] On veuglaires see e.g. Strzyż, *Broń palna* (as n. 20), pp. 92–104; idem, *Średniowieczna broń palna* (as n. 20), pp. 30–33; Smith, DeVries (as n. 53), pp. 230–236; Szymczak (as n. 19), pp. 55–56; Mielczarek, *Artyleria* (as n. 19), p. 69; Goetz (as n. 76), pp. 28–29; J. F. Finó, *L'artillerie en France à la fin du Moyen Âge*, Gladius 12 (1974), pp. 21–22; Rathgen, *Das Geschütz* (as n. 4), pp. 54–60, 397–399, 538–550, 557–559; Górski (as n. 53), pp. 19–20.

[118] GÄDO (as n. 26), pp. 69–70, 105–106, 108, 111, 165, 188–190, 436, 438, 443, 451, 455, 485, 544, 652–653, 656, 671, 744, 747–748; Grunau, vol. 3 (as n. 34), pp. 276–277; KKMT (as n. 30), No. 15; *Johann Lindaus* (as n. 37), pp. 603–605; MTB (as n. 23), pp. 479, 480, 483, 496, 497, 501, 502, 506, 510, 511, 515, 554, 558–559, 573; *Regesta*, vol. 3 (as n. 38), No. 20421,

16th century due to difficulties with securing a proper tightness of the powder chamber-chase connection, and the appearance of new types of low calibre cannons. Furthermore, the process of charging of cannons became quicker and more efficient, thus rendering removable powder chambers obsolete.[119] Also in this case these mentions do not contain much data on the construction of stands or carriages. It is known that a variety of immovable stands and wheeled carriage types were used for such cannons, depending on the size and other traits of such guns.[120]

When dealing with veuglaires, it is also worth making some comments on *schiffbuchssen* or naval guns (fig. 18).[121] The earliest mention of their use in the territory of the Order's state concerns the battle in Frisches Haff (Pol. Zatoka Świeża) on 15 September 1463 between the Order's troops and the fleets of Danzig (Pol. Gdańsk) and Elbing (Pol. Elbląg). Reports say that on some ships of the Prussian Confederacy there were bastions equipped with veuglaires.[122] Interestingly, almost all later (i.e., early 16th century) mentions of *schiffsbuchssen* refer to them as veuglaires (*schifbuchssen mit camern*).[123] It can be supposed that such a manner of loading the guns was believed to be more convenient onboard of a ship. Generally, it can be assumed that naval guns at that time were in many cases land guns which were adapted for the use on the sea.

The researcher's position is better in the case of early 16th century artillery. First of all, in this period cannon types commence to become more or less standardised, which facilitates the analysis. Furthermore, the introduction of cast iron cannonballs allowed to diminish the size and weight of the largest guns. Therefore, even very heavy cannons could be mounted on wheeled carriages. Of course, it did not mean a complete abandonment of stone projectiles.[124] Several different types of early 16th century cannons in the Teutonic Order's state are known from written sources.

Falcons (*falckennethlen or falckenmethlen*) were light cannons with long barrels weighing around 80–200 kg. A. R. Chodyński mentions falcons from the times of Maximilian I, which fired projectiles weighing 1–1.5 pounds (about 0.56–

p. 72; *Visitationen* 1 (as n. 26), No. 107, p. 183; *Visitationen* 2 (as n. 26), No. 147, pp. 21, 23, 31–32, 34–35, 40; No. 176, pp. 152–153; see also Stępiński, Żabiński, Strzyż (as n. 18), p. 177.

[119] Strzyż, *Broń palna* (as n. 20), pp. 93, 102, 104; idem, *Średniowieczna broń palna* (as n. 20), pp. 31–33; see also Szymczak (as n. 19), p. 56.

[120] See e.g. Smith, DeVries (as n. 53), p. 236; Szymczak, *Broń palna* (as n. 86), p. 294; Rathgen, *Das Geschütz* (as n. 4), pp. 547, 550, plate 10.36–37.

[121] For this issue see e.g. Szymczak (as n. 19), pp. 289–298.

[122] *Johann Lindaus* (as n. 37), pp. 603–605; Grunau, vol. 3 (as n. 34), pp. 276–277.

[123] GÄDO (as n. 26), pp. 109, 189–90.

[124] See e.g. Strzyż, *Broń palna* (as n. 20), pp. 129–130, 132; idem, *Średniowieczna broń palna* (as n. 20), pp. 63–65; Górski (as n. 53), pp. 35, 42–43.

–0.84 kg).[125] According to a French royal ordinance from 1544, the weight of the *faucon* was 750 pounds (c. 367.12 kg; 1 *livre* – c. 489.5 g), while its cannonball weighed 2 pounds (c. 0.98 kg). Concerning the *fauconneau*, these figures were 450 pounds (c. 220.27 kg) and 1 pound respectively.[126] The manual of S. de Saint Remy from 1697 states that the calibre (expressed by the weight of the projectile) of a *faucon* was 3 pounds (c. 1.47 kg), its weight was 2300 pounds (c. 1125.85 kg), while its length was 8 feet (c. 259.84 cm; 1 *pied du roi* – c. 32.48 cm). In the case of a lighter *fauconneau*, the relevant parameters were 2 pounds (c. 0.98 kg), 1350 pounds (c. 660.83 kg) and 10.5 feet (c. 341.04 cm).[127] However, this author also mentions much lighter *faucons* and *fauconneaux*, weighing even as little as 150 pounds (c. 73.43 kg).[128] Falcons are known from a few records from the early 1520s, with hardly any details on the construction of their carriages.[129] It can be supposed that another type of light cannons were guns which were provided with a colourful name of *dorndreher* (literally: red-back shrikes) (mentions from c. 1523[130]).

Yet another kind of light artillery were organ guns (*orgelpfeyffen*) (fig. 19), i.e., cannons consisting of multiple barrels mounted on a wheeled carriage. They are known from records dated to c. 1523.[131] Such guns perhaps evolved from late 14th century *ribaudiaux*, or sort of wheelbarrows provided with several small cannons.[132] R. D. Smith and K. DeVries argue that a similar term *ribaudequin* rather referred not to a specific type of gun, but to a type of carriage on which guns were mounted.[133]

Serpentines (*scherppentiner* or *schlangen*) were also cannons with long barrels; however, these were significantly heavier than those of falcons. In late 15th century Burgundy the term serpentine referred to rather light cannons, weighing somewhat more than 200 kg. They were in most cases mounted on wheeled carriages (fig. 20).[134] In the organisation system of artillery of Maximilian I, *schlangen* and their subcategories were field cannons.[135] A. R. Chodyński says that their barrels

[125] Chodyński, *Habsburg artillery* (as n. 11), p. 58; see also Goetz (as n. 76), p. 34.
[126] Finó (as n. 117), p. 21; see also Górski (as n. 53), p. 34.
[127] Saint Remy (as n. 43), p. 56.
[128] Saint Remy (as n. 43), p. 58.
[129] GÄDO (as n. 26), p. 123; Biskup (as n. 28), pp. 100–102.
[130] Biskup (as n. 28), pp. 100–101; Boeheim (as n. 76), p. 58.
[131] Biskup (as n. 28), pp. 100, 102; see also Szymczak (as n. 19), p. 59.
[132] McLachlan (as n. 53), p. 14; on organ guns and their variants see also e.g. Smith, DeVries (as n. 53), pp. 221–225; Szymczak (as n. 19), pp. 59–60; Mielczarek, *Artyleria* (as n. 19), p. 70; Müller (as n. 77), p. 21; Rathgen, *Das Geschütz* (as n. 4), pp. 244–245, 284, 335–336, 550–552.
[133] Smith, DeVries (as n. 53), pp. 237–238.
[134] Smith, DeVries (as n. 53), pp. 227–230.
[135] Boeheim (as n. 76), p. 58.

weighed over 25 Zentners (c. 1400 kg) while their projectiles weighed 16 pounds (c. 8.96 kg).[136] Saint Remy says that the weight of the serpentine's projectile was 24 pounds (c. 11.75 kg), its weight was 4300 pounds (c. 2104.85 kg) and its length was 13 feet (c. 422.24 cm).[137] The earliest mention of such guns from the Order's state comes from 1485 and they were in use up to the very end of the Order's existence in Prussia.[138] Extra long serpentines were called *notthschlangen* or *lange schlangen*.[139] Serpentines were also divided into several subcategories, such as half-serpentines (*halbschlangen*)[140] or quarter-serpentines (*quartirschlangen*).[141] In one record from c. 1523 the weight of this cannon was stated and it was 4 Zentners (over 180 kg).[142] Furthermore, a record from 1524 from Rhein (Pol. Ryn) suggests that a quarter-serpentine was to be transported onto the fortifications in a vessel or barrel (?) (*quartyr schlaengechen in eynem gefaessz auff dy mawr*).[143]

Carthauns or courteaux (*karthawen*) were heavy cannons, whose barrels weighed over 3000 kg (fig. 21). Such cannons were generally used in siege warfare. Variants of cannons of this kind which were heavier or lighter were known as half-carthauns, double carthauns and so on. In the artillery reform carried out by Maximilan I, carthauns were to launch projectiles weighing 25 pounds.[144] On the other hand, A. R. Chodyński states that long carthauns fired projectiles weighing 48 pounds, short carthauns – 44 pounds, while 25-pound cannonballs were used for so-called *Viertelbuchsen*.[145] In later times (about the mid-16th century) the term long carthauns could refer to double carthauns, whose barrels weighed 128 Zentners (c. 7168 kg) and for which 96-pound (c. 53.76 kg) projectiles were

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[136] Chodyński, *Habsburg artillery* (as n. 11), p. 56; see also Górski (as n. 53), p. 34; Goetz (as n. 76), p. 34; on *schlangen* see also Rathgen, *Das Geschütz* (as n. 4), pp. 316, 561; large serpentines were also mentioned in 1480 in Nancy in Lorraine, see V. Serdon-Provost, *The constitution of artillery parks and fortifications for defending. The dukes of Lorraine in Nancy: a case study*, in *Weapons Bring Peace?* (as n. 17), p. 194; on serpentines see also Szymczak (as n. 19), p. 57, idem, *Broń palna* (as n. 86), p. 287; and idem, *Die Feuerwaffenvorräte* (as n. 86), p. 11.

[137] Saint Remy (as n. 43), p. 55.

[138] Biskup (as n. 28), pp. 100–102; GÄDO (as n. 26), pp. 50, 60, 147–149, 208, 314, 358–359; Grunau, vol. 3 (as n. 34), pp. 426, 466, 499, 553–555, 654.

[139] Biskup (as n. 28), p. 102; Goetz (as n. 76), p. 34.

[140] Biskup (as n. 28), pp. 101–102; GÄDO (as n. 26), pp. 109–110, 112, 121–122, 147–148, 177, 184–185, 297; Grunau, vol. 3 (as n. 34), p. 654.

[141] Biskup (as n. 28), pp. 100, 102; GÄDO (as n. 26), pp. 112, 149, 204.

[142] Biskup (as n. 28), p. 100.

[143] GÄDO (as n. 26), p. 204.

[144] Boeheim (as n. 76), p. 58; Goetz (as n. 76), p. 34; see also Strzyż, *Średniowieczna broń palna* (as n. 20), p. 39; Szymczak (as n. 19), p. 66; Górski (as n. 53), p. 34.

[145] Chodyński, *Habsburg artillery* (as n. 11), p. 56; see also Szymczak (as n. 19), p. 62; idem, *Broń palna* (as n. 86), p. 287.

used. In the case of short carthauns, the weight of the barrel was 70–80 Zentners (c. 3920–4480 kg), while that of the projectiles – 45–70 pounds (25.2–39.2 kg).[146] Carthauns are known from several mentions dated to the late 1510s and the early 1520s[147], while *halbenkarthawen* were mentioned in the Order's list of firearms dated to c. 1523.[148] Furthermore, about 1523 there were 2 *syngerynes* at Königsberg (Russ. Kaliningrad). These cannons were interpreted by M. Biskup as long carthauns.[149]

Scharfmetzen were heavy siege cannons (fig. 22). In the classification introduced by Maximilian I, their barrels weighed 100 Zentners (i.e., about 5600 kg, assuming that 1 Vienna pound was c. 0.56 kg) and the weight of a projectile for such cannons was between about 50 and 100 pounds.[150] These differences in projectile weight were results of later developments.[151] *Scharfmetzen* are known from a few mentions in the period between 1511 and c. 1523.[152]

Mortars (*morser*) were cannons with short barrels, designed to launch projectiles in high-arching ballistic trajectories.[153] The earliest mentions of such guns come from the early 16th century and are very sporadic.[154] On the other hand, it has been suggested that a cannon depicted in a letter of a foundry master Hanns to the authorities of Danzig (Pol. Gdańsk) from 1454 (fig. 23) is actually a sort of mortar or a so-called *Ellenbogengeschütz* (literally: elbow-cannon).[155]

Interestingly, in 1508 some kind of short mortars (*kurtz buchssen fartzkacheln*) were mentioned at Tapiau (Russ. Gvardyeysk).[156] In contrast to many other early 16th century cannons, mortars from this period were in all probability mainly

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[146] Chodyński, *Habsburg artillery* (as n. 11), p. 57.

[147] Biskup (as n. 28), p. 100; Grunau, vol. 1 (as n. 34), p. 361; Grunau, vol. 3 (as n. 34), pp. 466, 499, 553–555; *Hanseatische Chronik* (as n. 36), p. 509.

[148] Biskup (as n. 28), pp. 100–102.

[149] Biskup (as n. 28), p. 100.

[150] Strzyż, *Średniowieczna broń palna* (as n. 20), p. 39; Szymczak (as n. 19), p. 65; Chodyński, *Habsburg artillery* (as n. 11), pp. 56, 58; Goetz (as n. 76), p. 34; Boeheim (as n. 76), p. 58; see also Górski (as n. 53), p. 34.

[151] Chodyński, *Habsburg artillery* (as n. 11), p. 57.

[152] Biskup (as n. 28), p. 100; Grunau, vol. 3 (as n. 34), p. 420; *Regesta*, vol. 3 (as n. 38), No. 20885, p. 96.

[153] Goetz (as n. 76), pp. 30–31; Rathgen, *Das Geschütz* (as n. 4), p. 443.

[154] Biskup (as n. 28), p. 100–101; Grunau, vol. 3 (as n. 34), p. 420.

[155] Strzyż, *Średniowieczna broń palna* (as n. 20), p. 46; Szymczak (as n. 19), pp. 186, 188, fig. 28; Możejko (as n. 12), pp. 172–174; Rathgen, *Das Geschütz* (as n. 4), pp. 441–442; idem, *Die Pulverwaffe* (as n. 4), pp. 92–94; Engel, *Waffengeschichte-Studien* (as n. 3), p. 118.

[156] GÄDO (as n. 26), p. 60.

mounted on immobile stands.[157] On the other hand, the manuscript of R. Valturio shows examples of such cannons on wheeled carriages as well[158] (fig. 24).

There are also numerous mentions in written sources which deal with gun stocks, stands and carriages as such. Of course, in many cases it is not possible to determine whether a given source mentions stocks for a hand-held firearms or stands or trestles for cannons. As it comes out from the above considerations, the term *laden* could be used for both. In 1403, the Order's Treasurer paid 13 Scot for the transportation of 3 guns and stone projectiles to Labiau (Russ. Polesk), and 0.5 Ferto for two *laden* and for fitting them with iron (*2 laden und die selben zu beslan*).[159] It could be therefore supposed that this concerns stands for cannons. The same term *laden* was used clearly in reference to lead bullet guns at Marienburg (Pol. Malbork) in 1409 (*0.5 Mark dem cleynsmeden vor 3 laden zu lotbochsen zu beslohen*[160]; *1.5 Mark Jauwernig dem smede vor 5 laden zu lotbochsen zu beslohen*[161]). The same was the case in 1410 in Elbing (Pol. Elbląg) – *1 Ferto vor 15 laden, lotbussen darin to leggende*.[162]

Nevertheless, in many cases it seems impossible to determine the kind of firearms for which stocks or stands were mentioned.[163] Sometimes, additional details were stated, such as the species of wood which was used. For instance, in 1409 the House Commander of Thorn (Pol. Toruń) paid 4 Marks 8 Scot and 6 Denars for oak wood and spruce or fir logs to be used for a gun stand (*vor eychin zymmer und vichtynne ronen zu den bochse stonunge*).[164] In 1411 in Elbing 1.5 Marks went for two oak beams (*eken tymmer*) for gun stands (*bussenstellen*).[165] Elm wood was used in 1412 at Marienburg (Pol. Malbork) (*vor rusternholcze czu bochszenladen czu snyden*).[166] In 1415 sawing of oak wood for making gun stocks or stands was recorded at the Order's capital castle (*Bochsenladen* [...] *vor eychenholcz den*

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[157] See e.g. Goetz (as n. 76), p. 31.

[158] Valturio (as n. 16), fol. 126v; Rathgen, *Das Geschütz* (as n. 4), pp. 135–136.

[159] MTB (as n. 23), p. 247.

[160] MTB (as n. 23), p. 571.

[161] MTB (as n. 23), p. 588; Świętosławski (as n. 10), p. 24; Schmidtchen (as n. 6), p. 70; Rathgen, *Das Geschütz* (as n. 4), p. 407–408; idem, *Die Pulverwaffe* (as n. 4), pp. 30, 32; Engel, *Nachrichten über Waffen* (as n. 3), p. 231; Toeppen (as n. 1), pp. 233–234.

[162] NKRSME I (as n. 29), p. 230; Świętosławski (as n. 10), p. 24; Toeppen (as n. 1), pp. 233–234.

[163] ABMH (as n. 25), pp. 20, 36, 61–62, 77, 101, 117, 126, 135–137, 143, 145, 176–177, 221, 252, 268, 279; NKRSME II (as n. 29), p. 80.

[164] MTB (as n. 23), p. 597; Rathgen, *Das Geschütz* (as n. 4), pp. 408, 439; idem, *Die Pulverwaffe* (as n. 4), p. 33.

[165] NKRSME II (as n. 29), p. 31; Stępiński, Żabiński, Strzyż (as n. 18), p. 183; Szymczak (as n. 19), p. 115; Świętosławski (as n. 10), p. 24.

[166] ABMH (as n. 25), p. 51.

bochsenschotczen czu snyden [...]).[167] R. Heś says that oak wood due to its hardness was the most commonly used raw material for gun stocks in the town of Görlitz (Pol. Zgorzelec) in Lusatia at the turn of the 14th and 15th centuries[168] A similar opinion on the popularity of oak wood was expressed by J. Szymczak.[169] In 1417, the use of willow wood was mentioned at Marienburg.[170] This is hardly surprising, as well-dried willow wood is very hard.[171] Concerning comparative data, it is assumed that the carriage of the *Faule Magd* from Dresden was made from oak wood. The carriage can be dated to the last third of the 16th century, while the cannon itself (a c. 2700 kg heavy *mittelbuchse* which is assembled from iron bars and rims) comes perhaps from the late 14th–early 15th century[172] In 1413 in Elbing (Pol. Elbląg) at the Town Hall there were several kinds of *buchsenladen*: *2 alde laden*, *2 grosse nie laden*, *der gemeinen laden der sin 13*.[173] As the inventory of the Town Hall mentions both lead bullet and stone cannonball guns[174], *alde laden* and *gemeine laden* could refer to stocks or stands for both kinds of firearms. On the other hand, it could be proposed that *grosse laden* were cannon stands or trestles. From 1414 there are two records of payments of 7 Scot for 7 *lotbussenladen* in Elbing.[175] Regrettably, it is hard to say whether these lead bullet guns were handheld firearms or light cannons. In the same year in Elbing a blacksmith named Stregener was paid 3 Ferto *vor 1 buchse czu beslande in dy lade*.[176] The sum suggests that this gun was a cannon. In 1415, carpenters at Marienburg (Pol. Malbork) made a special chamber in the *Karwan* (i.e., a storehouse of wagons and related equipment) to store *bochsenladen* there.[177] From the same year there is also a men-

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[167] ABMH (as n. 25), p. 176; Rathgen, *Das Geschütz* (as n. 4), p. 421; idem, *Die Pulverwaffe* (as n. 4), p. 57.

[168] Heś (as n. 97), p. 140.

[169] Szymczak (as n. 19), p. 96.

[170] ABMH (as n. 25), p. 278.

[171] Chodyński, *Magazyny broni* (as n. 11), p. 189.

[172] O. Baarmann, *Die 'Faule Magd' der Königlichen Arsenalsammlung zu Dresden*, Zeitschrift für Historische Waffenkunde 4 (1906–1908), pp. 232, 234.

[173] *Elbinger Kriegsbuch*, ed. M. Toeppen (henceforth: EK), Altpreussische Monatschrift 36 (1889), p. 254; Szymczak (as n. 19), p. 114; Chodyński, *Inwentarz broni* (as n. 11), pp. 75, 78; idem, *The stores of arms* (as n. 11), pp. 20, 22; Rathgen, *Das Geschütz* (as n. 4), p. 430; idem, *Die Pulverwaffe* (as n. 4), p. 72.

[174] EK (as n. 173), p. 253; see also Chodyński, *Inwentarz broni* (as n. 11), pp. 74–75, 77–78; idem, *The stores of arms* (as n. 11), pp. 20, 22.

[175] EK (as n. 173), p. 260; NKRSME II (as n. 29), p. 79; Świętosławski (as n. 10), p. 24.

[176] NKRSME II (as n. 29), pp. 94–95.

[177] ABMH (as n. 25), pp. 170–171; Jóźwiak, Trupinda (as n. 14), p. 406; for the *Karwan* see e.g. Dąbrowska, *Proces odlewania dział* (as n. 15), pp. 21, 40; eadem, *Badania archeologiczno-architektoniczne* (as n. 15), p. 303; Jóźwiak, Trupinda (as n. 14), pp. 404–408; Nowakowski,

tion on wood stores for *bochsenladen* at the Order's capital castle.[178] In 1417, some sort of a wooden structure to store *bochsenladen* was mentioned in the *Karwan* at Marienburg (*vor 80 elen holcz czu snyden czu dem schuwer im karwan czu den bochsenladen*).[179]

Another term which is not always clear is *stel* or *stelle*. From 1420 comes a mention of *stele* for guns at the Order's capital castle. 0.5 Mark 11 Scot and 6 Denars were paid for such stocks for 29 guns.[180] In this case a rather low price per item (24 Denars) and the number of requested items suggest that the *stele* were rods or shafts, round or polyhedric in cross-section, which were either inserted in sockets at the breech parts of guns, or on which hand-held firearms were fitted. The term *bossenstile* or *bostilen* also appears in accounts of Trier from the 1370s[181] In this case, however, nails for these *stile* were also bought, which implies that these were rather more complex stands for heavier guns.[182]

In some cases it seems impossible to decide whether *stele* were stocks for hand-held firearms or cannon stands or trestles. This is the case, e.g., with numerous records from the early 15th century from Elbing (Pol. Elbląg).[183] On the other hand, this term could also be used for artillery trestles. In 1411, 4 Scot and 12 Denars were paid for carrying a large gun with its trestle to the Town Hall (*de grotte bussen up dat Rathus to bringen mit dem stellen*).[184] In 1413 at the Town Hall of Elbing there were 11 *buchsengestelle*. Interestingly, this record, mentioning various kinds of gun stocks and trestles, commenced with a statement: *Hie volgen dy buchsenladen in deme gwanthuse*.[185] This is another piece of evidence suggesting that the term *laden* may have been used in a very broad sense. In 1414 at Marienburg (Malbork) 2 Marks and 0.5 Ferto was paid to 5 carpenters who made *laden und gestelle czu den bochsen* [...] *in dem fyrmaniengarthe und gestelle uff dy*

Arsenał zamku (as n. 7), p. 226; S. Ekdahl, *The Strategic Organization of the Teutonic Order in Prussia and Livonia,* in: *La commanderie, institution des ordres militaires dans l'occident médiéval*, ed. A. Luttrell, L. Pressouyre (Archéologie et d'histoire de l'art 14), Paris 2002, pp. 231, 236.

178 ABMH (as n. 25), p. 173.

179 ABMH (as n. 25), p. 271; Jóźwiak, Trupinda (as n. 14), p. 406.

180 ABMH (as n. 25), p. 357.

181 Rathgen, *Das Geschütz* (as n. 4), p. 175.

182 B. Rathgen supposes that the terms *stele* and *gestelle* were used interchangeably, see Rathgen, *Das Geschütz* (as n. 4), p. 439; and idem, *Die Pulverwaffe* (as n. 4), p. 87.

183 NKRSME I (as n. 29), pp. 16, 21, 229–230; NKRSME II (as n. 29), p. 31; Stępiński, Żabiński, Strzyż (as n. 18), p. 183; Rathgen, *Das Geschütz* (as n. 4), p. 427; idem, *Die Pulverwaffe* (as n. 4), pp. 67–71.

184 NKRSME II (as n. 29), p. 31; Chodyński, *Inwentarz broni* (as n. 11), p. 72; idem, *The stores of arms* (as n. 11), p. 17,

185 EK (as n. 173), p. 254; Szymczak (as n. 19), p. 114; Chodyński, *Inwentarz broni* (as n. 11), pp. 75, 77–78; Chodyński, *The stores of arms* (as n. 11), pp. 20, 22.

bolwerk.[186] This mention says that these *gestelle* were to be placed on the castle's fortifications, which obviously implies some kind of stands or trestles. Furthermore, in 1414 in Elbing a payment for *buchsenstelle* was recorded.[187] This mention was preceded with a record of payment made by the town to Danzig (Pol. Gdańsk) for one large gun which weighed 12.5 Zentners (i.e., over 590 kg), 7 stone cannonball guns, 10 large and 13 small lead bullet guns.[188] This may imply that at least some of these *buchsenstelle* were artillery stands or trestles. Furthermore, in 1417 at Marienburg (Pol. Malbork) an apprentice (*geselle*) was paid 6 Scot and 20 Denars for 5 days of work *zcum buchsengestelle*.[189] Even more (21 Scot and 10 Denars) was paid in the same year at the capital castle to Peter Wegener and his three companions for work *am buchsengestelle*.[190] Interestingly, some of these records mention the participation of a catapult master (*blydenmister*) Hannus in the construction of these trestles.[191] This is of no surprise bearing in mind possible technical similarities in structures of siege engine and artillery stands. 3 *gestellen* were also recorded in 1421 in the inventory of the Commandery of Nessau (Pol. Wielka Nieszawka).[192] As these were mentioned separately (the inventory listed both cannons and hand-held firearms), it can be assumed that these *gestellen* were cannon trestles.

There are also records which clearly refer to artillery stands or trestles. In 1414 at Marienburg (Pol. Malbork), the manufacture of *laden und gestelle czu den bochsen* was mentioned.[193] In the same year and location there were works on *stonunge unde loger czu den bochsen*.[194] In 1415 at Marienburg it was recorded that 10 men from a nearby village of Blumenstein (Pol. Kwietniewo) spent one day on processing wooden logs for a gun stand with files (*dy eynen tag dy ronen czu bochsenlade flyeten*).[195] The number of men may imply a considerable size of this structure. In 1419 at Marienburg 14 Scot was paid to 2 carpenters who worked on axles for *buchsenladen* (*14 Scot czu arbeiten 2 czimmerluten an den achsen czu den buchsenladen*).[196] It this case it can be naturally supposed that wheeled carriages were meant.

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[186] ABMH (as n. 25), p. 137.
[187] EK (as n. 173), p. 260; NKRSME II (as n. 29), p. 79.
[188] NKRSME II (as n. 29), p. 78.
[189] ABMH (as n. 25), p. 269; Żabiński, *Ways of acquisition* (as n. 17), pp. 129–130.
[190] ABMH (as n. 25), p. 269; for other similar expenses see ibidem, pp. 271, 278–279, 327–329.
[191] ABMH (as n. 25), pp. 269, 278, 300–301, 305; Jóźwiak, Trupinda (as n. 14), p. 416.
[192] GÄDO (as n. 26), p. 482; Stępiński, Żabiński, Strzyż (as n. 18), p. 177.
[193] AMBH (as n. 25), p. 137.
[194] ABMH (as n. 25), p. 148.
[195] ABMH (as n. 25), p. 193.
[196] ABMH (as n. 25), p. 327.

A special attention is required for the famous Teutonic heavy cannon – the *Grose Bochse* from the end of the first decade of the 15th century. This gun in all probability weighed over 13 tons and it was a veuglaire. It was no doubt mounted in an immobile wooden bed (fig. 25). Sources mention a *bock* associated with this cannon, which may imply an immobile stand or trestle.[197] In 1408 a smith Swenkenfeld was paid for nails of various size which were to be used for this gun's stand (*12 grosse clinkennagel und 24 cleyner nagel zum bocke zur grossen bochsen*).[198] Furthermore, 3 Ferto was paid to a rope-maker for a harness (*gezoume zur grossen bochsen dem seyler*).[199] In the following year, two ropes and two "short pieces" were bought for the trestle (*2 lynen* [...] *und* [...] *2 korze stocke zu dem bocken*).[200] Of interest is another record from 1409, mentioning a payment of 7.5 Marks and 7 Scot for casting of *12 erynne schywen* [...] *zu dem bocke zur grosen bochsen*.[201] These bronze *schywen* were in all probability pulleys or drums. B. Rathgen supposes that these pulleys and the *bock* were part of an lifting device or crane, which was used for placing the gun on its transportation wagon.[202] R. D. Smith and K. DeVries say that large bombards which were transported on carts were usually provided with some kind of lifting devices[203] (fig. 26). Pulleys are also known from other records. In 1412 at Marienburg (Pol. Malbork) 24 Denars was spent on *czu buchzen 2 schyben*[204], while in the following year a pair of such devices was purchased for 1 Scot 2 Denars.[205] While B. Rathgen's proposal seems to be perfectly sound, it could be also assumed that – in combination with the afore-mentioned ropes – such pulleys or drums may have been part of a system used to move the gunpowder chamber backwards and forwards in order to first charge it and then secure it back to the chase. This assumption is partially confirmed by another mention from 1409. It says about a payment of 3 Marks and 1 Ferto for 4 hemp ropes weighing 12 stones for the heavy cannon (*vor 4 lynen dy haben 12 steyne hanf*

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[197] *Bock zu der grosser busen* was also mentioned in Trier in 1375–1376, see Rathgen, *Das Geschütz* (as n. 4), pp. 175–176, 180.

[198] MTB (as n. 23), p. 515; Żabiński, *The Grose bochse* (as n. 17), p. 35, tab. 3.

[199] MTB (as n. 23), p. 511; Żabiński, *The Grose bochse* (as n. 17), p. 35, tab. 3; Schmidtchen (as n. 6), p. 70; Rathgen, *Das Geschütz* (as n. 4), p. 406; idem, *Die Pulverwaffe* (as n. 4), p. 28.

[200] MTB (as n. 23), p. 525; Rathgen, *Das Geschütz* (as n. 4), p. 406; idem, *Die Pulverwaffe* (as n. 4), p. 28.

[201] MTB (as n. 23), p. 558; Żabiński, *Die Grose bochse* (as n. 17), p. 35, Tab. 3; Rathgen, *Das Geschütz* (as n. 4), p. 406, 441; idem, *Die Pulverwaffe* (as n. 4), p. 29; on these expenses see also Toeppen (as n. 1), p. 234–235.

[202] Rathgen, *Das Geschütz* (as n. 4), p. 441; idem, *Die Pulverwaffe* (as n. 4), pp. 90–91.

[203] Smith, DeVries (as n. 53), pp. 204, 207–208, 256; see also Szymczak (as n. 19), p. 71.

[204] ABMH (as n. 25), p. 75.

[205] ABMH (as n. 25), p. 113.

[...] *zur grosen bochsen*). 1 Mark was paid for 4 short straps, used to span the gun together (*vor 4 korze stroppen do mete man dy grose bochse zu samne spennet*). Furthermore, another 8 straps were purchased for 2 Marks. Out of these, 2 went for the heavy cannon and 4 for another new gun (*vor 8 stroppen, 2 zur grosten bochsen und 4 zur nuwen bochsen*).[206] Another record from 1409 says that the stand or crane was made again and fitted again with iron (*vor den bog weder zu machen* [...] *den bok weder zu beslohen*). Furthermore, 1.5 Mark was paid for fitting the heavy cannon with iron (*dy groste buchse zu beslon*).[207] It cannot be excluded that these expenses were somewhat related to the use of the heavy cannon in siege warfare in the initial part of the war against Kingdom of Poland in August 1409. The same could be supposed about a brace or clamp to the gun stand or crane (*cloben zum bochsenbocke*).[208] It is possible that the payment of House Commander of Thorn (Pol. Toruń) for oak wood and spruce or fir logs to be used for a gun stand is also related to the Teutonic Order's heavy cannon.[209]

Data on wheeled carriages as such is not very numerous. Apart from records which were discussed above, attention is also drawn to a mention from 1409, saying that 3.5 Marks was paid to locksmiths for fitting gun carriages with iron (*3.5 Mark den cleynsmeden vor dy karren zu den bochsen zu beslohen, yo vor eyner 0.5 Mark*).[210] It is difficult, however, to determine whether these fittings were designed for carriages themselves or for their wheels (as shown below, there are numerous records of fitting wheels for gun wagons with iron). Furthermore, in 1414 in Elbing (Pol. Elbląg) harness-makers (*schirmecher*) were paid 14 Scot for 2 "wagon trestles" for large guns (*wagengestelle zu den grosen bussen*).[211] These *wagengestelle* may have been some sort of early wheeled carriages for heavy artillery. On the other hand, W. Świętosławski proposes that this term may refer to wooden frameworks of artillery wagons.[212]

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[206] MTB (as n. 23), p. 574; Żabiński, *The Grose bochse* (as n. 17), p. 35, tab. 3; Rathgen, *Das Geschütz* (as n. 4), pp. 407, 441; idem, *Die Pulverwaffe* (as n. 4), pp. 32, 46.

[207] MTB (as n. 23), p. 597; Żabiński, *Die Grose bochse* (as n. 17), p. 35, tab. 3; Rathgen, *Das Geschütz* (as n. 4), pp. 408–409; idem, *Die Pulverwaffe* (as n. 4), p. 33.

[208] MTB (as n. 23), p. 597; Żabiński, *Ways of acquisition* (as n. 17), p. 137; idem, *Die Grose bochse* (as n. 17), p. 37–39.

[209] MTB (as n. 23), p. 597; for the expenses on the *Grose Bochse*'s stand see also Engel, *Nachrichten über Waffen* (as n. 3), p. 231.

[210] MTB (as n. 23), p. 573; Rathgen, *Das Geschütz* (as n. 4), pp. 407, 420; idem, *Die Pulverwaffe* (as n. 4), p. 30; Engel, *Nachrichten über Waffen* (as n. 3), p. 231.

[211] NKRSME II (as n. 29), p. 84; Żabiński, *Ways of acquisition* (as n. 17), pp. 133–134; Szymczak (as n. 19), p. 114; Rathgen, *Das Geschütz* (as n. 4), p. 429; idem, *Die Pulverwaffe* (as n. 4), p. 71; Chodyński, *Inwentarz broni* (as n. 11), p. 72; idem, *The stores of arms* (as n. 11), p. 17.

[212] Świętosławski (as n. 10), p. 24.

An interesting piece of information is known from 1409 from the Order's capital castle. In this year 0.5 Mark was paid to a locksmith who fitted a caisson with iron. This caisson was used to transport gun equipment (*eyme cleynsmede der eynen kommen beslog, dor inne man bochsengerete furte*).[213]

There are also several records mentioning wheels for guns. In 1394 at Marienburg (Pol. Malbork) there were 22 wheels for a large gun (*grose buchse*). 10 of these were fitted with iron (*beslagene rade*) and 12 were not.[214] It would be interesting to know whether these 12 wheels were supposed to be fitted with iron in the future or both kinds were to be used, e.g., depending on terrain conditions. Prices of gun wheels varied. In 1409 at Marienburg (Pol. Malbork) 1 Mark was paid for 24 small wheels for gun carriages (*cleyne rade zu bochsenkarren zu machen*).[215] In the same year, a comparable sum of 3 Ferto was paid for 4 large gun wheels and 1 wheel for a gun carriage (*Hannos Hoffeman dem rademecher vor 4 grose bochsenrade und vor 1 rat zum bochsenkarren*).[216] Also in 1409 5 Scot was spent on 4 wheels for gun carriages (*rade zu bochsenkarren*).[217] On the other hand, in 1417 6 Marks went for 24 wheels for gun carriages (*Urban dem rademacher von Dirssaw vor 24 rade czu bochsenkarren*).[218] It could be asked whether the size of these wheels was the only factor to make them six times more expensive than the 24 small wheels from 1409. In 1419 at Marienburg (Pol. Malbork), 30 gun wheels were manufactured for the price of 3 Marks and 0.5 Ferto.[219] Furthermore, there are also mentions of iron rims used to fit gun wheels with. In 1406 in Elbing (Pol. Elbląg) 4 Marks and 0.5 Ferto was paid for 8 iron bars for guns (*ysern schenen vor bussen*).[220] This price seems to be pretty high, as in 1409 8 Marks and 4 Scot was spent on 2 bundles of bars and 50 large bars for gun wheels (*vor 2 gebunt schenen und vor 50 grose schenen*

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[213] MTB (as n. 23), p. 574; Stępiński, Żabiński, Strzyż (as n. 18), p. 175; Rathgen, *Das Geschütz* (as n. 4), p. 420; idem, *Die Pulverwaffe* (as n. 4), p. 55; Toeppen (as n. 1), p. 233.

[214] MÄB (as n. 26), pp. 101–102.

[215] MTB (as n. 23), p. 559; Schmidtchen (as n. 6), p. 70; Rathgen, *Das Geschütz* (as n. 4), p. 407; idem, *Die Pulverwaffe* (as n. 4), p. 29; Engel, *Nachrichten über Waffen* (as n. 3), p. 231.

[216] MTB (as n. 23), p. 559; Schmidtchen (as n. 6), p. 70; Rathgen, *Das Geschütz* (as n. 4), p. 407; idem, *Die Pulverwaffe* (as n. 4), p. 30; Engel, *Nachrichten über Waffen* (as n. 3), p. 231.

[217] MTB (as n. 23), p. 580; Rathgen, *Das Geschütz* (as n. 4), p. 408; idem, *Die Pulverwaffe* (as n. 4), p. 32; Engel, *Nachrichten über Waffen* (as n. 3), p. 231.

[218] ABMH (as n. 25), p. 279; Żabiński, *Ways of acquisition* (as n. 17), p. 131; Świętosławski (as n. 10), 1993, p. 24.

[219] ABMH (as n. 25), p. 328.

[220] NKRSME I (as n. 29), p. 67; Żabiński, *Technology of manufacture* (as n. 17), p. 89.

zu bochsenraden).[221] In 1410, 2 Marks was spent on fitting four gun wheels with iron in Elbing (Elbląg) (*4 rade to beslande to den bussen*).[222]

A separate problem are carts and wagons which were solely used for transportation of cannons and were not applied as carriages during the operation of artillery in the field.[223] Such wagons should not be confused with battle wagons, which were usually equipped with firearms (both hand-held and light cannons), although a distiction between them may have not always been clear.[224] Furthermore, it cannot be excluded that agricultural carts could be used for transport of lighter guns (and vice versa), as suggested by a record from 1434 concerning a farm in Dristschmin (Pol. Drzycim) near Graudenz (Pol. Grudziądz), which mentions 1 *buchschenwayn*.[225] An opinion that "ordinary" carts were initially used for the transportation of cannons has also been expressed by J. Szymczak.[226] On the other hand, it seems obvious that special wagons with reinforcing iron fittings must have been used in the case of heavy cannon barrels (fig. 27). As early as 1396 the register of the *Karwan* at Marienburg (Pol. Malbork) recorded 5 large gun wagons, 19 wheels with iron rims for such wagons and 12 wheels with no rims for these (*5 grose buchsenwayn, 19 beslagene rade czu den buchsenwayn, 12 unbeslagene rade czu denselbin wayn*).[227] In 1402, *54 schenen czu bochsenwagen* were mentioned.[228] These were probably iron bars to make rims to fit wagon wheels with. There are also many other mentions of gun wagons and wheels for them; regrettably, in a majority of cases they do not provide more details on their construction.[229]

There are also several more detailed records. In 1409 2 Scot was paid for 2 hooks (*hoken*) and 4 *geslofe* (perhaps reinforced locks) to a gun wagon.[230] In

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[221] MTB (as n. 23), p. 571; Schmidtchen (as n. 6), p. 70; Rathgen, *Das Geschütz* (as n. 4), p. 407; idem, *Die Pulverwaffe* (as n. 4), p. 30; Toeppen (as n. 1), p. 153).

[222] NKRSME I (as n. 29), p. 218.

[223] Strzyż, *Broń palna* (as n. 20), p. 109, fig. 17; Heś (as n. 97), p. 142; Smith, DeVries (as n. 53), pp. 256–258; Goetz (as n. 76), p. 50; Rathgen, *Das Geschütz* (as n. 4), pp. 22, 37–38, 270, 277–279.

[224] On battle wagons see e.g. Strzyż, *Broń palna* (as n. 20), pp. 162–188; McLachlan (as n. 53), pp. 42–45; Szymczak (as n. 19), pp. 317–319; Oakeshott (as n. 53), pp. 36–37; Müller (as n. 77), p. 35; Rathgen, *Das Geschütz* (as n. 4), p. 60.

[225] GÄDO (as n. 26), p. 619.

[226] Szymczak (as n. 19), p. 213.

[227] MÄB (as n. 26), pp. 102–103; the same numbers were recorded in 1401, see MÄB, pp. 103––104; see also Toeppen (as n. 1), pp. 133–134, 235.

[228] MÄB (as n. 26), p. 142.

[229] ABMH (as n. 25), p. 69; Biskup (as n. 28), p. 101; GÄDO (as n. 26), pp. 619–620, 622, 766––767; MÄB (as n. 26), pp. 104–105; NKRSME II (as n. 29), p. 95; KT (as n. 31), p. 177.

[230] MTB (as n. 23), p. 597; Rathgen, *Das Geschütz* (as n. 4), p. 409; idem, *Die Pulverwaffe* (as n. 4), p. 33.

1410 in Elbing (Pol. Elbląg) 1 Mark was paid for iron equipment for a gun wagon (*yserwerk to deme bussenwagen*). Furthermore, 2 Marks and 4 Scot went for 14 wagon rims (*wagenschenen*), 2 shovels (*schuffln*), 3 spades (*spaden*), wheel and gun nails (*redenegele*, *bussennagele*), as well as 2 *ridebloke* and *traderynken*.[231] In 1414 in Elbing harness-makers (*schirmecher*) received 4 Scot for 2 *leteren* for gun wagons (*bussenwagen*).[232] B. Rathgen interpreted these *leteren* as ladders[233], while W. Świętosławski assumes that this term refers to lanterns for gun wagons.[234] On the other hand, iron-fitted ladders as part of gun wagon equipment were mentioned in Elbing in the same year, when 12 Mark was paid to a smith Vasolt *vor dy buchsenwagene unde leyteren czu beslon*.[235] In 1418 at Marienburg (Pol. Malbork) 6 Marks and 3.5 Ferto was spent on 10 wheels to a gun wagon and 12 wheels for 3 expedition wagons (*reyszeweinen*).[236] One year later 0.5 Mark went for boring of gun wheels (*buchsenrade czu boren*).[237] This can suggest that these wheels were made from solid discs of wood, which had to be provided with openings for axles. An example of a 14th century Italian cannon with such wheels is given by D. Goetz. These wheels were made from thick logs which were put together along their lengths and were provided with iron rims.[238] A lock for a gun wagon (*slos* [...] *czu buchsenwaynen*) was also mentioned in 1419.[239] Furthermore, in 1414 in Elbing (Pol. Elbląg) 6 Scot and 4 Denars was spent on tallow (*talch*) used to grease gun wagons and winders.[240]

An interesting description of a wagon can be found in a letter of the Grand Master to Danzig (Pol. Gdańsk) from 19 April 1433, concerning war preparations agains the Hussites. This description refers to battle wagons (*furweyne*) and not gun transporting wagons, but there are still several similar points. Such a wagon should be iron-fitted (*beslagen*), on high wheels with iron rims (*mit hogen raden, die beslagen sien*) and it should be pulled by 5–6 good horses. It should be equipped with 2 strong chains, a hoe, a spade and a shovel.[241]

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[231] NKRSME I (as n. 29), p. 219.

[232] NKRSME II (as n. 29), p. 84; Żabiński, *Ways of acquisition* (as n. 17), pp. 133–134.

[233] Rathgen, *Das Geschütz* (as n. 4), pp. 429, 439; idem, *Die Pulverwaffe* (as n. 4), pp. 71, 88.

[234] Świętosławski (as n. 10), p. 24.

[235] NKRSME II (as n. 29), p. 95; Żabiński, *Ways of acquisition* (as n. 17), p. 134; Rathgen, *Das Geschütz* (as n. 4), pp. 429, 439; idem, *Die Pulverwaffe* (as n. 4), pp. 71, 88.

[236] ABMH (as n. 25), p. 310; Żabiński, *Ways of acquisition* (as n. 17), p. 131.

[237] ABMH (as n. 25), p. 327.

[238] Goetz (as n. 76), p. 37.

[239] ABMH (as n. 25), p. 338; Żabiński, *Ways of acquisition* (as n. 17), p. 131.

[240] NKRSME II (as n. 29), p. 81; Rathgen, *Das Geschütz* (as n. 4), p. 429; idem, *Die Pulverwaffe*, p. 71.

[241] *Acten der Ständetage Preussens unter der Herrschaft des Deutschen Ordens*, ed. M. Toeppen, 5 vols., Leipzig 1878–1886, here vol. 1, No. 448, p. 593; see also Strzyż, *Broń palna* (as n. 20),

Sometimes it is possible to relate such mentions to specific cannons which are known from sources. In 1409 at Marienburg (Pol. Malbork) 16 Scot was paid for 4 wheels (*rade*) to a large gun wagon (*groser bochsenwayn*) and later on in the same year 1 Mark was spent on 4 large wheels (*grose rade*) to a gun wagon.[242] These records can perhaps be related to the *Grose Bochse*. Also in 1409 2 Marks went for making a wagon for this gun.[243] As these expenses come from the period when the the heavy cannon was in the field during the campaign against Kingdom of Poland, it can be assumed that they testify to a need of frequent repairs or replacements. It is hardly suprising that wheels of the wagon used to transport such a heavy cannon were especially vulnerable to damages. Another record from 1409 mentions *luse lonen zum grosen bochsenwayne*[244], which were perhaps some sort of movable shutters (fig. 28). Also in 1409 2.5 Marks was paid for iron fittings for a wagon for the long gun cast in Danzig (Pol. Gdańsk) (*vor 1 wayn zu beslohen zu der langen bochsen dy zu Danczk gegossen wart*).[245]

A necessary part of gun or wagon constructions were iron fittings.[246] Apart from mentions concerning fittings of specified types of stands, trestles, carriages and wagons there are also some more general ones. In 1403 at Marienburg (Pol. Malbork) 17 guns which were to be sent to Ragnit (Russ. Neman) were iron-fitted.[247] Two years thereafter at Königsberg (Russ. Kaliningrad) 3 Marks and 13 Scot was paid for 6 stones of iron for gun equipment and other tools (*zu dem buchsengezoy und vor alle gerethe dorzu*).[248] In 1409 at the Order's capital castle a smith Jauwernig was paid 1 Mark for fitting 4 small guns with iron (*vor 4 cleyne bochsen zu beslohen*).[249]

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p. 166; and D. Heckmann, *Kriegstechnische Innovationen in den mittelalterlichen Deutschordenslanden Preussen und Livland*, Militärgeschichtliche Zeitschrift 65 (2006), p. 127.

[242] MTB (as n. 23), pp. 555, 559; Żabiński, *The Grose bochse* (as n. 17), p. 35, tab. 3; Schmidtchen (as n. 6), p. 70; Rathgen, *Das Geschütz* (as n. 4), p. 407.

[243] MTB (as n. 23), p. 577; Żabiński, *The Grose bochse* (as n. 17), p. 35, tab. 3; Rathgen, *Das Geschütz* (as n. 4), p. 408; Toeppen (as n. 1), p. 158.

[244] MTB (as n. 23), p. 579; Rathgen, *Das Geschütz* (as n. 4), p. 408, and idem, *Die Pulverwaffe* (as n. 4), p. 31, he says that these were *Spannägel* or large nails; Żabiński, *Ways of acquisition* (as n. 17), p. 130; idem, *The Grose bochse* (as n. 17), p. 35, tab. 3; Toeppen (as n. 1), p. 235.

[245] MTB (as n. 23), p. 573; Żabiński, *Ways of acquisition* (as n. 17), p. 131; Rathgen, *Das Geschütz* (as n. 4), p. 407; idem, *Die Pulverwaffe* (as n. 4), p. 30; Engel, *Nachrichten über Waffen* (as n. 3), p. 231; for other cases of wagons for heavy bombards see e.g. Serdon-Provost (as n. 136), p. 192.

[246] For comparative data see e.g. Heś (as n. 97), pp. 139–140; Rathgen, *Das Geschütz* (as n. 4), p. 15.

[247] MTB (as n. 23), p. 247.

[248] MTB (as n. 23), p. 364; Engel, *Nachrichten über Waffen* (as n. 3), p. 232.

[249] MTB (as n. 23), p. 573; Rathgen, *Das Geschütz* (as n. 4), pp. 408, 420; idem, *Die Pulverwaffe* (as n. 4), p. 30; Engel, *Nachrichten über Waffen* (as n. 3), 1897–1899, p. 231.

As mentioned above while discussing the stand of the *Grose Bochse*, ropes of all kind were indispensable part of gun equipment. However, mentions of such ropes are rather rare in sources. In 1408 at the Order's capital castle 2 Marks was paid to a rope-maker for making 2 ropes for guns (*dem seyler of rechenschaft of 2 lynen zu machen zur bochsen*).[250] In the following year, 3 Marks and 8 Scot was spent on 10 stones of rope yarn, to be used for throwing engine ropes, gun straps and other ropes (*vor 10 steyne kabelgarn zu blydenlynen und bochsenstroppen und lyne*).[251] About 1523 at Königsberg (Russ. Kaliningrad) 122 *syllen* were recorded.[252] In all probability these were ropes used for wagon harness. A somewhat analogous role may have been played by chains, which are also sporadically mentioned. A gun chain was recorded in 1432 in the *Karwan* at Marienburg (Pol. Malbork). Interestingly, it was stated that it was used to chain prisoners (*1 kete von 12 buchsen do man die gefangen ane snirt*).[253] From 1521 there comes a mention of 1 half-serpentine with a chain (*1 halbe schlange 1 ketten dorczu*) at (Preußisch) Eylau (Russ. Bagrationovsk).[254] Furthermore, the list of the Order's firearms from c. 1523 records 184 chains (*ketten*) at Königsberg (Russ. Kaliningrad).[255]

Another problem are horse teams used for wagons and carriages with individual types of guns. On the basis of data concerning the participation of the *Grose Bochse* in the campaign against Kingdom of Poland in 1409 it can be said that a team of merely 8 horses was used for the transportation of this heavy cannon, which weighed perhaps more than 13 tons. This implies a load of c. 1.7 ton per horse (or c. 840 kg, in case each part of the gun was transported separately and their weight was more or less similar). On the other hand, the main part of the travel in all probability occurred by water, as unloading of the cannon from the ship was mentioned. Therefore, horses perhaps drew the gun wagon for very short distances only (e.g., from the ship to the gun post).[256] In Maximilian I's propaganda paintings, the wagon with the *Lew* (heavy siege cannon, mounted on an immovable stand) is drawn by a team of 15 horses. Maximilian's inventory sources mention teams of 18 horses for heavy *scharfmetzen* and those of 6 horses form smaller *scharfmatzen*.[257] The issue of transportation of cannons has also been thor-

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[250] MTB (as n. 23), p. 511; Żabiński, *Ways of acquisition* (as n. 17), p. 131.
[251] MTB (as n. 23), p. 590; Rathgen, *Das Geschütz* (as n. 4), p. 408.
[252] Biskup (as n. 28), p. 101.
[253] MÄB (as n. 26), p. 109–110.
[254] GÄDO (as n. 26), p. 177.
[255] Biskup (as n. 28), p. 101.
[256] MTB (as n. 23), pp. 557–578; Żabiński, *Ways of acquisition* (as n. 17), p. 137; idem, *The Grose bochse* (as n. 17), pp. 38–39, tab. 5.
[257] Chodyński, *Habsburg artillery* (as n. 11), p. 58.

oughly discussed by J. Szymczak. This scholar assumes that a team of 12 horses was needed to draw the wagon of a 2.5 ton cannon, while another 16 horses were needed for the wagon which transported the cannon's stand. In 1467 in Silesia, a team of 24 horses pulled the wagon with the barrel of a c. 4 ton cannon.[258]

Gun equipment

Data on gun equipment of various kinds (fig. 29) occurs quite frequently in sources. The first category which can be isolated are general mentions, which simply state the very presence of such tools. In some cases it is stated that the equipment is stored in a given room or a container. As mentioned above, a purchase of iron for making gun equipment and other tools for firearms was recorded at Königsberg (Russ. Kaliningrad) in 1405.[259] In 1413 at the Order's capital castle a payment of 1 Mark to a master gunner (*bochszenschutcz*) Hartman was made. Interestingly, the money was taken by a local hospitaller (*spitteler*), who bought equipment (*gerethe*) for the artilleryman.[260] In the same year various gun tools stored in small chests (*kleine kysten, do der buchsen gerethe mancherleye inne is*) were recorded in the Town Hall in Elbing (Pol. Elbląg).[261] Three years thereafter a Teutonic Order's inventory of the local commandery mentioned 1 medium-sized stone cannonball gun with all the equipment (*1 mittelmessige steynbuchze mit allen czugehorungen*).[262] A similar record is known from 1508 concerning Teutonic weaponry stores at Angerburg (Pol. Węgorzewo), where 2 veuglaires with all the equipment (*vogeler mit aller zugehor*) were mentioned.[263] In 1417 1 Mark was paid at Marienburg (Pol. Malbork) to 3 carpenters for a week of works on a gun equipment chamber in the *Karwan* (*czu der kamer im karwan czu bochsengerethe*).[264]

The first action in preparing the gun to fire was to put the gunpowder into the barrel.[265] This was done using ladles, which were sometimes fitted with metal. In

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[258] Szymczak (as n. 19), pp. 215–230, tab. 12; see also A. Bołdyrew, *Equus Polonus. Koń w wojsku polskim w XVI wieku*, Piotrków Trybunalski 2016, pp. 130–139, who assumes a "normal" load of c. 200 kg per horse for longer distances.

[259] MTB (as n. 23), p. 364.

[260] ABMH (as n. 25), p. 113; Jóźwiak, Trupinda (as n. 14), p. 434.

[261] EK (as n. 173), p. 254; see also Chodyński, *Inwentarz broni* (as n. 11), pp. 75, 77–78; idem, *The stores of arms* (as n. 11), pp. 20, 22).

[262] GÄDO (as n. 26), p. 86.

[263] GÄDO (as n. 26), p. 7.

[264] ABMH (as n. 25), p. 268; Żabiński, *Ways of acquisition* (as n. 17), p. 130.

[265] On individual stages of gun firing see also e.g. Szymczak (as n. 19), pp. 73–75; Goetz (as n. 76), pp. 64–65; Schmidtchen (as n. 6), pp. 15–18, figs. 4–6.

1409 at Marienburg (Pol. Malbork) the smith Jauwernig made 5 charging ladles (*ladeleffel*) for the *Grose Bochse*.[266] In the same year 2 Scot was paid for a metal sheet for a ladle to the heavy cannon (*blech zum ladeleffer zur grosten bochsen*).[267] This sum was perhaps a half of the price for a complete ladle, as suggested by a mention from 1414 from Elbing (Pol. Elbląg), where the smith Vasolt received 8 Scots for 2 powder ladles for large guns (*2 pulverleven czu den grosen buchsen*).[268] Apart from that, *ladeschuffeln* or *pulverschuffeln* are also sometimes mentioned in inventory sources, usually with no further details of their construction.[269] A very interesting record is known from 1414 from Elbing (Pol. Elbląg) and it mentions a payment of 4 Scot for 2 pipes for gunpowder (*2 roren, do man das pulver mete intut*).[270]

After the gun had been charged with gunpowder, a wooden stopper was inserted into the barrel. Its role was to secure additional tightness and prevent combustion gases from escaping.[271] According to Johannes Bengedans, a mid-15th century German master gunner (who also spent some time in the Order's service), such a stopper (*proff*) was to be wrapped in a piece of cloth (*tuch*).[272] Interestingly, 2 ells of fustian (*2 elen parcham*) were bought for 0.5 Ferto at Königsberg (Russ. Kaliningrad) in 1405, with a mention that master gunners needed it for firearms (*die die buchsenschuczen zum fuyrgeschos haben wolden*).[273] Prices of stoppers varied, according to the size of gun they were meant for. In 1405 at Königsberg 13 Scot was paid for 100 gun stoppers (*pfroppen zu den buchsen*).[274] A variety of

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[266] MTB (as n. 23), p. 573; Żabiński, *The Grose bochse* (as n. 17), p. 35, tab. 3.

[267] MTB (as n. 23), p. 597; Stępiński, Żabiński, Strzyż (as n. 18), p. 175; Żabiński, *The Grose bochse* (as n. 17), p. 35, tab. 3; Schmidtchen (as n. 6), p. 71; Rathgen, *Das Geschütz* (as n. 4), pp. 407–408; idem, *Die Pulverwaffe* (as n. 4), pp. 30, 33; Engel, *Nachrichten über Waffen* (as n. 3), p. 232; Toeppen (as n. 1), p. 231.

[268] NKRSME II (as n. 29), p. 95; Chodyński, *Inwentarz broni* (as n. 11), p. 73; idem, *The stores of arms* (as n. 11), p. 18; Rathgen, *Das Geschütz* (as n. 4), p. 429; idem, *Die Pulverwaffe* (as n. 4), p. 71.

[269] GÄDO (as n. 26), pp. 142, 204, 544; 620, 622; MÄB (as n. 26), pp. 19–20, 22–24; Stępiński, Żabiński, Strzyż (as n. 18), p. 180.

[270] NKRSME II (as n. 29), p. 95.

[271] On such stoppers see e.g. Heś (as n. 97), p. 140; Smith, DeVries (as n. 53), p. 258; Szymczak (as n. 19), pp. 73–75, 119–120; Oakeshott (as n. 53), p. 32; Müller (as n. 77), p. 18; Rathgen, *Das Geschütz* (as n. 4), pp. 18, 122, 203, 481; Baltzer (as n. 2), p. 22; see also Jakubowski (as n. 44), pp. 406, 411.

[272] Bengedans (as n. 40), chapter 34, p. 50; see also Rathgen, *Das Geschütz* (as n. 4), p. 203.

[273] MTB (as n. 23), p. 364; Rathgen, *Das Geschütz* (as n. 4), p. 404; idem, *Die Pulverwaffe* (as n. 4), p. 25; Engel, *Nachrichten über Waffen* (as n. 3), p. 232.

[274] MTB (as n. 23), p. 364; Schmidtchen (as n. 6), p. 72; Rathgen, *Das Geschütz* (as n. 4), p. 404; idem, *Die Pulverwaffe* (as n. 4), p. 25.

stoppers was recorded four years thereafter at Marienburg (Pol. Malbork). 1 Mark and 108 Denars was paid for fitting 23 stoppers for the large gun (perhaps the *Grose Bochse*) with rings on both ends, which gives 36 Denars per item. Interestingly, only 8 Scot was paid for 21 stoppers for the largest gun. 1 Mark was paid for turning 180 stoppers for old large guns (*proppe zu drehen zu den alden grosen bochsen*). The price of 120 stoppers for medium-sized guns was 0.5 Mark, while 1 Ferto was paid for 420 stoppers for small stone cannonball guns on wheeled carriages.[275] Another detailed record is also known from 1409. 1 Mark 10 Scot and 20 Denars was paid for 5 large stoppers for the largest gun and more than 60 for the second largest one. The price of these largest stoppers was 8 Denars per item. 120 stoppers for another large cannon called the "Wall-Breaker" (*Vellemuwer*) were also bought and their cost was 4 Denars per item. Furthermore, there were 60 stoppers for an Osterode (Pol. Ostróda) gun and 30 stoppers for a medium-sized Graudenz (Pol. Grudziądz) gun. Their respective prices were 3 and 2 Denars per item. Eventually, 1 Ferto was paid for fitting 5 large stoppers with rings on both ends.[276] Gun stoppers are also sporadically mentioned in inventory sources.[277] Furthermore, records from 1423 and 1424 concerning Schwetz (Pol. Świecie) and 1413 and 1428 for Elbing (Pol. Elbląg) mention *pfropeysen*[278], which may have been iron fittings for stoppers. Eventually, it is possible that a *pulverklocz*, recorded in 1413 in the inventory of the Town Hall of Elbing[279], was also a kind of stopper. On the other hand, A. R. Chodyński states that it was rather a ramrod.[280] Yet another opinion was expressed by J. Szymczak who interpreted this device as a gunpowder pounder.[281]

Projectiles were inserted into barrels using ramrods. These tools were also used

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[275] MTB (as n. 23), p. 573; Żabiński, *The Grose bochse* (as n. 17), p. 35, Tab. 3; Świętosławski (as n. 10), p. 26; Schmidtchen (as n. 6), p. 72; Rathgen, *Das Geschütz* (as n. 4), pp. 407, 413; idem, *Die Pulverwaffe* (as n. 4), pp. 31, 41.

[276] MTB (as n. 23), pp. 589, 597; Stępiński, Żabiński, Strzyż (as n. 18), pp. 174–175; Żabiński, *The Grose bochse* (as n. 17), p. 35, tab. 3; for stoppers see also Rathgen, *Das Geschütz* (as n. 4), pp. 408–409, 413; idem, *Die Pulverwaffe* (as n. 4), p. 32; Engel, *Nachrichten über Waffen* (as n. 3), p. 232; Toeppen (as n. 1), pp. 159, 233.

[277] EK (as n. 173), p. 253; see also Chodyński, *Inwentarz broni* (as n. 11), pp. 74, 77–78; idem, *The stores of arms* (as n. 11), pp. 20, 22; GÄDO (as n. 26), p. 656.

[278] GÄDO (as n. 26), pp. 88, 620, 622; EK (as n. 173), p. 253; see also Chodyński, *Inwentarz broni* (as n. 11), pp. 74, 77–78; Chodyński, *The stores of arms* (as n. 11), pp. 20, 22; Stępiński, Żabiński, Strzyż (as n. 18), p. 180.

[279] EK (as n. 173), pp. 253–254; see also Chodyński, *Inwentarz broni* (as n. 11), pp. 77–78; idem, *The stores of arms* (as n. 11), p. 22; Rathgen, *Das Geschütz* (as n. 4), p. 430; idem, *Die Pulverwaffe* (as n. 4), p. 72.

[280] Chodyński, *Inwentarz broni* (as n. 11), p. 75; idem, *The stores of arms* (as n. 11), p. 20.

[281] Szymczak (as n. 19), p. 76.

to clean barrels after the gun had been fired. Ramrods (*stempel*) are sometimes mentioned in Order's inventories, but in most cases with no additional details on their construction or function (e.g., ramrods for cannons and for hand-held firearms).[282] Sporadically, more information is offered. In 1414 in Elbing (Pol. Elbląg) a price of 48 Denars was paid for 2 ramrods.[283] In 1434 at Graudenz (Pol. Grudziądz) 2 iron ramrods (*eysern stempel*) were recorded.[284] It is difficult, however, to determine whether this meant all-iron tools (rather heavy and thus not very practical), or, more probably, wooden ramrods with iron fittings. The use of ramrods made entirely from iron can be suggested by a record from 1434 from Christburg (Pol. Dzierzgoń), which mentions 1 *ladeyszen*.[285] Furthermore, there are several mentions of iron rods (*yserynne/eysern stangen*) in Teutonic Order's inventories in the context of firearms.[286] Although it cannot be said for certain, one could perhaps tentatively assume that these rods may have had a similar function to ramrods.

After the projectile had been inserted into the barrel, it was usually additionally fastened with wedges (fig. 30). On the other hand, wedges were also used to aim cannons, by means of hammering them under the back part of the breech.[287] Such wedges, as minor items, are only sporadically mentioned. In 1405 at Königsberg (Russ. Kaliningrad) 13 Scot and 12 Denars was paid for 500 shots (*hagilschos*) and 60 wedges for guns (*kyle zu buchsen*).[288] Furthermore, 0.5 barrel of wedges for guns (*0.5 tonne clotczer zcu bochsen*) was recorded at Brandenburg (Russ. Ušakovo) in 1452.[289]

Gunpowder in firearms' breeches was ignited using various methods, such as matches, glowing iron rods or linstocks.[290] Expenses on 3 *entczundeysen* were re-

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[282] GÄDO (as n. 26), pp. 88, 278, 282, 367, 412, 653, 658, 656, 660, 663, 665, 668–669, 769–770; Schmidtchen (as n. 6), p. 36.

[283] NKRSME II (as n. 29), p. 95.

[284] GÄDO (as n. 26), p. 603.

[285] GÄDO (as n. 26), p. 142.

[286] GÄDO (as n. 26), pp. 335, 339, 766–767; *Visitationen* 1 (as n. 26), No. 123, p. 261; on ramrods in Teutonic sources see also Stępiński, Żabiński, Strzyż (as n. 18), p. 179.

[287] Müller (as n. 77), p. 19; Rathgen, *Das Geschütz* (as n. 4), p. 131; see also Jakubowski (as n. 44), plate XIX, fig. 5.

[288] MTB (as n. 23), p. 364; Engel, *Nachrichten über Waffen* (as n. 3), p. 232; Rathgen, *Das Geschütz* (as n. 4), p. 404; idem, *Die Pulverwaffe* (as n. 4), p. 25; Stępiński, Żabiński, Strzyż (as n. 18), p. 175.

[289] GÄDO (as n. 26), p. 244; Stępiński, Żabiński, Strzyż (as n. 18), p. 180.

[290] See e.g. Smith, DeVries (as n. 53), p. 258; Szymczak (as n. 19), p. 75; Oakeshott (as n. 53), p. 32; Schmidtchen (as n. 6), p. 71; Rathgen, *Das Geschütz* (as n. 4), p. 123.

corded in the account book of Elbing (Pol. Elbląg) in 1404.[291] These may have been simple iron rods, which were heated and then used to ignite the gunpowder charge. The *entczuende haken* (literally: igniting hook), mentioned in resources of the Town Hall in Elbing in 1413[292] was perhaps a more complex device. It may have been provided with a slow match. It cannot be excluded that similar devices were recorded there under the name of *hoken czu buchsen*.[293] *Czundehoken* (3 and 4 respectively) were also mentioned among weaponry resources at Tilsit (Russ. Sovetsk) in 1419 and 1425.[294] A fully developed form of linstock was recorded in 1516 at Neidenburg (Pol. Nidzica), where 8 such artefacts (*fuerspiesse so gut sie seynt*) were stored.[295] An interesting piece of information is known from 1414 from Elbing (Pol. Elbląg) where 0.5 Ferto was paid for two pincers used to "put charcoal on guns" (*2 czangen, do man dye kolen mete uff dy buchsen leyt*).[296] This suggests that guns were fired using a glowing piece of charcoal, which was held in special pincers and ignited the gunpowder charge.[297]

In case it was necessary to carry fire in the field, containers of various kind may have been used. In 1409 at Marienburg (Pol. Malbork) 4 pipes used by master gunners to carry fire were mentioned (*roren, do der bochsenschocze fuwer mag inne tragen*).[298]

When discussing methods of igniting the gunpowder charge, one must also pay attention to touch holes. After a long period of use, touch holes in cannons (with special reference to those made from copper and its alloys) could become burnt through and thus make the cannon less efficient. This is evidenced by a record from 1409, stating that a medium-sized gun was transported from Graudenz (Pol. Grudziądz) to Marienburg (Pol. Malbork), as its touch hole was widely burnt through (*dy mittelbochse von Grudencz ken Marienburg zu furen, als das zondeloch*

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[291] NKRSME I (as n. 29), p. 16; Rathgen, *Das Geschütz* (as n. 4), pp. 427, 439; idem, *Die Pulverwaffe* (as n. 4), p. 67.

[292] EK (as n. 173), p. 253; Szymczak (as n. 19), p. 75; Chodyński, *Inwentarz broni* (as n. 11), pp. 74, 77–78; idem, *The stores of arms* (as n. 11), pp. 20, 22; Rathgen, *Das Geschütz* (as n. 4), p. 429; idem, *Die Pulverwaffe* (as n. 4), p. 72.

[293] EK (as n. 173), p. 254; Rathgen, *Das Geschütz* (as n. 4), p. 429; idem, *Die Pulverwaffe* (as n. 4), p. 72; Chodyński, *Inwentarz broni* (as n. 11), pp. 75, 77–78; idem, *The stores of arms* (as n. 11), pp. 20, 22.

[294] GÄDO (as n. 26), pp. 278, 282; Stępiński, Żabiński, Strzyż (as n. 18), p. 180.

[295] GÄDO (as n. 26), p. 348.

[296] NKRSME II (as n. 29), p. 95.

[297] Oakeshott (as n. 53), p. 32.

[298] MTB (as n. 23), p. 572; Stępiński, Żabiński, Strzyż (as n. 18), p. 175; Schmidtchen (as n. 6), p. 72; Rathgen, *Das Geschütz* (as n. 4), pp. 407, 420, 440; idem, *Die Pulverwaffe* (as n. 4), pp. 30, 54, 89; Engel, *Nachrichten über Waffen* (as n. 3), p. 232.

wyt gebrant was).[299] Therefore, steel pipes were inserted into touch holes, as the former were more resistant to high temperatures and wear. Manufacture of such steel pipes by locksmiths is sometimes mentioned in Teutonic sources with regard to Marienburg (1411 – 5 Ferto *dem kleynsmeden vor stelen yn czundelochen czu den buchsen und vor ander ding dy doczu gehoren und vor slos*[300]; 1411 – 1 Mark *dem cleynsmede vor stellyne czondelocher czu smeden czu bochsen*[301]; 1412 – 1 Mark 2 Scot *vor stelinne czundelocher czu den buchzen*[302]; 1414 – 16 Scot *vor stelin roren czu den nuwen bochssen czu den czondelager*[303]). It is remarkable that an iron or steel pipe can be still seen in the touch hole of the light field cannon from Kauernick (Pol. Kurzętnik).[304] Interestingly, a record from 1414 concerning the Order's capital castle mentions a payment of 216 Denars for 9 locks, used to lock touch holes (*9 slos zu den bochsen do mete man dy condelocher vorsluset*).[305] Traces suggesting the presence of a touch hole coverplate have been found on the powder chamber of the well-known Boxted bombard, which was a wrought iron heavy cannon.[306] Another mention from 1414 concerns a payment of 144 Denars for *6 slos czu den bochsen*.[307] As the price per item was the same (24 Denars), it can be supposed that the latter ention refers to identical devices. It 1415 at Marienburg (Pol. Malbork) 96 Denars was paid for *2 slosse czu den bochsen*.[308] As the price per item was twice as high as in the preceding year, it could be tentative explained that the locks from 1415 were larger and perhaps meant for heavier cannons. There is also a record mentioning 2 priming pans for a gun in Engelsburg (Pol. Pokrzywno) (*2 tegel czu der buchse*). They belonged to a stone cannonball gun which was to be sent to Thorn (Pol. Toruń) for repair.[309]

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[299] MTB (as n. 23), p. 574; Stępiński, Żabiński, Strzyż (as n. 18), p. 181; Schmidtchen (as n. 6), p. 64; Rathgen, *Das Geschütz* (as n. 4), pp. 407, 440–441; idem, *Die Pulverwaffe* (as n. 31), pp. 31, 90; Engel, *Nachrichten über Waffen* (as n. 3), p. 230; Toeppen (as n. 1), p. 157.

[300] ABMH (as n. 25), p. 24.

[301] ABMH (as n. 25), p. 28.

[302] ABMH (as n. 25), p. 62.

[303] ABMH (as n. 25), p. 143; Żabiński, *Ways of acquisition* (as n. 17), p. 124; Rathgen, *Das Geschütz* (as n. 4), p. 421, 440–441; idem, *Die Pulverwaffe* (as n. 4), p. 57; see also Goetz (as n. 76), p. 27.

[304] Stępiński, Żabiński, Strzyż (as n. 18), pp. 156–157, Fig. 2.

[305] ABMH (as n. 25), p. 148.

[306] R. D. Smith, R. R. Brown, *Bombards Mons Meg and Her Sisters* (Royal Armouries Monograph 1), London 1989, p. 57, fig. 37.

[307] ABMH (as n. 25), p. 148; for similar devices see also Rathgen, *Das Geschütz* (as n. 4), p. 365.

[308] ABMH (as n. 25), p. 187; on gun locks in the Order's artillery see also Rathgen, *Das Geschütz* (as n. 4), p. 441; idem, *Die Pulverwaffe* (as n. 4), p. 90.

[309] GĂDO (as n. 26), p. 589; Stępiński, Żabiński, Strzyż (as n. 18), p. 180; Rathgen, *Das Geschütz* (as n. 4), p. 397; idem, *Die Pulverwaffe* (as n. 4), p. 12.

Tools which are sometimes mentioned in the context of firearms are hammers[310] (fig. 31). Regrettably, available sources hardly inform us for what purpose these tools were used. A record from 1413 from Neumark which mentions 1 hammer and nails for the gun (*1 hamer und nagel czur buchsen*)[311], implies that these tools may have been used for field repairs of gun stands.

Sporadically, there are also mentions concerning other tools associated with the use of firearms (fig. 32). The inventory of Memel (Lit. Klaipeda) from 1398 records one grease kettle (*smerkessil*)[312], but without specifying its use. The list of the Order's firearms stores from c. 1523 mentions 900 shovels (*schauffeln*), 300 spades (*spatten*) and 100 picks (*bicken*).[313] The latter may have been used for the manufacture of stone cannonballs, although it must be remembered that at that time cast iron projectiles were already widespread. On the other hand, all these tools may have also been used for ground works related to the use of artillery in the field.

Such tools were sometimes stored in chests (fig. 33). The inventory of the Town Hall in Elbing (Pol. Elbląg) from 1413 mentions a chest (*kysten*) which contained 24 lead bullet guns (*lotbuechsen*), as well as linstocks and stoppers (*entczuende haken unde proppen unde proppe yseren*).[314] This source also records two cloth chests (*gewantkysten*). The first one contained as many as 800 small stone cannonballs (*kleine buchsensteine*) and 44 stone cannonballs which were slightly larger. In the other chest there were 162 stone cannonballs which were even larger than the afore-mentioned ones. This chest also contained 4 boxes or small chests with various gun tools (*4 laden adir kleine kysten, do der buchsen gerethe mancherleye inne is*). The source also states that in the first chest there were 62 stone cannonballs for the largest guns.[315] In the following year the municipal authorities of Elbing (Pol. Elbląg) spent 16 Scot on 2 long chests where gun equipment and stoppers could be stored (*2 lange kasten do man das buchsengerethe unde proppen inlegen mag*).[316] Also in 1414 the same sum was spent on fitting 2 chests for

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[310] GÄDO (as n. 26), pp. 278, 282, 321, 367, 766–767, 770; MTB (as n. 23), p. 573; Stępiński, Żabiński, Strzyż (as n. 18), pp. 175, 179; Schmidtchen (as n. 6), p. 33; Rathgen, *Das Geschütz* (as n. 4), p. 407.

[311] GÄDO (as n. 26), p. 769.

[312] GÄDO (as n. 26), p. 302.

[313] Biskup (as n. 28), p. 101.

[314] EK (as n. 173), p. 253; Chodyński, *Inwentarz broni* (as n. 11), pp. 74, 77–78; idem, *The stores of arms* (as n. 11), pp. 20, 22; Rathgen, *Das Geschütz* (as n. 4), p. 429.

[315] EK (as n. 173), p. 254; Chodyński, *Inwentarz broni* (as n. 11), pp. 75, 77–78; idem, *The stores of arms* (as n. 11), pp. 20, 22; Rathgen, *Das Geschütz* (as n. 4), p. 429.

[316] EK (as n. 173), p. 260; NKRSME II (as n. 29), p. 80; Rathgen, *Das Geschütz* (as n. 4), p. 429; idem, *Die Pulverwaffe* (as n. 4), p. 71.

gun equipment with iron (*2 kasten zu beslan, do man das buchsengerete inlegt*).[317] It could be asked whether this record concerned the previously mentioned chests. The habit of storing gun equipment together with projectiles is also evidenced by other sources.[318] Some records mention chests with projectiles only, such as those from Preußisch Mark (Pol. Przezmark). In 1507, 1 chest with small and large iron shots (*1 kasten mit eisern schrotten clein und gros*) was recorded, while the inventory from 1508 mentions *1 kasten mit glotten clein und gros*.[319]

Finally, for the sake of comparison it is worth mentioning a list of gun equipment stated in the manual of S. de Saint Remy from 1697 (fig. 34).[320] The most important instruments are:

– charging ladles or "lanterns" (*lanternes*, *cuillieres*), composed of copper tubes and wooden shafts,

– ramrods (*refouloirs*), being wooden pounders on wooden shafts,

– bore brushes or sponges (*ecouvillons*), consisting of heads covered with ram's fleece or wild boar's bristle mounted on wooden shaft, sometimes provided with metal fittings (*virolles*) at the end of the shaft,

– wad-screws (*tirebourres*), or corkscrew-like tools used to unload the gun, mounted on wooden shafts,

– linstocks (*bouttefeux*), consisting of M-shaped heads to hold the match mounted on wooden shafts,

– *chats* (literally – cats), or hook-shaped instruments mounted on wooden shafts and used to examine cannon barrel bores for possible defects,

– priming irons (*dégorgeoirs*), or needle-or nail-shaped instruments for cleaning of touch holes. There are loops on their ends, preventing them from falling into the barrel,

– primers (*fourniments*), or leather flasks or horns which should contain at least one pound of ignition powder,

– leather sacks with ignition powder (*sacs à amorce*),

– funnels (*entonnoirs*), used to fill ignition powder into the touch hole,

– pointing wedges (*coins de mire*), used to regulate the angle of elevation of the barrel,

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[317] NKRSME II (as n. 29), p. 87; Rathgen, *Das Geschütz* (as n. 4), p. 429; idem, *Die Pulverwaffe* (as n. 4), p. 71.

[318] GÄDO (as n. 26), pp. 88, 91, 97, 105; *Visitationen* 1 (as n. 26), No. 120, p. 250.

[319] GÄDO (as n. 26), pp. 147–148; Żabiński, *Technology of manufacture* (as n. 17), p. 93.

[320] Saint Remy (as n. 43), pp. 71–76; a similar description is also offered by J. Jakubowski, see Jakubowski (as n. 44), pp. 265–270, plate VIII, figs. 13–23; see also Boeheim (as n. 76), pp. 58–59, fig. 1.

– pointing frontons (*fronteaux de mire*), or rectangular pieces of hard wood with a semicircular hollowing in their bottom parts, placed under the barrel to regulate its angle of elevation,

– aprons (*chapiteaux*, or literally – capitals), consisting of two boards of hard wood joint obliquely; these were used to cover the touch holes of cannons against rain or dirt,

– levers (*leviers*), being long bars of had wood with wedge-shaped points.

Tools for the manufacture of projectiles

Before the introduction of cast iron cannonballs at the end of the 15th century, stone was the most popular raw material for artillery projectiles.[321] In the case of stone projectiles, the most frequently mentioned tools were picks. A series of expenses on the manufacture of 150 stone cannonballs made by the House Commander of Königsberg (Russ. Kaliningrad) was recorded in 1403 and 7 Scot was spent on picks (*bicken*). Apart from that, 1 Ferto went for carburising of picks (*bicken zu stelen*), and another payment of 0.5 Mark for sharpening and carburising (*vor scherfyn und stelyn*) was recorded. Eventually, 4 Scot was spent on 2 spades, used to dig stones out of the ground (*vor 2 spaten, do mete man die steyne us der erden hat gegraben*).[322] In 1407 at Königsberg 24 picks were stored together with guns and gunpowder.[323] In the following year at Marienburg (Pol. Malbork) 3 Marks was spent on 12 picks used to make large stone cannonballs (*vor 12 bicken, do ma dy grossen bochsensteyne mete hib*).[324] In 1409 the Order's Treasurer paid 16 Scot and 20 Denars for sharpening of picks, as stone-cutters were manufac-

[321] Strzyż, *Broń palna* (as n. 20), pp. 127–130, 247–250; idem, *Średniowieczna broń palna* (as n. 20), pp. 49–50, 59–69; Szymczak (as n. 19), pp. 144–152; Arszyński, Sikorska-Ulfik (as n. 9), pp. 70–71; Goetz (as n. 76), p. 31; on stone projectiles from the Teutonic Order's state see also Strzyż, Czubla, Mackiewicz (as n. 13); P. Strzyż, *Pociski do średniowiecznej broni palnej z pogranicza polsko-krzyżackiego*, in: *Arma et Medium Aevum. Studia nad uzbrojeniem średniowiecznym*, ed. P. Kucypera, P. Pudło, G. Żabiński, Toruń 2009, pp. 198–223; idem, *Zespół kamiennych kul* (as n. 13); A. Wasilewski, *Późnośredniowieczne kule artyleryjskie znalezione na zamku w Pucku*, Zapiski Puckie 3 (2004), pp. 148–152; Świętosławski (as n. 10), p. 25.

[322] MTB (as n. 23), pp. 246–247.

[323] GÄDO (as n. 26), p. 11.

[324] MTB (as n. 23), p. 497; Stępiński, Żabiński, Strzyż 2013 (as n. 18), p. 175; Żabiński, *The Grose bochse* (as n. 17), p. 37, tab. 4; Schmidtchen (as n. 6), p. 71; Rathgen, *Das Geschütz* (as n. 4), p. 405; idem, *Die Pulverwaffe* (as n. 4), p. 26.

turing projectiles in Sobbowitz (Pol. Sobowidz).[325] In the same year the House Commander in Thorn (Pol. Toruń) spent 8 Scot on one stone of steel, needed to sharpen picks.[326] The purchase of metal actually implies a bit more extensive scope of repair than mere sharpening. It cannot be excluded that, e.g., working parts of these picks needed to be replaced. In the same year in Thorn another 5 Ferto went for sharpening of picks and for one large hammer for splitting stones (*grosen schelhammer*).[327] There are also other mentions of expenses on repairs of picks. In 1410 in Elbing (Pol. Elbląg) 7.5 Marks was spent on carburising of picks used to make cannonballs (*vor de picken to stelende, dar se mede de stene houwen*). 5 Marks went on sharpening of picks, and 2 Scot was spent on an unspecified repair of another pick. Eventually, one new pick was bought for 0.5 Ferto.[328] In 1411 the smithing master at the Order's capital castle received 1 Mark for sharpening of picks, to be given to a smith in Sobbowitz (Pol. Sobowidz) where stone cannonballs were made.[329] Furthermore, there are other records mentioning stores of picks at the Order's castles. 2 picks were found in 1410 at Schönsee (Pol. Kowalewo (Pomorskie))[330], 6 large picks were kept in 1422 at Brandenburg (Russ. Ušakovo)[331], and 3 picks were recorded in 1432 at Nessau (Old Pol. Nieszawa), now part of Thorn (Pol. Toruń).[332] As mentioned above, 100 picks were stored about 1523 at Königsberg (Russ. Kaliningrad).[333]

Another tool used in the manufacture of projectiles were pincers. Large iron pincers for stone projectiles (*grosse yserene czange czu steinen*) were recorded in 1413 in the inventory of the Town Hall in Elbing (Pol. Elbląg).[334] On the other hand, A. R. Chodyński interprets these pincers as tools used to ignite stone can-

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[325] MTB (as n. 23), p. 523; Żabiński, *Ways of acquisition* (as n. 17), p. 135; Stępiński, Żabiński, Strzyż (as n. 18), p. 175.

[326] MTB (as n. 23), p. 596.

[327] MTB (as n. 23), p. 597; Schmidtchen (as n. 6), p. 71; Rathgen, *Das Geschütz* (as n. 4), p. 409; idem, *Die Pulverwaffe* (as n. 4), p. 33.

[328] NKRSME I (as n. 29), p. 230; Rathgen, *Das Geschütz* (as n. 4), p. 428; idem, *Die Pulverwaffe* (as n. 4), p. 69.

[329] MKB (as n. 24), p. 252.

[330] GÄDO (as n. 26), p. 412; Żabiński, *Ways of acquisition* (as n. 17), p. 127; Schmidtchen (as n. 6), p. 36.

[331] GÄDO (as n. 26), p. 222; Żabiński, *Ways of acquisition* (as n. 17), p. 127.

[332] GÄDO (as n. 26), p. 484–485.

[333] Biskup (as n. 28), p. 101.

[334] EK (as n. 173), p. 254; Szymczak (as n. 19), p. 75; Chodyński, *Inwentarz broni* (as n. 11), pp. 77–78; idem, *The stores of arms* (as n. 11), p. 22; Rathgen, *Das Geschütz* (as n. 11), p. 430; idem, *Die Pulverwaffe* (as n. 11), p. 72.

nonball cannons[335], which seems to be a misunderstanding, as the source clearly speaks of stone projectiles.

In order to ensure proper dimensions of stone projectiles, compasses and callipers of various kind were used. In 1408 at Marienburg (Pol. Malbork) a carpenter was paid 4 Scot for making C-shaped devices used for the manufacture of cannonballs (*dem tischer vor kromme holzer zu machen noch zirkelmose, do man dy grosen bochsensteyne hoch gehawen hat*).[336] In 1414 in Elbing (Pol. Elbląg) 0.5 Ferto was spent on a ring, through which stone projectiles were beaten (*vor 1 ring, do man dy steine czu den buchsen durchhib*).[337] Interestingly, such rings with handles (so-called *passe-boulets* or *passe-balles*), which were used to make sure that projectiles were of proper calibre, are mentioned in the work of S. de Saint Remy (fig. 35).[338]

Much less is said on tools used in the manufacture of metal projectiles.[339] In 1410 in Elbing (Pol. Elbląg) 4 Marks was spent on a pan for a bullet founder (*vor ene panne, de kofft de lotgeter*).[340] Furthermore, one founding cauldron (*giszkessel*) was recorded in the inventory of the Order's castle in Brandenburg (Russ. Ušakovo) in 1452.[341] Eventually, a set of instruments including a copper mould for bullets (*coppern forme zu geloten*), a stone mould (*gissteyn*) and a casting ladle (*gisskelle*) (fig. 36) was recorded as part of weaponry resources sent from Thorn (Pol. Toruń) to the Prussian Confederacy troops which were besieging Schwetz (Pol. Świecie) in 1461.[342]

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[335] Chodyński, *Inwentarz broni* (as n. 11), p. 75; idem, *The stores of arms* (as n. 11), p. 20; see also Szymczak (as n. 19), p. 337.

[336] MTB (as n. 23), p. 497; Stępiński, Żabiński, Strzyż (as n. 18), p. 175; Żabiński, *The Grose bochse* (as n. 17), p. 37, tab. 4; Schmidtchen (as n. 6), p. 65; Rathgen, *Das Geschütz* (as n. 4), pp. 405, 433; idem, *Die Pulverwaffe* (as n. 4), p. 26; Engel, *Nachrichten über Waffen* (as n. 3), p. 231; on similar devices see Szymczak (as n. 19), pp. 145–146, fig. 26c; and Górski (as n. 53), p. 43.

[337] NKRSME II (as n. 29), p. 94; Żabiński, *Ways of acquisition* (as n. 17), p. 135.

[338] Saint Remy (as n. 43), pp. 82–83.

[339] On metal projectiles see e.g. Strzyż, *Broń palna* (as n. 20), pp. 113–118, 244–246; idem, *Średniowieczna broń palna* (as n. 20), pp. 50–53, 70–73; Smith, DeVries (as n. 53), p. 253; Szymczak (as n. 19), p. 152–157; Świętosławski (as n. 10), p. 25.

[340] NKRSME I (as n. 29), p. 229; Żabiński, *Technology of manufacture* (as n. 17), p. 103; Rathgen, *Das Geschütz* (as n. 4), p. 427; idem, *Die Pulverwaffe* (as n. 4), p. 68.

[341] GÄDO (as n. 26), p. 244; Żabiński, *Technology of manufacture* (as n. 17), p. 103; idem, *Ways of acquisition* (as n. 17), p. 127; Stępiński, Żabiński, Strzyż (as n. 18), p. 180.

[342] Biskup (as n. 31), p. 89; Żabiński, *Technology of manufacture* (as n. 17), p. 104.

Equipment related to gunpowder

Concerning gunpowder, tools used for its manufacture will be discussed first (fig. 37).[343] The work of Johannes Bengedans mentions copper kettles for cleaning (*luteren*) of saltpetre[344], as well as pots with lids for preparing gunpowder.[345] The inventory of Ortelsburg (Pol. Szczytno) from 1521 recorded 4 *kienphan* in the gunpowder chamber (*pulfferchammer*).[346] It cannot be excluded that these were vessels related to a certain stage of gunpowder manufacture.

An indispensable tool were pounders of various kinds.[347] In 1409 the House Commander of Thorn (Pol. Toruń) spent 1 Mark 2 Scot on an iron club or pestle used to pound gunpowder (*yserynne kolwe, polfer domete yn zu stossen*).[348] The inventory of Königsberg (Russ. Kaliningrad) from 1446 mentions 35 *poffoysen* among resources of gunpowder and saltpetre.[349] These artefacts may have been iron feet of pounders. One tool of this kind was also recorded two years thereafter at Insterburg (Russ. Černyahovsk).[350] Although not many details are known from sources from the territory of the Order's state, it can be supposed that some gunpowder pounders were more complex devices. This is suggested by a record from 1414 from Elbing (Pol. Elbląg), mentioning a payment of 2 Scot for nails used to prepare strings in order to pound gunpowder (*vor negele, vor strenge mete anczurichten, das pulver czu stosen*).[351]

Another necessary tool in the manufacture of gunpowder were sieves.[352] In 1401 at Marienburg (Pol. Malbork) 2.5 Marks was spent on one gunpowder sieve (*pulversyp*) and 4 charcoal pans (*kolphannen*).[353] The latter were perhaps used as containers for glowing charcoal. Four year thereafter, 72 Denars went for one

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343 For general data on gunpowder manufacture see e.g. McLachlan (as n. 53), pp. 7, 10–12, 18–26; Szymczak 2004 (as n. 19), pp. 122–138; Oakeshott (as n. 53), pp. 34–35; Rathgen, *Das Geschütz* (as n. 4), pp. 93–111; Górski (as n. 53), p. 29.

344 Bengedans (as n. 40), chapter 5, p. 16.

345 Bengedans (as n. 40), chapter 12, p. 26.

346 GÄDO (as n. 26), p. 123.

347 See e.g. Rathgen, *Das Geschütz* (as n. 4), p. 101.

348 MTB (as n. 23), p. 597; Żabiński, *Ways of acquisition* (as n. 17), p. 128; Engel, *Nachrichten über Waffen* (as n. 3), p. 232; Toeppen (as n. 1), p. 231.

349 GÄDO (as n. 26), p. 45; *Visitationen* 1 (as n. 26), No. 122, pp. 259–260.

350 GÄDO (as n. 26), p. 65.

351 NKRSME II (as n. 29), p. 79; Rathgen, *Das Geschütz* (as n. 4), p. 428.

352 See e.g. Smith, DeVries (as n. 53), p. 247.

353 MTB (as n. 23), p. 127; Żabiński, *Ways of acquisition* (as n. 17), p. 128; Engel, *Nachrichten über Waffen* (as n. 3), p. 232.

gunpowder sieve and 4 measures for gunpowder (*polvermoes*).[354] In 1409, among expenses on gunpowder making at the Order's capital castle there were 10 Scot on 5 sieves and 0.5 Mark on 4 sieves.[355] The price of about 2 Scot per sieve is also confirmed by other sources. This was the case in Elbing (Pol. Elbląg) in 1410[356] and Marienburg (Pol. Malbork) in 1411.[357] There is also data on more expensive artefacts, such as those mentioned in 1414 at the Order' capital castle. In this case, the price of 3 *polffersewe* was 12 Scot and 24 Denars.[358]

Gunpowder was manufactured in special premises, i.e., powder mills. Regrettably, available sources from the Order's state do not yield much data on this issue. In 1409 at Marienburg (Pol. Malbork) a series of expenses was made on gunpowder manufacture. 3 Marks was paid to an oil-maker for using the mill, powered by his own horses (*dem olesleger vor dy mole, yo von der tonne 8 Scot, mit synen pferden zu tryben*).[359] Another 3 Marks was paid, perhaps to the same specialist, for making 14 barrels of gunpowder (*dem olesleger vor dy mole, 14 tonnen polfer*).[360] Furthermore, 7 Ferto was paid to the oil-maker for a mill in Neuteich (Pol. Nowy Staw) near the Order's capital for 6 barrels of gunpowder (*dem olsleger vor dy mole zum Nuwentyche, 6 tonne polfer gemachet*).[361] These expenses were made in Autumn, already after the outbreak of the war with Kingdom of Poland and Grand Duchy of Lithuania. This strongly suggests that the Order was forced to make use of all available resources to meet the demand for explosives.

As mentioned above, gunpowder measures were mentioned in 1401 at Marienburg (Pol. Malbork). Another record of such tools is also known from the Order's capital castle from 1409, when 4 measures made from metal sheet were mentioned (*polfermesechen von bleche gemacht*). These were bought for 4 Scot, together with 4 pipes for carrying fire.[362]

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[354] MTB (as n. 23), p. 364; Stępiński, Żabiński, Strzyż (as n. 18), p. 175; Rathgen, *Das Geschütz* (as n. 4), p. 404; idem, *Die Pulverwaffe* (as n. 4), p. 25).

[355] MTB (as n. 23), p. 587.

[356] NKRSME I (as n. 29), p. 229; Chodyński, *Inwentarz broni* (as n. 11), p. 72; idem, *The stores of arms* (as n. 11), p. 17; Świętosławski (as n. 10), p. 27; Rathgen, *Das Geschütz* (as n. 4), p. 428; idem, *Die Pulverwaffe* (as n. 4), p. 69.

[357] ABMH (as n. 25), pp. 10, 28.

[358] ABMH (as n. 25), p. 147.

[359] MTB (as n. 23), p. 587.

[360] MTB (as n. 23), p. 587.

[361] MTB (as n. 23), p. 587; on these records see also Żabiński, *Ways of acquisition* (as n. 17), p. 128; Rathgen, *Das Geschütz* (as n. 4), pp. 437–438; idem, *Die Pulverwaffe* (as n. 4), pp. 84–86; Toeppen (as n. 1), p. 154.

[362] MTB (as n. 23), p. 572; Schmidtchen (as n. 6), p. 72; Engel, *Nachrichten über Waffen* (as n. 3), p. 232; Toeppen (as n. 1), p. 233.

The next issue are containers for storing gunpowder, components used in its manufacture, as well as ammunition. With regard to gunpowder and its components, the most popular ones were barrels – they are mentioned so many times in sources that it is impossible to deal with them individually. The most common term for a barrel was *tonne* (*tunne*, *thunne*). Other terms which were in use were *vas* (*fas*) and its diminutive *veschin* (*vessgen*, *feschen*, *veszlein*), as well as *loge* (*lagel*).[363] It must of course be remembered that these terms could refer both to physical containers and to volume units. *Tonne* was a volume unit which was 1/12 of *Last* (*1 Last* was c. 3143.22 litres). 1 *Tonne* would therefore equal to c. 261.94 litres. *Loge* was a volume unit used for wine and it equaled to c. 72.76 litres.[364] As far as *Vas* is concerned, J. A. Eytelwein mentions a Modern Period unit used in Hamburg.[365] Its volume equals to c. 58.43 litres. Furthermore, this author also mentions a Modern Period Prussian system of beer volume units, in which 1 *Faß* equalled to 2 *Tonnen*.[366] After a conversion to the metrical system, 1 *Tonne* would equal to c. 114.5 litres. It may be asked, however, to what extend this data was relevant for the discussed period. An interesting piece of information was recorded in 1408 at the Order's capital castle. 511.5 Marks and 5 Scot was spent of 280 stones of saltpetre and the delivery was shipped in *23 logen und in eyme vasse*.[367] The saltpetre was bought in Breslau (Pol. Wrocław) in Silesia, so one can assume that its weight was expressed in local measures. 1 stone in Breslau was about 10 kg, while in Prussia it could equal to between c. 10 and c. 14 kg, depending on the town.[368] Using the Silesian unit, one receives c. 2800 kg. The density of KNO_3 is 2.109 g/cm^3, so the volume of the purchased saltpetre was about 1327.64 litres. Taking the *Loge* of c. 72.76 litres, the purchased amount of saltpetre matches about 18.25 such units. Therefore, the *Logen* mentioned in 1408 must have been much smaller, perhaps

[363] *Ältere Hochmeisterchronik* (as n. 32), pp. 647–648; Biskup (as n. 28), p. 102; EK (as n. 173), pp. 253–254, 260; GÄDO (as n. 26), passim; KŻZP (as n. 31), pp. 102, 104; MÄB (as n. 26), pp. 19–20, 22–24, 30–39; MTB (as n. 23), pp. 287, 428, 494, 514, 587; NKRSME I (as n. 29), p. 229; NKRSME II (as n. 29), pp. 32, 79; *Visitationen* 1 (as n. 26), No. 89, p. 103; No. 90, p. 111; No. 91, p. 111; No. 92, p. 119; No. 107, p. 183; No. 108, p. 184; No. 110, p. 185; No. 111, p. 187; No. 116, p. 211; No. 117, p. 214; No. 118, p. 221; No. 122, pp. 259–260; No. 120, pp. 249–250; No. 123, pp. 261–262; No. 124, p. 276; No. 125, pp. 278–279; No. 133, p. 305; No. 134, p. 322; *Visitationen* 2 (as n. 26), No. 147, pp. 21, 24–29, 31, 32, 35, 37–38, 40, 107; No. 176, pp. 152–153.

[364] See also Kwiatkowski (as n. 16), p. 255, Scheme 4.

[365] J. A. Eytelwein, *Vergleichungen der gegenwärtig und vormals in den königlich preußischen Staaten eingeführten Maaße und Gewichte mit Rücksicht auf die vorzüglichsten Maaße und Gewichte in Europa*, Berlin 1810, pp. 89, 91.

[366] Eytelwein (as n. 365), p. 96.

[367] MTB (as n. 23), p. 514.

[368] See e.g. Kwiatkowski (as n. 16), p. 255, Scheme 4; Schmidtchen (as n. 6), p. 27.

c. 50 litres each. The *Vass* from 1408 may have been around 170 litres, i.e., about half of the volume of the *Tonne*. In 1414 in Elbing 1 Mark 18 Denars was spent on *13 vessgen zu pulver*, while a *Tonne* for gunpowder with a volume of 0.5 *Last* was purchased for 9 Scot.[369] The price of *1 vessgen* would equal to less than 2 Scot, which suggests that the volume of the *Lasttonne* was about 4.5 times larger than that of the *vessgen*. Taking the afore-mentioned volume of c. 3143.22 litres for 1 *Last*, the volume of the *vessgen* would equal to c. 349.25 litres.

When discussing stores of gunpowder and its components, in some cases it is possible to assume that terms used in sources actually referred to containers. For instance, in 1413 the inventory of the Town Hall in Elbing (Pol. Elbląg) recorded 3 quarters of a barrel of sulphur, stored in two half-empty barrels (*3 virdel van 1 tonne swefel, der is in 2 halben tonnen*). This inventory also mentions a barrel of sulphur which weights 10.5 stones minus 3 or 4 pounds (*1 tonne swevels, dy wyget 10.5 stein minus 3 adir 4 pfunt*). 10.5 stones would equal to about 144.58 kg.[370] As the density of solid sulphur is about 2 g/cm^3, the volume of 144.58 kg would equal to about 72.29 litres. Quite obviously, one should take differences in density between solid and pulverised sulphur into consideration (the density of the latter could be even two times smaller, so its volume would be two times greater). Anyway, this would mean that the barrel in question was either filled up to c. 30–60% of its capacity or that another barrel was used, whose capacity was much smaller than the mentioned "standard" c. 261.94 litres. The latter assumption receives support from the record of a purchase of one barrel of sulphur in Elbing (Pol. Elbląg) in 1414. The barrel weighed 14 stones and 10 pounds and was bought for 10 Marks and 18 Scot (*1 tonne swevel, dy wuk 14 steine und 10 lb, den stein vor 18 sc*).[371] The weight of the sulphur would be about 196.83 kg, while its volume in the solid state would equal to c. 98.41 litres and two times that much in the pulverised state.

For other mentions of barrels as containers, in 1415 at Schlochau (Pol. Człuchów) there were 2.25 barrels with lime wood charcoal (*vas mit lyndynnen kolen*).[372] Interestingly, the inventory of that castle from 1420 mentioned 1 quarter with lime wood charcoal (*1 fyrtil mit lyndynnen kolen*).[373] In this case the quarter could be understood either as a quarter of the *vas* from 1415 (whose capacity was

[369] EK (as n. 173), p. 260; NKRSME II (as n. 29), p. 79; Rathgen, *Das Geschütz* (as n. 4), p. 429; idem, *Die Pulverwaffe* (as n. 4), p. 71.

[370] Kwiatkowski (as n. 16), p. 255.

[371] NKRSME II (as n. 29), p. 79; Rathgen, *Das Geschütz* (as n. 4), p. 428; idem, *Die Pulverwaffe* (as n. 4), p. 70.

[372] GÄDO (as n. 26), p. 653.

[373] GÄDO (as n. 26), p. 656.

unspecifed), or as a volume unit, being ¼ of the *Tonne* (i.e., c. 65.48 litres).[374] 1 barrel of saltpetre was stored in 1418 at Danzig (Pol. Gdańsk) and it was recorded that it was not full (*1 tonne salpeter und ist nicht vol*).[375] In 1425 at Tilsit (Russ. Sovetsk) there were 1 and ¾ barrels of gunpowder and one of these was not full, lacking about 1 quarter (*tonnen pulver, eine ist bey eynem firtel nicht vol*).[376] In 1430 at Schönsee (Pol. Kowalewo (Pomorskie)) there were 2 barrels of gunpowder, which were, however, not full (*2 tonnen pulver aber nicht foil*).[377] Furthermore, in 1433 at Schlochau (Pol. Człuchów) there was 1 *feschen mit swebele*.[378] The same expression was used in 1446 at Elbing (Pol. Elbląg), where *12.5 tonnen mit pulver were recorded*[379], as well as in 1449 at Rehden (Pol. Radzyń (Chełmiński)) (*2 veschen mit pulver, 1 veschen mit salpeter, 1 veschen mit swebel*).[380] This was also the case at Neidenburg (Pol. Nidzica) in 1485 and 1488, where *1 thonne mit pulver und 6 pfund* was recorded[381], at Preußisch Mark (Pol. Przezmark) in 1507 and 1508 (*6 fessichen mit pulver*)[382], as well as at Osterode (Pol. Ostróda) in 1507 and 1508 (*4 fessichen mit pulfer*).[383] Furthermore, the inventory of Ortelsburg (Pol. Szczytno) from 1507 mentioned 3 quite full barrels of gunpowder (*3 fessichen pulfer gar fol*).[384] Interestingly, a year thereafter *3 vessichen mit pulffer nicht gantz vol* were recorded there.[385] A similar expression can be found in 1518 at Mohrungen (Pol. Morąg), where *1 thon salbetir nicht fol* was mentioned.[386] Eventually, *2 faessgen mit pulver* were recorded at Rhein (Pol. Ryn) in 1524.[387]

Barrels understood as containers (fig. 22) are also mentioned in non-inventory sources. In 1408 at Marienburg (Pol. Malbork), in the course of preparations for an expedition to Livonia, 4 empty barrels (*ledige tonnen*) were commisioned. These were to be used for gunpowder, oats, groats and bread (*zum polfer, erwis, grocze und zum brote*).[388] A year thereafter, as part of expenses on gunpowder mak-

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374 Kwiatkowski (as n. 16), Scheme 4, p. 255.
375 GÄDO (as n. 26), p. 697.
376 GÄDO (as n. 26), p. 282.
377 GÄDO (as n. 26), p. 420.
378 GÄDO (as n. 26), p. 660; see also ibid., p. 663.
379 GÄDO (as n. 26), p. 104; *Visitationen* 1 (as n. 26), No. 120, p. 249.
380 GÄDO (as n. 26), p. 582.
381 GÄDO (as n. 26), pp. 353, 355–356.
382 GÄDO (as n. 26), pp. 147–148.
383 GÄDO (as n. 26), pp. 344–345.
384 GÄDO (as n. 26), p. 118.
385 GÄDO (as n. 26), p. 119.
386 GÄDO (as n. 26), p. 114.
387 GÄDO (as n. 26), p. 204.
388 MTB (as n. 23), p. 494.

ing at the Order's capital castle, 7 Scot was spent on 0.5 *Last* of barrels. Another 4 Scot was paid to a cooper for binding barrels and fitting them with iron (*eyme botcher vor dy tonnen zu binden und zu slohen*).[389] Further expenses on gunpowder making in 1409 at Marienburg (Pol. Malbork) included 10 Scot for barrels (*tonnen zum polfer*) and 4 Scot for fitting a barrel with iron (*dy tonne zuzuslohen*). Furthermore, 96 Denars went for 8 barrels for gunpowder to a guardian of the lowest gate (*vor 8 tonnen zu polfer vom nedersten thorwerter*).[390]

Barrels were sometimes used for storing projectiles. This was the case in 1413 in Elbing (Pol. Elbląg), where there was a half-barrel with lead bullets (*1/2 tonne mit loeten*).[391] Furthermore, in 1518 at Preußisch Holland (Pol. Pasłęk) shots were kept in a small barrel (*etlisch schock schrot in eim feschen*).[392]

Apart from barrels, gunpowder and its components were also stored in sacks (Fig. 38). As it was the case with barrels, most inventory records of such sacks are very schematic and they merely state their number in a given premise.[393] Some mentions, however, contain more detailed pieces of information. For instance, the inventory of Schwetz (Pol. Świecie) from 1392 recorded 13 leather sacks with gunpowder (*lederynne secke mit pulver*).[394] The choice of leather for gunpowder sacks seems to well-founded, as it certainly offered much better protection against moisture than cloth. The use of leather is also confirmed by other sources. The inventory of Schlochau (Pol. Człuchów) from 1413 mentions *8 lederyn secke mit pulver*[395], and one such sack was also mentioned at Lötzen (Pol. Giżycko) in 1420[396] and at Schaaken (Russ. Nyekrasovo) near Königsberg (Russ. Kaliningrad) in 1422.[397]

An interesting record comes from Elbing (Pol. Elbląg), where in 1410 a certain Bertold Schumaker was paid 16 Scot for *22 secke to pulver*.[398] If his family

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[389] MTB (as n. 23), p. 587.

[390] MTB (as n. 23), p. 587.

[391] EK (as n. 173), p. 253; Chodyński, *Inwentarz broni* (as n. 11), pp. 74, 77–78; idem, *The stores of arms* (as n. 11), pp. 20, 22; Rathgen, *Das Geschütz* (as n. 4), p. 429.

[392] GÄDO (as n. 26), p. 111.

[393] EK (as n. 173), p. 253, see also Chodyński, *Inwentarz broni* (as n. 11), pp. 74, 77–78; idem, *The stores of arms* (as n. 11), pp. 20, 22; GÄDO (as n. 26), pp. 68, 87, 217, 267, 278, 282, 430, 443, 467, 470, 615, 653, 656, 658, 688, 747, 766–767; *Visitationen* 1 (as n. 26), No. 107, p. 183.

[394] GÄDO (as n. 26), p. 614; Schmidtchen (as n. 6), p. 39.

[395] GÄDO (as n. 26), p. 652; Toeppen (as n. 1), p. 231.

[396] GÄDO (as n. 26), p. 197.

[397] GÄDO (as n. 26), p. 23.

[398] NKRSME I (as n. 29), p. 229; Chodyński, *Inwentarz broni* (as n. 11), p. 72; idem, *The stores of arms* (as n. 11), p. 17; Świętosławski (as n. 10), p. 27; Rathgen, *Das Geschütz* (as n. 4), p. 428; idem, *Die Pulverwaffe* (as n. 4), p. 69.

name was related to his profession, it can also be naturally assumed that leather was used as raw material. Furthermore, a price of a sack can be calculated at less than 22 Denars. On the other hand, prices of gunpowder sacks varied considerably, which was no question related to differences between sacks as such, in all probability concerning their sizes and types of leather that was used. For instance, in 1409 at Marienburg (Pol. Malbork) 9 Scot was paid for making 7 gunpowder sacks (*polfersecke zu machen*)[399], which implies a price of more than 38.5 Denars per item. A year thereafter in Elbing, 7 gunpowder sacks were purchased for 0.5 Mark[400], which means that one such sack cost almost 51.5 Denars. Gunpowder sacks bought in 1414 at Marienburg were slightly more expensive – 8 sacks went for 14 Scot and 12 Denars[401], which gives a price of 54 Denars per item.

Small sacks were also used to store projectiles, as evidenced by the inventory of Osterode (Ostróda) from 1516, which mentioned *1 seckleyn mit glote*.[402]

As far as other containers are concerned, there are individual mentions of troughs, in which projectiles and gunpowder components were kept. One large through with iron shots (*grosse mulde mit eisern schrotten*) was recorded in 1507 and 1508 at Preußisch Mark (Pol. Przezmark).[403] From the same years comes a mention of one through with sulphur (*mule mit schwefel/mulde mit schwebel*), stored at Osterode (Pol. Ostróda).[404] Furthermore, there are several records of powder flasks, which were in some cases mentioned together with hand-held firearms. Interestingly, all this data comes from the last period of the Order's existence in Prussia. In 1507 at Rastenburg (Pol. Kętrzyn) there were 6 hackbuts with 4 powder flasks (*6 hockenbuchssen dartzu sint 4 flaschen*) and 4 *handbuchsen* with 4 powder flasks and moulds, perhaps for casting of projectiles (*4 handtbuchssen und 4 flaschen mit formen*).[405] Interestingly, the inventory of Rastenburg (Pol. Kętrzyn) from 1508 mentions only 4 *handbuchssen* and 4 *flaschen* mit formen.[406] 4 *buchssenflaschen* were stored at Lötzen (Pol. Giżycko) in 1507 and 1508.[407] On the other hand, the inventory of the castle in Lötzen (Pol. Giżycko) from 1513

[399] MTB (as n. 23), p. 573; Rathgen, *Das Geschütz* (as n. 4), p. 407; idem, *Die Pulverwaffe* (as n. 4), p. 30.
[400] NKRSME I (as n. 29), p. 246; Rathgen, *Das Geschütz* (as n. 4), p. 428; idem, *Die Pulverwaffe* (as n. 4), p. 70.
[401] ABMH (as n. 25), p. 149.
[402] GÄDO (as n. 26), p. 348.
[403] GÄDO (as n. 26), pp. 147–148; Żabiński, *Technology of manufacture* (as n. 17), p. 93.
[404] GÄDO (as n. 26), pp. 344–345.
[405] GÄDO (as n. 26), p. 184.
[406] GÄDO (as n. 26), p. 185.
[407] GÄDO (as n. 26), pp. 251–252.

mentioned 4 *pulverflaeschen*[408], but it can be assumed that both terms referred to the same artefacts.

Conclusions and suggestions for further research

The available data allow for a reasonable discussion on firearms' equipment in the Teutonic Order's state in Prussia. We are informed about a broad repertoire of equipment associated with guns, from gun stocks, beds, carriages and wagons, via gun equipment (charging ladles, ramrods, linstocks, aiming wedges, chests, barrels, sacks and so on) to tools used in the manufacture of projectiles (picks, hammers, compasses, *passe-balle* rings, casting ladles and moulds) and gunpowder (sieves, pounders). In many cases, it is possible to identify kinds of gun beds, trestles or carriages. Concerning the latter, it is noteworthy that the appearance of wheeled carriages as early as the beginning of the 15th century can be proven for the Order's state. In numerous instances an analysis of prices of individual elements of gun equipment can be carried out.

On the other hand, this discussion has its limitations, which are chiefly due to the very nature of sources. As already stated in the Introduction, the discussed period is very unevenly covered with written source data. Written accounts, which are the main bulk of source data, rarely mention construction details of equipment, such as, e.g., wood species used in the manufacture of gun stocks or stands. It is in a handful of cases only that it is possible to relate the discussed equipment to a particular gun. The famous Teutonic *Grose Bochse* is a notable example, as in this case there is a lot of data on its bed, wagon and its parts, as well as other equipment.

Most regrettably, there are hardly any sources available than written accounts. There are only few surviving finds of firearms from the Order's state in Prussia and in their case only barrels survived (as mentioned above, there are strong doubts concerning the stock of the Curonian Spit *handbuchse*). The lion's share of archaeological finds are projectiles, chiefly stone cannonballs. Iconographic evidence is also sparse and it does not allow for a thorough reconstruction of all details.

All in all, with the help of available sources and comparative data it is possible to offer a reasonably informative image of gun equipment in the Order's state. It can be hoped that new research will bring more evidence to light. It seems that there is still some potential in unpublished archival records, with special reference to municipal sources and diplomatic correspondence, especially from periods of armed conflicts in which the Order participated. New discoveries can also be

[408] GÄDO (as n. 26), pp. 252–254.

made by archaeology, although it must be remembered that artefacts made from organic material (such as, e.g., wooden stocks) are usually much more prone to decomposition than metal barrels.

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Abstract

Not Only Barrels – Equipment for Firearms in the State of the Teutonic Order in Prussia

The study focuses on equipment for firearms in the state of the Teutonic Order in Prussia in the Middle Ages and the Early Modern Period. The paper is chiefly based on written sources, both concerning the Order itself (mainly account books, inventories and visitation reports) and those related to Prussian towns (chiefly account books). In some cases relevant pieces of information could also be retrieved from narrative sources. For the sake of comparison, data from contemporary and later manuscripts on firearms was consulted. The first issue which is dealt with are stocks for hand-held firearms and trestles, stands and carriages for artillery. In many cases it is possible to offer a closer identification of kinds of gun beds, trestles and carriages. Then, gun instruments are discussed: charging ladles, ramrods, linstocks, and the like, as well as various kinds of containers for gunpowder, projectiles and tools for firearms. Regrettably, it is only in exceptional cases that it is possible to relate discussed equipment to a particular gun. A separate section is devoted to the analysis of tools which were used in the manufacture of projectiles and gunpowder. In spite of all the limitations resulting from the nature of consulted sources, it is possible to offer a reasonable image of equipment which accompanied firearms in the Order's state.

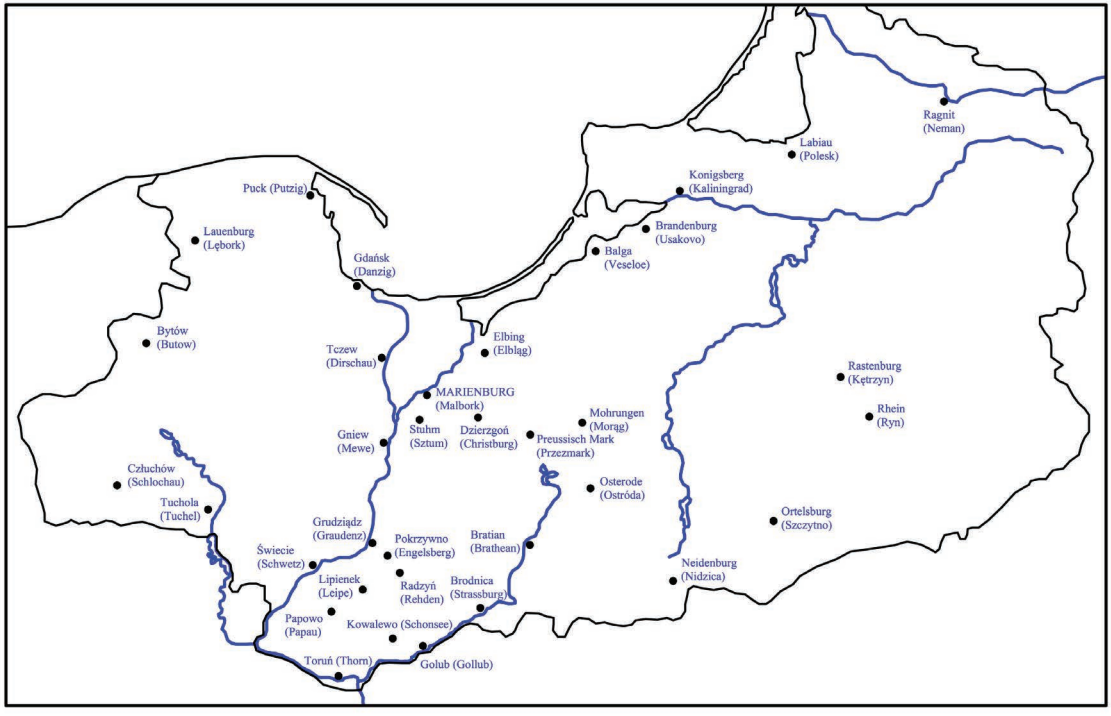

Fig. 1. The state of the Teutonic Order in Prussia in the early 15th century. After Żabiński, *Ways of acquisition* (as n. 17), p. 120, fig. 1

Fig. 2. Danzig (Pol. Gdańsk) soldier with a *handbuchse* depicted in a painting "Siege of Marienburg (Malbork) in 1460" (c. 1480). A short barrel is mounted on a stock with a butt. Photocopy in the collection of the Institute of Archaeology of the Polish Academy of Sciences, Łódź Branch

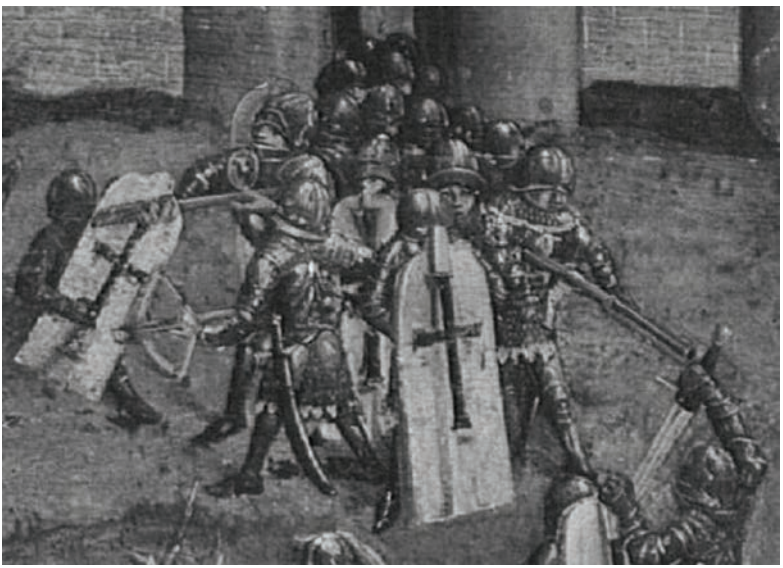

Fig. 3. Teutonic soldiers with *handbuchsen*. "Siege of Marienburg (Malbork) in 1460" (c. 1480). Photocopy in the collection of the Institute of Archaeology of the Polish Academy of Sciences, Łódź Branch

Fig. 4. Early *handbuchse*. After Kyeser (as n. 39), fol. 103v. Afterdrawing G. Żabiński

Fig. 5. *Handbuchse* with a matchlock. A partially hidden ramrod can be seen in the front part of the stock. After *Zeugbuch* (as n. 42), fol. 166r. © Bayerische Staatsbibliothek München

Fig. 6. Landsknechts with *messing hanndtbüchsen* equipped with matchlocks. Ramrods and a leather bag can be seen. After *Zeugbuch* (as n. 42), fol. 61r. © Bayerische Staatsbibliothek München

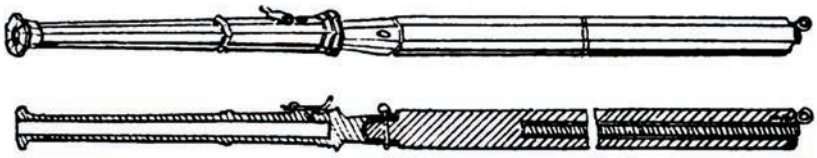

Fig. 7. *Handbuchse* from the Curonian Spit, early 15th century. After Thierbach (as n. 54), p. 130, fig. 4

Fig. 8. *Messing hagkennpuchse*. There is a priming pan on the right side of the barrel. After *Zeugbuch* (as n. 42), fol. 72v. © Bayerische Staatsbibliothek München

Fig. 9. Heavy brass hackbut on a wooden trestle. The gunpowder charge is ignited with a match. After *Zeugbuch* (as n. 42), fol. 72r. © Bayerische Staatsbibliothek München

Fig. 10. Iron-forged hackbut. The gun is supported on a wooden trestle and the gunpowder charge is ignited with a match. A priming pan can be seen on the right side of the barrel. After *Zeugbuch* (as n. 42), fol. 73r. © Bayerische Staatsbibliothek München

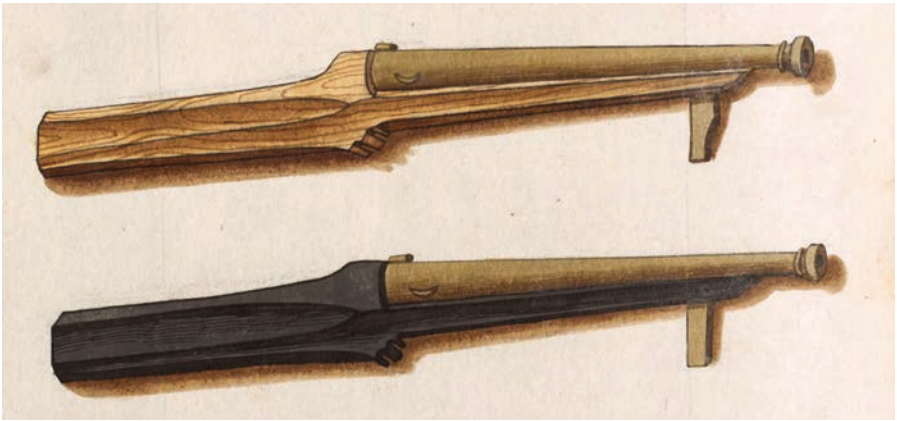

Fig. 11. Hackbuts in stocks with butts. Priming pans can be seen on the right side of barrels. After *Zeugbuch* (as n. 42), fol. 122r. © Bayerische Staatsbibliothek München

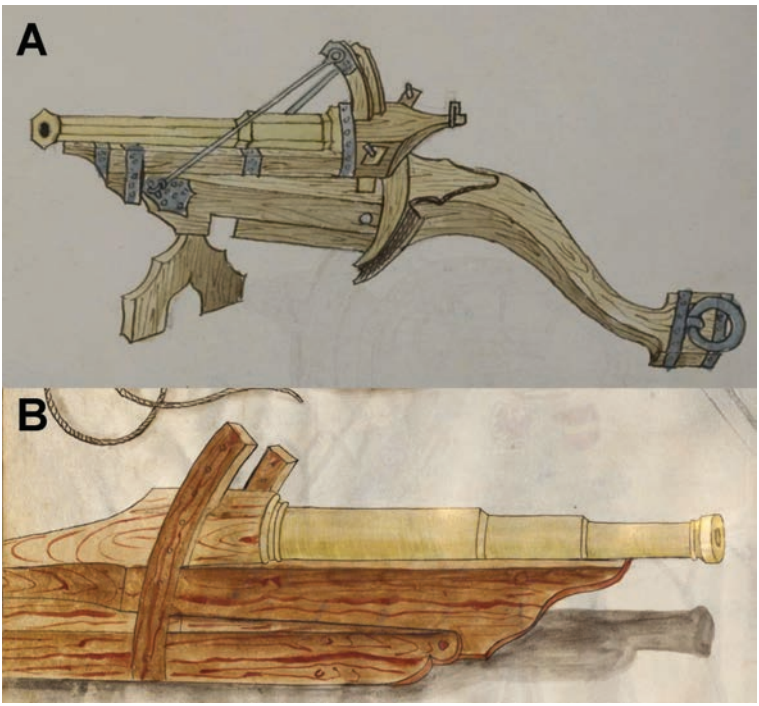

Fig. 12. Light guns on trestles. Both are equipped with split-trail elevation devices (so-called aiming brackets)
A – after Mönch (as n. 41), fol. 24 r. © Universitätsbibliothek Heidelberg
B – after *Zeugbuch* (as n. 42), fol. 23v. © Bayerische Staatsbibliothek München

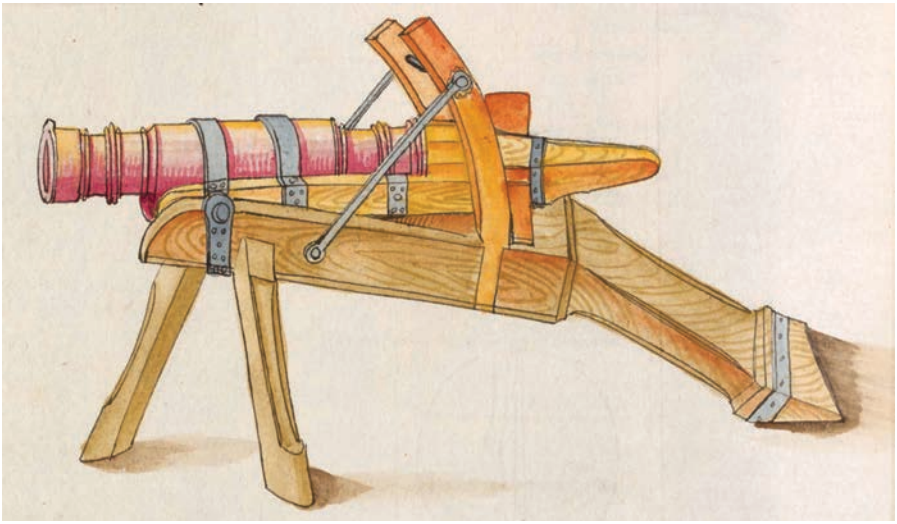

Fig. 13. Terrace-gun on a trestle. The gun is equipped with a split-trail elevation. Iron fittings attaching the barrel to the bed are visible. After *Zeugbuch* (as n. 42), fol. 171v. © Bayerische Staatsbibliothek München

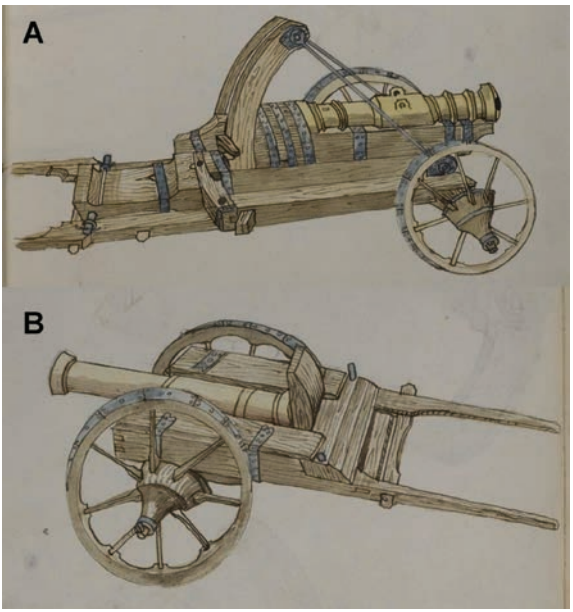

Fig. 14. Light cannons on carriages
A – after Mönch (as n. 41), fol. 23r. A split-trail elevation device can be seen. © Universitätsbibliothek Heidelberg
B – after Mönch (as n. 41), fol. 23v. © Universitätsbibliothek Heidelberg

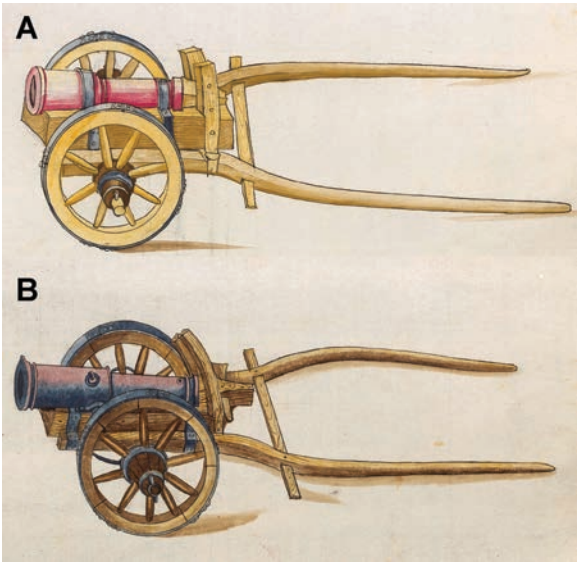

Fig. 15. Field guns on carriages
A – after *Zeugbuch* (as n. 42), fol. 187v. © Bayerische Staatsbibliothek München
B – after *Zeugbuch* (as n. 42), 1502, 188v. © Bayerische Staatsbibliothek München

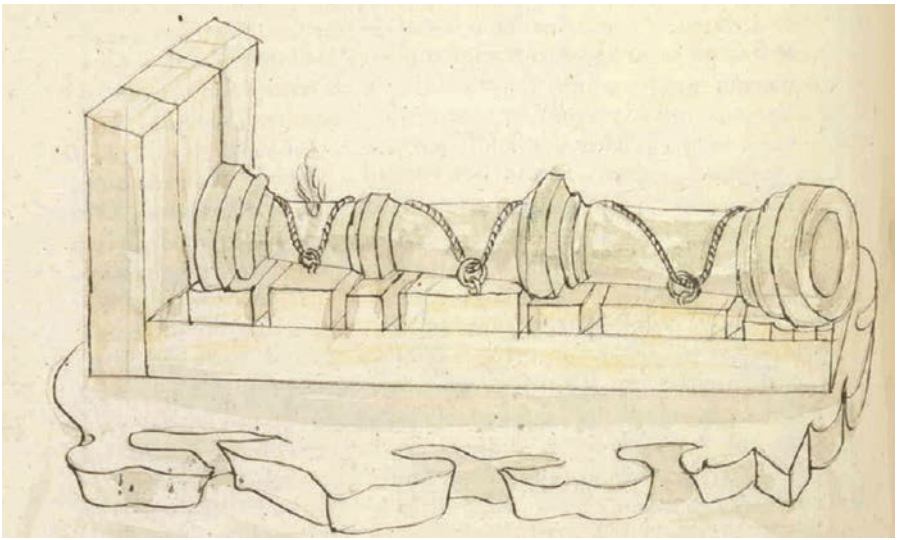

Fig. 16. Heavy gun on an immovable stand. The barrel is attached to the bed with a rope and rings. After R. Valturio, *De re militari*, c. 1460, fol. 122v. Rosenwald Collection, Rare Books and Special Collections Division of the Library of Congress, Washington, DC

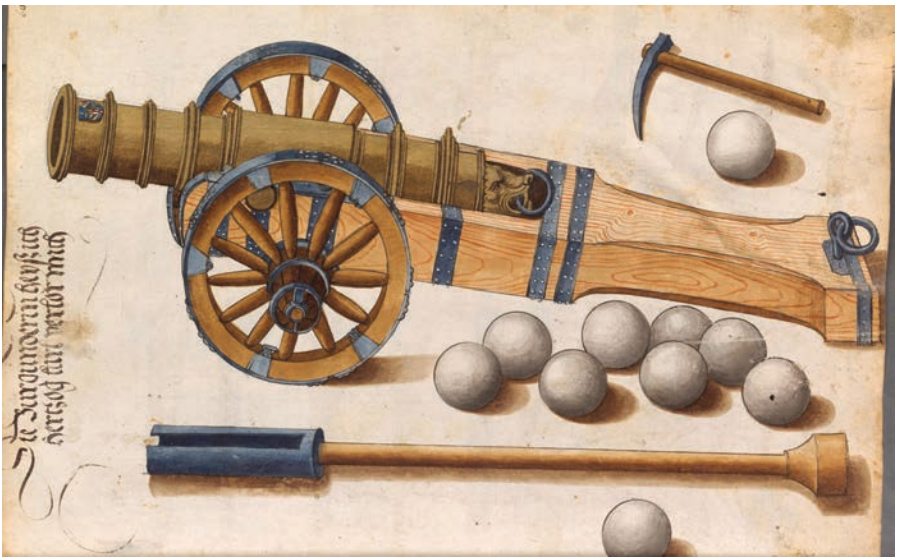

Fig. 17. Heavy gun on a carriage – the *Burgunderin* of Charles the Bold of Burgundy (died 1477). Next to the cannon there is a charging ladle with a ramrod and a pick. After *Zeugbuch* (as n. 42), fol. 60r. © Bayerische Staatsbibliothek München

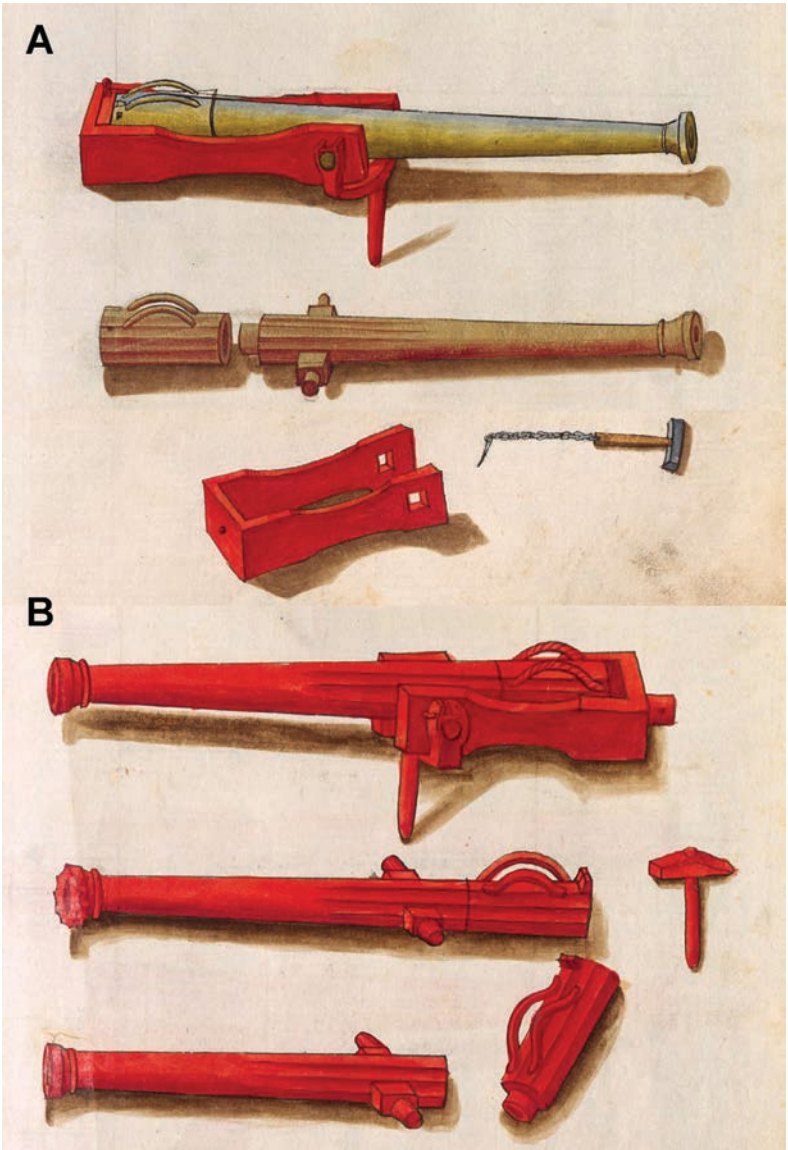

Fig. 18. Naval guns

A – cast veuglaires (*gossen camerslanngen*). Behind chambers there are wooden wedges on chains. These wedges were intended to thicken the chamber in the barrel. There is also a hammer for beating the wedge behind the chamber. After *Zeugbuch* (as n. 42), fol. 63r. © Bayerische Staatsbibliothek München

B – iron-forged veuglaires (*geschmidt eysne camerslangen*). After *Zeugbuch* (as n. 42), fol. 68r. © Bayerische Staatsbibliothek München

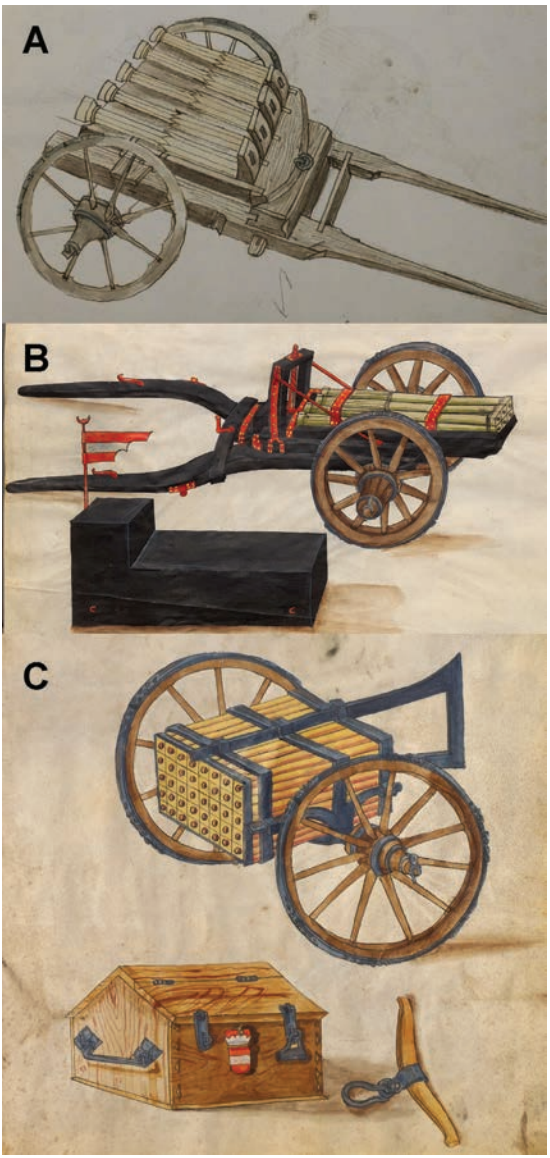

Fig. 19. Organ guns on carriages
A – after Mönch (as n. 41), fol. 28r. © Universitätsbibliothek Heidelberg
B – the gun is equipped with a screw elevation device. Numerous iron fittings and iron rims on wheels can be seen. After *Zeugbuch* (as n. 42), fol. 18r. © Bayerische Staatsbibliothek München
C – a chest with equipment and a yoke can be seen. After *Zeugbuch* (as n. 42), fol. 26r. © Bayerische Staatsbibliothek München

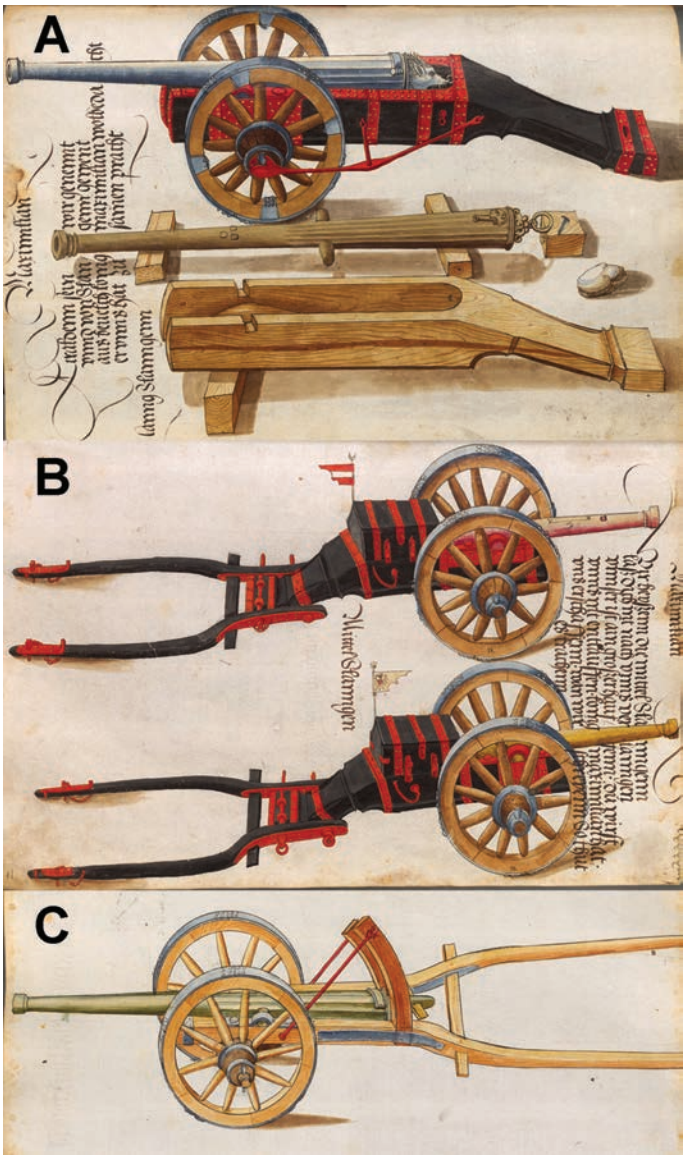

Fig. 20. Different types of *schlangen*

A – *lanng slanngen* on carriages. After *Zeugbuch* (as n. 42), fol. 51v. © Bayerische Staatsbibliothek München

B – *mittel slanngen* on carriages. Iron-fitted chests are transported on the carriages. After *Zeugbuch* (as n. 42), fol. 54r. © Bayerische Staatsbibliothek München

C – light *schlange* on the carriage with an aiming bracket. After *Zeugbuch* (as n. 42), fol. 189r. © Bayerische Staatsbibliothek München

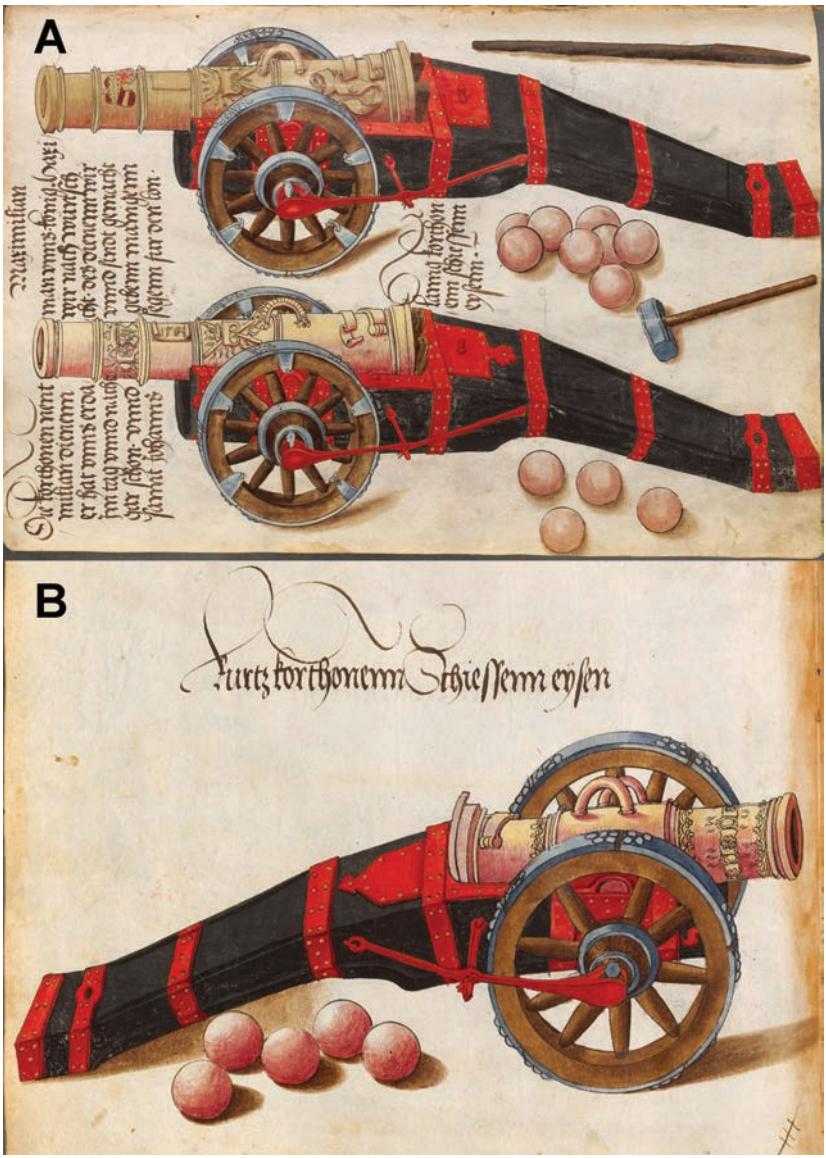

Fig. 21. Carthauns on carriages. There are aiming wedges behind end parts of breeches
A – long carthauns. Next to the cannons there are a hammer and a lever. After *Zeugbuch* (as n. 42), fol. 31v. © Bayerische Staatsbibliothek München
B – short carthaun. After *Zeugbuch* (as n. 42), fol. 37v. © Bayerische Staatsbibliothek München

Fig. 22. *Scharfen mätzen* on the carriage. Aiming wedges and a gunpowder barrel can be seen. After *Zeugbuch* (as n. 42), fol. 32v. © Bayerische Staatsbibliothek München

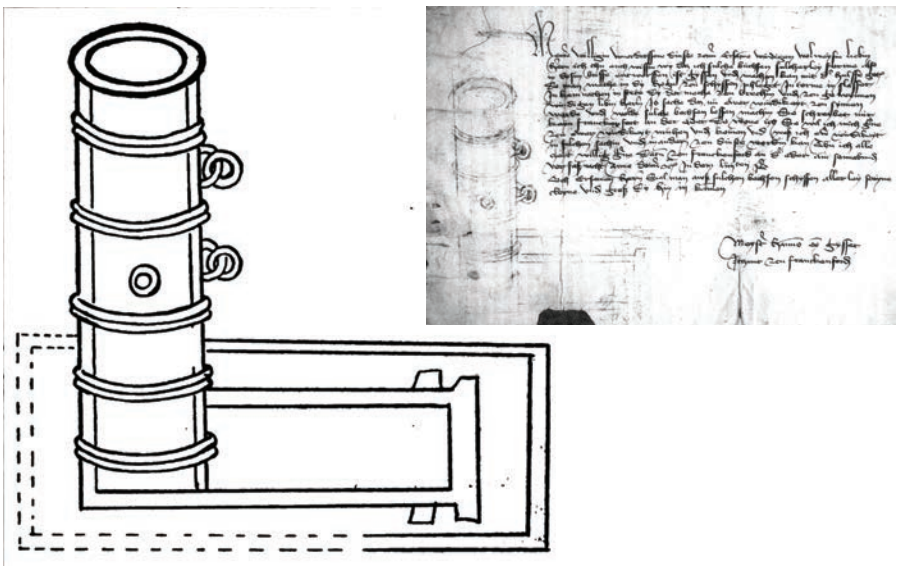

Fig. 23. Gun depiction from the letter of master Hanns to Danzig (Pol. Gdańsk), 1454. The gun seems to be mounted on an immobile stand. After Engel, *Waffengeschichte-Studien* (as n. 3), p. 118 (see also Szymczak (as n. 19), p. 188, fig. 28; and Możejko (as n. 12), p. 173, fig. 1)

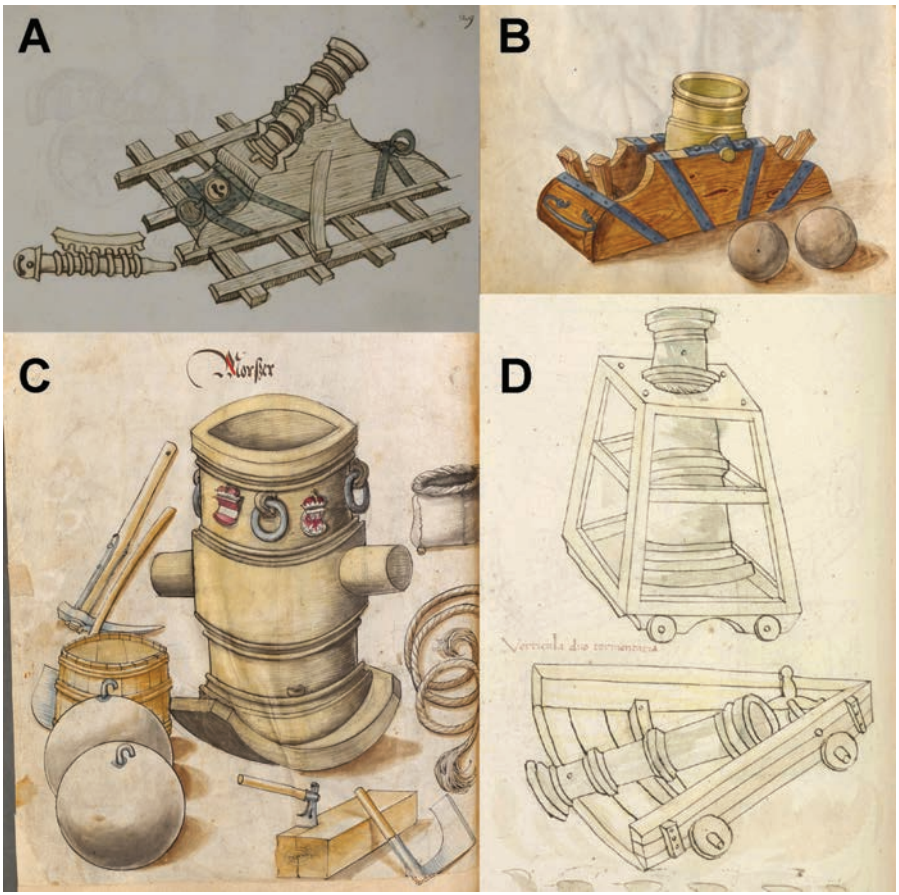

Fig. 24. Mortars

A – mortar on an immobile stand. After Mönch (as n. 41), fol. 29r. © Universitätsbibliothek Heidelberg

B – mortar on an immobile stand. Aiming wedges can be seen. After *Zeugbuch* (as n. 42), fol. 26v. © Bayerische Staatsbibliothek München

C – mortar: peculiar shaping of the chase end can be seen. It facilitated aiming with the use of aiming wedges. After *Zeugbuch* (as n. 42), fol. 83v. © Bayerische Staatsbibliothek München

D – mortars on carriages. After Valturio (as Fig. 16), fol. 126v. Rosenwald Collection, Rare Books and Special Collections Division of the Library of Congress, Washington, DC

Fig. 25. Heavy cannon (*hauptbuchs*) on an immobile stand – the *Lew* (*Leo*). Attention is drawn to a barrier constructed from massive beams joint with iron braces. It was supposed to absorb the recoil impact when the cannon was fired. A ramrod and a lever can be seen in the background. After *Zeugbuch* (as n. 42), fol. 36r. © Bayerische Staatsbibliothek München.

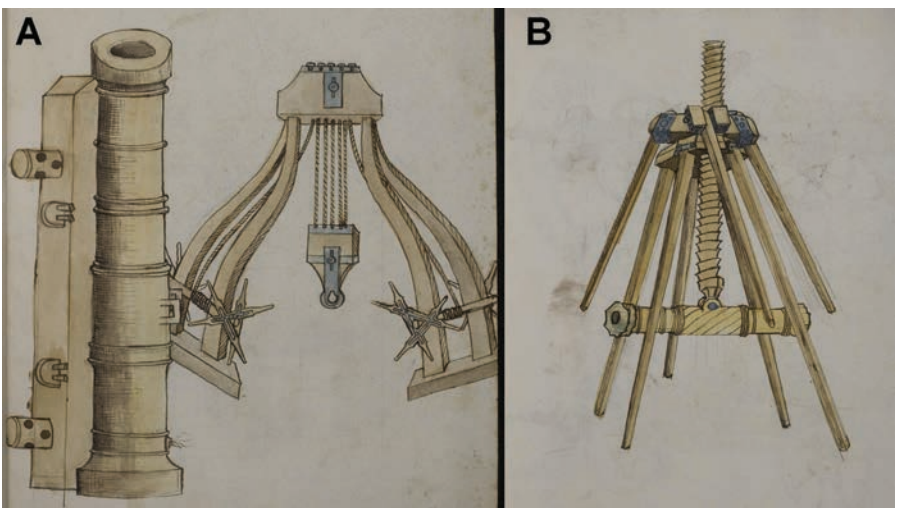

Fig. 26. Cannon cranes
A – after Mönch (as n. 41), fol. 7r. © Universitätsbibliothek Heidelberg
B – after Mönch (as n. 41), fol. 22r. © Universitätsbibliothek Heidelberg

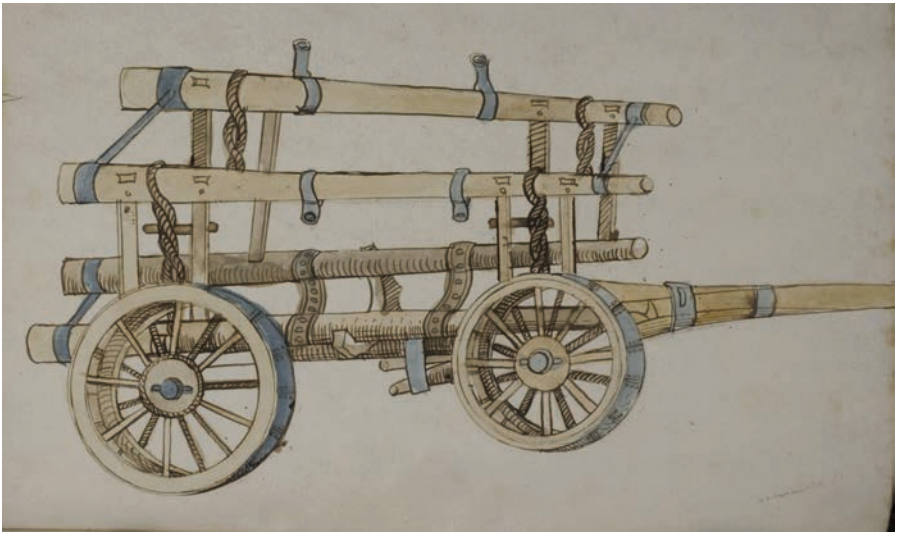

Fig. 27. Wagon for heavy gun transport. After Mönch (as n. 41), fol. 6v. © Universitätsbibliothek Heidelberg

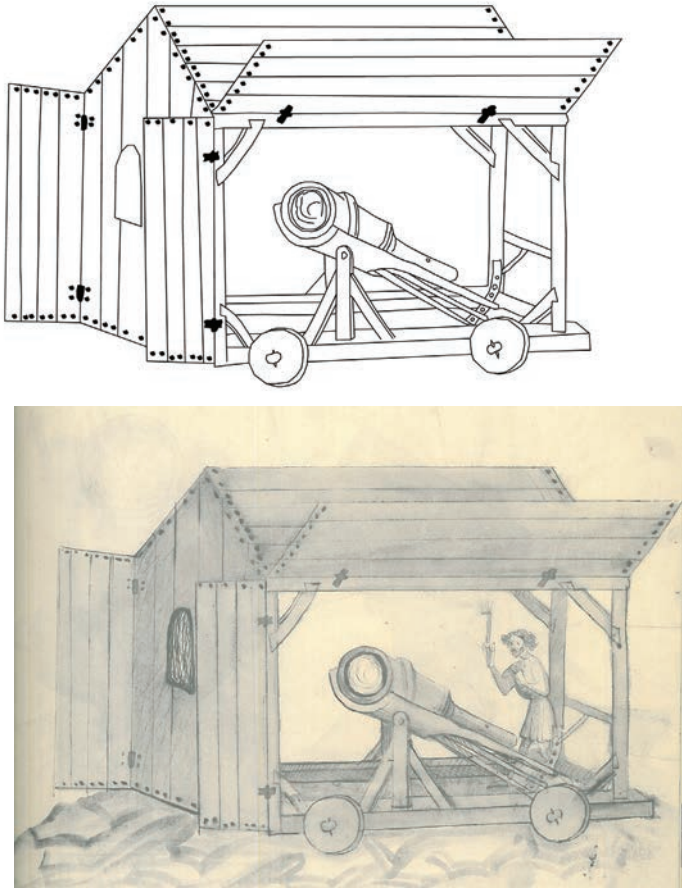

Fig. 28. Cannon in a wheeled shutter. After Kyeser (as n. 39), fol. 108r. Afterdrawing G. Żabiński

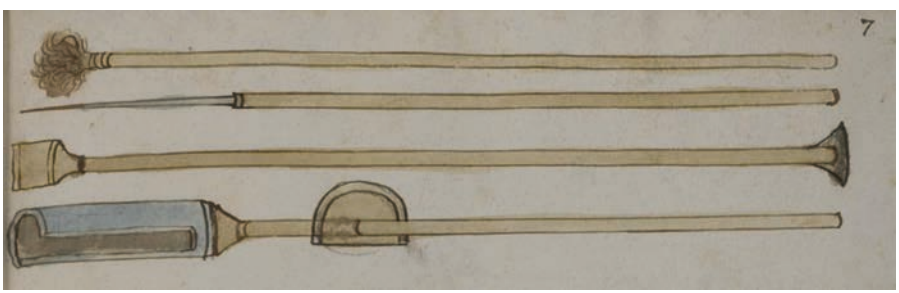

Fig. 29. Artillery equipment – a bore brush, a linstock (?), a ramrod and a charging ladle. After Mönch (as n. 41), fol. 7r. © Universitätsbibliothek Heidelberg

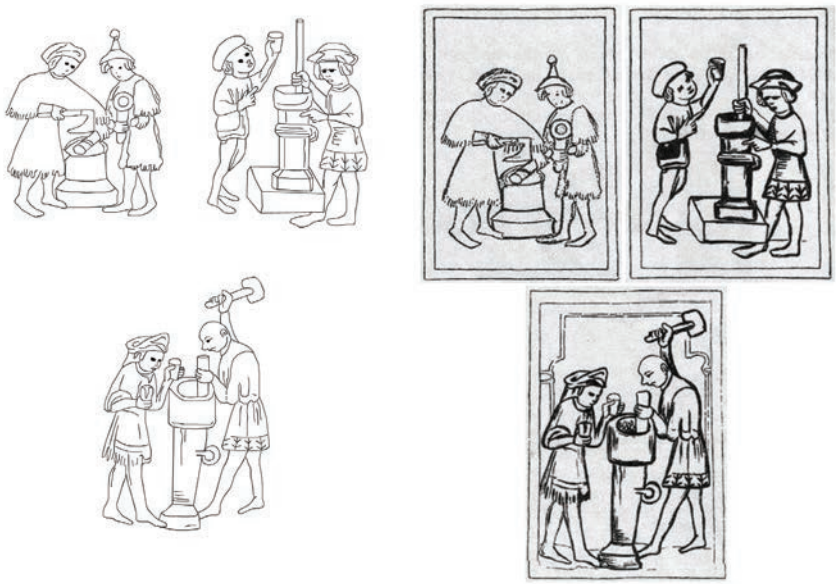

Fig. 30. Stoppers and wedges for fastening projectiles. *Codex germanicus monacensis 600*, c. 1350, Bayerische Staatsbibliothek, München, Cgm 600, after Schmidtchen (as n. 6), pp. 15–17, figs. 4–6. Afterdrawing G. Żabiński

Fig. 31. Hammer next to a short carthaun. After *Zeugbuch* (as n. 42), fol. 38v. © Bayerische Staatsbibliothek München

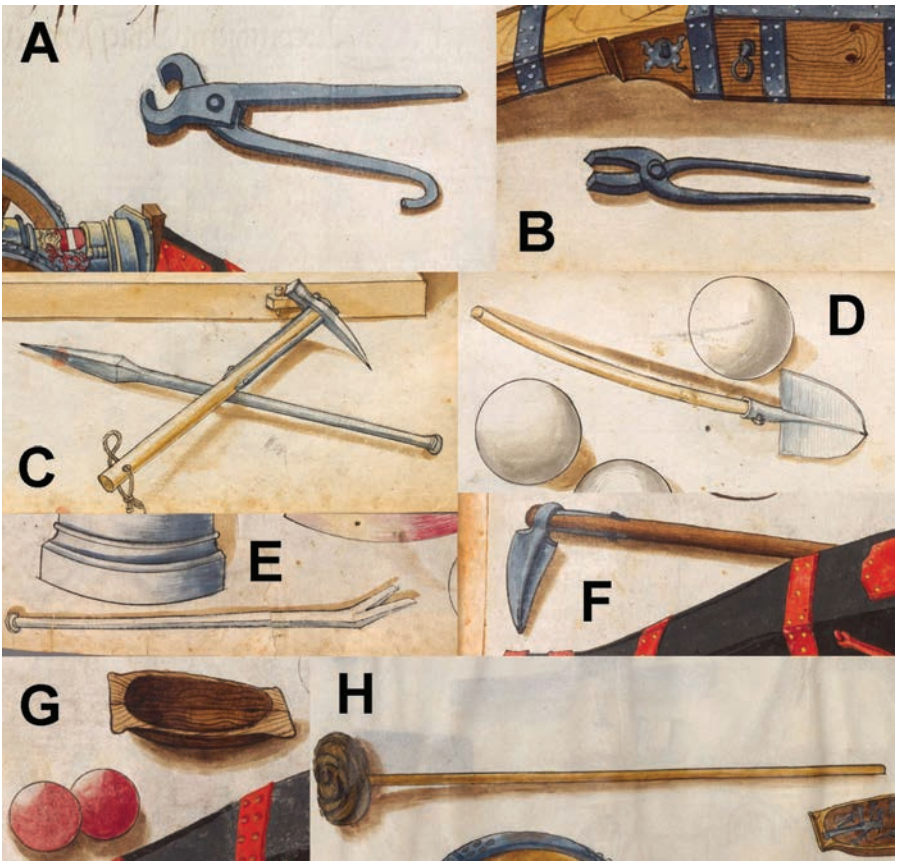

Fig. 32. Other tools associated with firearms
A – iron pincers. After *Zeugbuch* (as n. 42), fol. 35v. © Bayerische Staatsbibliothek München
B – iron pliers. After *Zeugbuch* (as n. 42), fol. 51r. © Bayerische Staatsbibliothek München
C – pick and punch. After *Zeugbuch* (as n. 42), fol. 79v. © Bayerische Staatsbibliothek München
D – spade. After *Zeugbuch* (as n. 42), fol. 79v. © Bayerische Staatsbibliothek München
E – iron lever. After *Zeugbuch* (as n. 42), fol. 83r. © Bayerische Staatsbibliothek München
F – mattock. After *Zeugbuch* (as n. 42), fol. 38r. © Bayerische Staatsbibliothek München
G – trough for carrying cannonballs. After *Zeugbuch* (as n. 42), fol. 40r. © Bayerische Staatsbibliothek München
H – bore brush. After *Zeugbuch* (as n. 42), fol. 17r. © Bayerische Staatsbibliothek München

Fig. 33. Artillery chest. After *Zeugbuch* (as n. 42), fol. 2r. © Bayerische Staatsbibliothek München

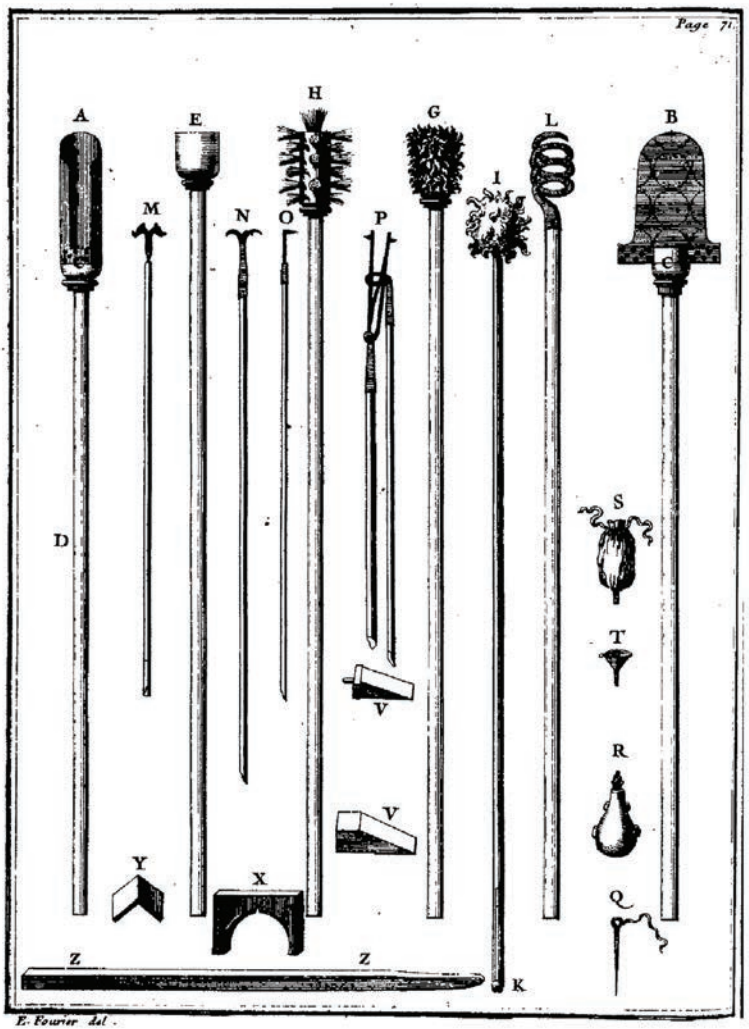

Fig. 34. Artillery equipment, late 17th century. After Saint Remy (as n. 43), p. 71
A–D – charging ladles and their parts; E–F – ramrod; G–K – bore brushes and their parts; L – wad-screw; M – linstock; N–P – *chat*; Q – priming iron; R – primer; S – sack for ignition powder; T – funnel for ignition powder; V – pointing wedge; X – pointing fronton; Y – apron; Z – lever.

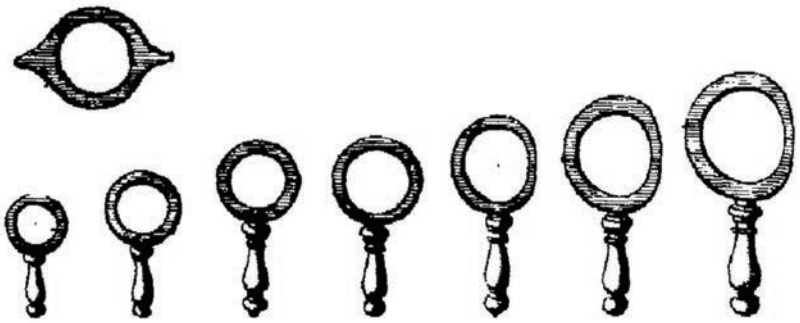

Fig. 35. *Passe-boulets* or *passe-balles*. After Saint Remy (as n. 43), pp. 82–83

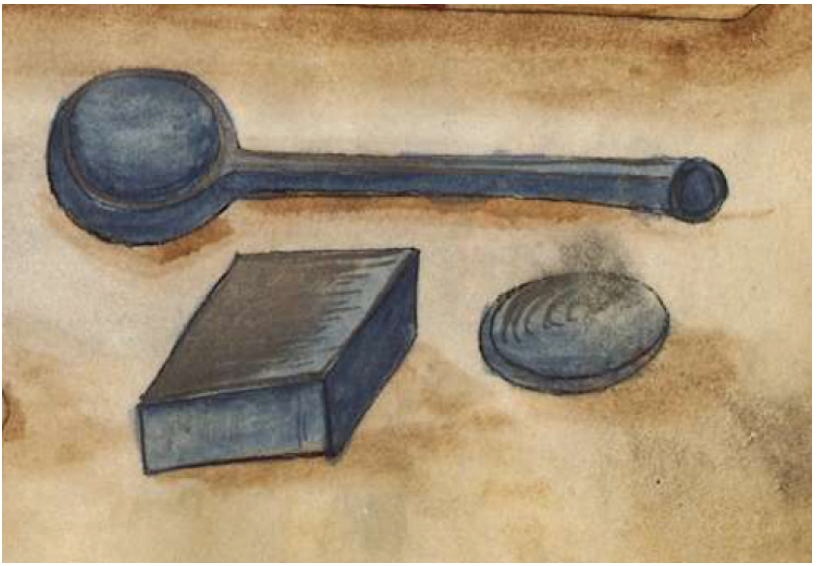

Fig. 36. Ladle for casting projectiles (?). After *Zeugbuch* c. 1502 (as n. 42), fol. 25r. © Bayerische Staatsbibliothek München

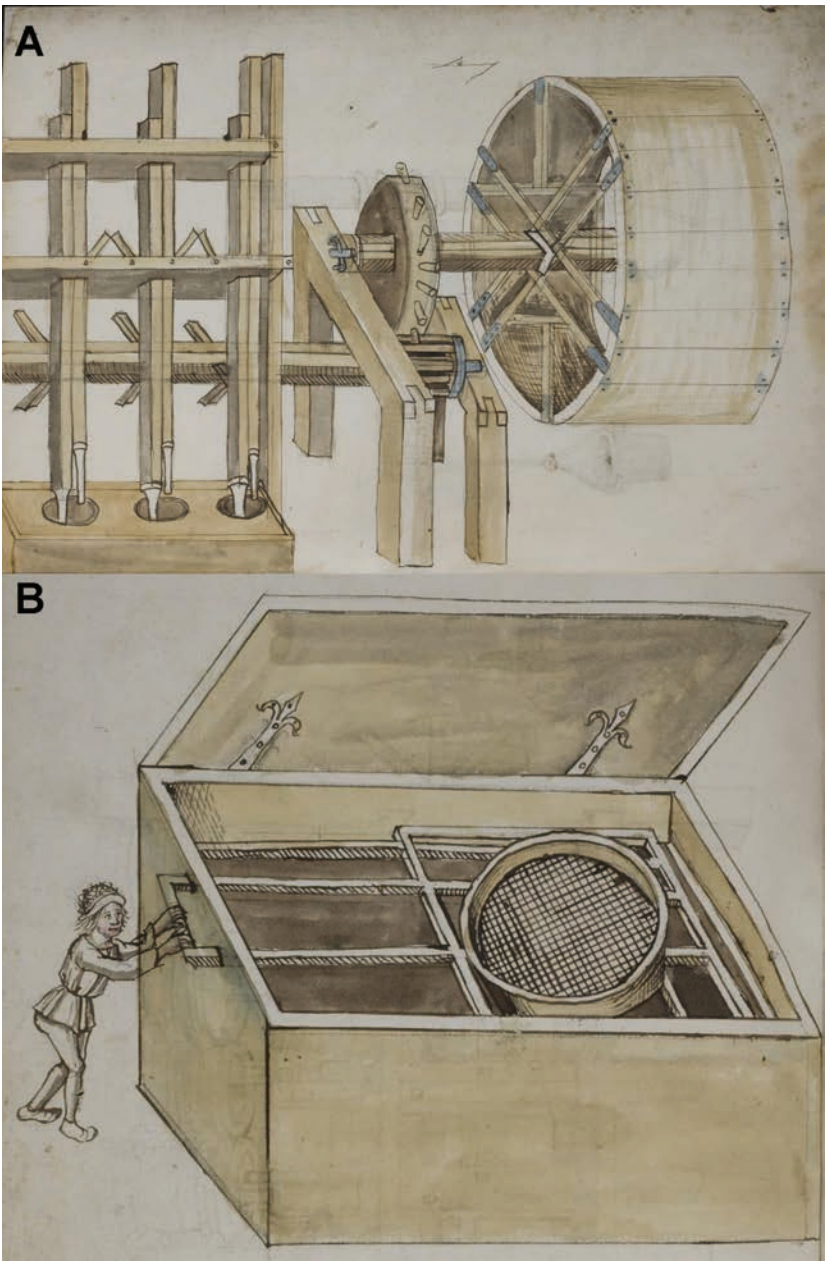

Fig. 37. Tools for gunpowder manufacture
A – device for gunpowder pounding. After Mönch (as n. 41), fol. 4r. © Universitätsbibliothek Heidelberg
B – sieve. After Mönch (as n. 41), fol. 3v. © Universitätsbibliothek Heidelberg

Fig. 38. Sacks and bags
A – leather sacks for gunpowder. After *Zeugbuch* (as n. 42), fol. 70v. © Bayerische Staatsbibliothek München
B – leather bags for gunpowder. After *Zeugbuch* (as n. 42), fol. 70v. © Bayerische Staatsbibliothek München
C – linen sack. After *Zeugbuch* (as n. 42), fol. 48r. © Bayerische Staatsbibliothek München