Tracing technology through terminology:

Ottoman nautical terminology as attested in the 18th century archival sources

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ABSTRACT

This paper aims to provide a general assessment of the Ottoman nautical terminology as this appears in Ottoman archival records of the 18th century. Through the examination of the nautical terms, phrases and words of the time, it attempts to give an idea of the technological state of the Ottoman navy at the time

NAUTICAL DEVELOPMENTS OF THE 18TH CENTURY

The late eighteenth century witnessed important technological developments in the Ottoman navy. In addition to the systematic construction of new sailing warships, such as three-decker, corvettes, and frigates, the hulls and bottoms of Ottoman naval ships began to be sheathed with copper from 1792-93 onwards. The first dry-dock in the shipyard of the Golden Horn was constructed between 1797 and 1780. The first negotiations with Great Britain regarding the purchase (at first) and hiring (later) of a steam engine started in that century. The Ottoman authorities intended to use this engine in evacuating the water of the dry-dock. The construction of an anchor house and a ship-modelling house also took place in that century. New mast machines and fire conduits, a new ship launching method (floating-out method), the keeping of navigational log books, a new central kitchen and provisioning system were all introduced in the late eighteenth century.[1] All these subjects will be examined mostly through the archival evidence provided by Cevdet-Bahriye (CB), Hatt-i Hümayun (HH), Kamil Kepeci (KK) and classifications in the Prime Ministerial Archives of the Ottoman Period (BOA)

The technological developments that were either improted from abroad or created by Ottoman exprets in collaboration with foreigners necessitated the appearance of new nautical terms. Although it is difficult to determine what was new at the time, we can get hints regarding about the novelties. Fortunatelly, in some Ottoman archival documents in BOA there appear frequently words, such as 'nev-icâd' (newly-invented), 'nemçekârî' (Austrian type), 'ingilizkârî' (English type), 'Frenk' (Foreign/European) and 'isveçkârî' (Swedish type), that refer to new naval technologies. The following terms are just a few of those that can be linked to the aforementioned new technologies: *havz-i kebir* (dry-dock), *nuhas kaplama* (copper sheathing), *üç ambarli kalyon* (three-decked galleon), *kirpashane* (sailcloth production house), *boclana* (puzzolane morter for underwater constructions), *macuna maa cerr-i eskal* (mechanical crane, a wheeled and multi-cogged crane of foreign invention), *seyir*

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[1] Tuncay Zorlu, (2008), *Innovation and Empire in Turkey: Sultan Selim III and Modernisation of the Ottoman Navy*, I.B. Tauris Publishers, London and New York.

defteri/gemi jurnali (logbook), *hadde* (machine used to produce thin plates or wires out of mines such as copper and iron), *haddehane* (copper processing house), *ates tulumbasi* (fire pump/conduit), *endâzehâne* (measuring and modelling house for ships), *lengerhane* (anchorhouse), *âhenî çilingirkârî mühimmat* (equipment made of iron and its manufacture), *ingilizkârî devir ayna camlı fânus* (newly invented compasses and oil lamp with rotating glass of English production), *müteharrik nemçekârî pusula* (moving compass of Austrian type), *ingiliz perdahtı barut* (gunpowder of English type), *sigorta etmek* (to insure), and *sualtı dürbünü* (underwater glass).

The introduction and adoption of new technologies created a new division of labour among the naval personnel as well. Caulkers, sail makers, gunners, cooks, men of religion (both Muslim and Christian, depending on the religious identities and needs of the crew), surgeons, and many other personnel transformed the ships into small towns, which in turn, put a considerable burden to the Ottoman economy. All this personnel came to be named after their new work.

Beside the new terms referring to new machines, buildings, tools and instruments there was already in use in the Ottoman navy a domestic nautical terminology. This terminology had been created by the Ottomans (Muslim and non-Muslim subjects) or was produced thanks to the Ottomans' prolonged interaction with the Mediterranean powers.

In the introduction or production of both the technology and the terminology, foreign technicians played significant roles. For instance, French ship building engineer Jacques-Balthasard Le Brun (1793-1800) constructed new sailing warships in Ottoman shipyards, contributed to the preparation of the curriculum of Naval Engineering School, offered ship construction and navigation courses, introduced new building materials and workbenches, and started a new galleon launching method; Swedish engineers headed by A. E. Rhodé (1795-1811) constructed the Ottomans' first drydock; Baily (1803-1805, later Selim) was commissioned for the adoption of new fire-pumps and for the negotiations with Great Britain to buy or hire Boulton- and Watt-type steam engines to evacuate the drydock's water[2].

SHIP CONSTRUCTION MATERIALS AS INDICATORS OF THE NAUTICAL TERMINOLOGY

Examining the materials used in the construction, rigging and caulking of the ships is of great significance in order to grasp the level of the nautical terminology of the late eighteenth century, when the wooden sailing ships began to dominate the Ottoman navy. As a matter of the course of this article, first raw materials and then new inventions will be taken up successively in order to show the interaction between the new ship building materials and their terminological reflections.

Timber (kereste)

Timber, being the most important raw material for the construction of the new wooden war ships, comes in a variety of kinds, and this fact appears to have contributed to the making of a substantial part of the new jargon. The Ottoman archives provide information about the timber sources, its transportation to the construction sites, its various types and quantities, as well as some domestic and foreign transactions for its supply. The construction of new ships in an unexpectedly short time, after the destruction of the Ottoman fleet at Lepanto (*Inebahtı*) in 1571 and in Çeşme in 1770, provides a clear indication that Ottomans had ample timber

[2] For more information about the foreign missions contribution of the naval technology of the late 18th century see the third chapter of the book by Tuncay Zorlu, (2008), *Innovation and Empire in Turkey: Sultan Selim III and Modernisation of the Ottoman Navy*. London and New York: I.B. Tauris Publishers.

sources and well-organised timber administration. Ottoman sources, in general, indicate that the types of timber used in shipbuilding and related naval works were mostly oak (*meşe*), pine (*çam*), elm (*karaağaç*), fir (*köknar*), larch (*melezçam*), chestnut (*kestane*), hornbeam (*gürgen*), ash tree (*dişbudak*), *kayacık* tree, lime tree (*ıhlamur*), *gökez* and *pırnar*/*pırnal* (Quercus ilex, holly oak, holm oak) trees.

Timber was used in a variety of works related to shipbuilding. Beside its use in the construction of masts, yards, planks, keels, knees, hulls, broadsides, rudders, tillers and water barrels, timber was also used for the production of pulleys. Especially ash wood, *kayacık* and elm wood was used for that purpose.[3] Timber was essential in the construction of tools and equipment used in naval works and dry docks as well. In 1795–96 a certain amount of *teknelik elvah-ı ıhlamur kalas* (timber for hulls), s*ütun orta çap meşe* (oak for average columns)*, kanatlık elvâh-ı çam* (pine plates for wings)*,* a sack of *ambar sandal* (timber for boats)*, kumluk sakadiye* and some other woods were provided from the *mahzen-i çûb* (timber store) for the construction of two workbenches (*destgâh*), a wheel with a clamp (*mengeneli çarh*) and some other tools.[4] Furthermore, timber for yards (*serenlik kereste*) was used in the production of cannon moulds in Hasköy in the beginning of September 1795.[5] There is evidence indicating that 500 pieces of elm tree, provided from the province of Salonica, were used in the production of gunstocks to be used on the three-deckers, galleons and frigates in 1796–97.[6]

Timber was named in many ways. The regions from which it was supplied and the part of the ship in which it was used were two important references in naming the timber. In a register book (*defter*), dated 22 July 1803, which records the timber bought from a certain Kosta, we come across the following names: *Kara sağir, çam tahtası* (pine wood), *çifte kanatlık, bostan oluğu*, *çifte bordalık*, *çifte çam tahtası*, *çifte kalas*, *on iki arşın lata* (thinnish pine board of 12 *zira*),[7] *on iki arşın kebir çam* (12 pieces of large-sized pine timber)*, çifte mane, kestane agacı tahtası* (timber of chestnut tree)*, Rumeli omurgası* (timber for the keel from Rumelia)*, Kidros omurgası* (timber for the keel from Kidros), *Bartın kanatlığı, Karasu tahtası* (timber from Karasu)*, Fındıklı dolabı*,[8] *Fıstıklı koğuşu*[9] and so on. In addition to these types, the following ones were used in the shipyard of the northern Anatolian city of Sinop: *asdar* (pine), *barbelik*, *barbe-i kebîr*, *baryalık-ı kebîr*, *bedel koğuş kablı*, *bedel koğuş çam kablı*, *çubuk çam*, *diyame-i sağîr* (any tree), *diyame-i kebîr* (any tree), *döşek*, *döşek mişe kütük* (oak), *ecnâs-ı çam* (pine), *felenk*, *fındık çubuğu* (*tecne çubuğu*), *katene*, *kazıklık* (hornbeam for stakes), *kızak*, *koğuş* (pine), *koğuş-ı çam* (pine), *kütük* (log), *kütük-i mişe* (oak log), *iskelelik* (timber for building wharves), *ırğad-ı sağîr* (elm for pulleys), *ırğâd-ı manula*, *latakına*, *levm-i yar*, *makaralık-ı kebîr* (big sizes of elm log for pulleys), *makaralık-ı sağîr* (small sizes of elm), *makas direk* (fir for masts), *mertanlık kürek*, *mülk*, *omurga* (keel), *tahtalık* (pine wood), *tahtalık-ı çam* (pine wood), *taslak kürek*, *tiyame-i sağîr*, *üsküce*, *küyeşte*, *varyozluk* (elm for the production of heavy hammer), *varyalık*, *yarpalık*, *seren direği* (*gökez* tree for yards) and *seren-i sağîr* (timber for small yards) (Güler 2003, 33). Most of these types are mentioned in a document dated 21 March 1797 as well, with some additions including *Tırhandil-i kebr-i çam*, *yeke-i dümen*, *ser kütük*, *çatal bükme*, *çatal kazık*, *kemerelik lata-i kebir-i çam* and so on.[10]

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[3] BOA. CB, no. 7720

[4] BOA. CB, no. 9981

[5] BOA. CB, no. 6336

[6] BOA. CB, no. 2407.

[7] *Lata* (lath) is a long, narrow, thinnish board made of pine timber. See Kahane and Tietze, 1988, 272–73. *Lata* was also used in the construction of the big dry dock at the Imperial Naval Arsenal. See BOA. CB, no. 1585.

[8] BOA. D.BŞM TRE, no. 15412.

[9] *Koğuş* was generally made of pine tree and used for covering the distance between ports in 1800–01. BOA. CB, no. 4511.

[10] BOA. CB, no. 10896.

As for the system of measurements used in the wood trade and in the building of naval ships, *zirâ* (75.8 cm), *arşun/arşın* (75.8 cm), *kadem* (37.9 cm), *karış* (25.26 cm), and *kulaç* (fathom, 185 cm) were the basic units. Out of these measures, *zirâ* and *arşun* were equal units of length, while *kadem* was for width. In measuring the width of the timbers, *karış* and *kulaç* were used (Güler 2003, 43) (Güler 2003, 43). It is important to note that some French measures of length were also used. For instance, at the end of Mahmud Raif Efendi's book entitled *Tableau des nouveaux règlements de l'Empire Ottoman* (1789), pictures of ships constructed by French engineers were measured in French *pic/pus* (75.8 cm), corresponding to the Ottoman *arşun/arşın*.[11]

Raw Iron (Âhen-i Hâm)

In the late eighteenth century, iron, both raw and processed, was used in many forms in the Ottoman navy. Mostly coming from Samakoçak/Samakovcuk[12] and Ayna (or İne) Adası,[13] it was generally stored in and delivered from the *mahzen-i surb* (store for iron pieces, nails, copper pots, lead plates, hemp, cords, barrels, sail, awning, anchor, cannon, lamp and paper).[14]

The Imperial Mint (*Darphâne-i Âmire*) also stored, processed and delivered iron when the need arose. Raw iron was mainly used in the manufacture of common anchors (*lenger*), warping anchors[15] (*tonoz demiri*), nails, hands/cranks (*akrep/kol*), bolts and screws, rings, axes, sledgehammers (*balyoz/variyoz*), sledgehammers for fids[16] (*variyoz-ı kaşkaval*), chisels, shovels, torches (*meşale*), rings for water barrels (*çember-i macana-i âb*), axles *(mil*), forks, tongs, levers (*manivela*), augers/drills for guns (*burgu-i top*), hooks for gunports (*kanca-i lumbar*), hooks for threefold purchase[17] (*kanca-i firaşkon*), hooks for cat davit/catheads (*kanca-i griva*), hooks for boats (*kanca-i sandal*), cannons, some joints and parts of gunstocks, common chains, chain plates of backstays (*landa-i pateraça*), hawses (*gomana*), stoves (*ocak*)[18] and so on.[19]

Nails and Bolts (Mismâr and Civata)

Funda/Fonda coal (*funda kömürü*) and *hark-ı nâr* (a substance used in iron melting process) were used to melt and pour the raw iron into moulds for the production of nails and some other iron tools to be used in the construction of frigates and galleons.[20] The cast nails were

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[11] Feza Günergun argues that the earliest comparisons of measures of length between French and Ottoman were most probably realised at the end of the eighteenth century and adds that one Ottoman *arşın* equalled 1.176 French *kadem*. See Günergun 1998, 25.

[12] BOA. HH, no. 12356.

[13] BOA. CB, no. 2223, and 9297 (29 June 1808).

[14] BOA. CB, no. 3365 (1803-04).

[15] Also called 'kedge anchor' thrown from the stern to sea, attached to a wire in order to keep the ship in a certain direction. See Zaloğlu 1988, 373, and Kahane and Tietze, 1988, 584.

[16] Fid or *kaşkaval* means a square bar to support the weight of the topmast. Kahane and Tietze, 1988, 130.

[17] They mostly consisted of double blocks with three sheaves and were used to lift very heavy objects. See Zaloğlu 1988, 139.

[18] BOA. D. BŞM. TRE, no. 15211 (15 January 1791); HH, no. 10011 (1790–91); KK, nos. 5724 (1790–91) and 5726 (1790–91); CB, nos. 9418 (1797–98), 2223 (1800–01), 2379 (1799–1800) and 2186 (1807).

[19] 2,150 *kantars* of raw iron was spent for a 51-*zira* galleon built in Bodrum, 1,200 *kantars* for two galleons of 53 and 51 *ziras* respectively in Sinop, 350 *kantars* for a 55-*zira* galleon in Gemlik and finally 770 *kantars* for a 45-*zira* frigate constructed in Karabiga in 1791–92. See BOA. CB, no. 2194. On the other hand, 57 *lodra* of raw iron were provided by the *mahzen-i sürb* on 18 June 1804 for this purpose. See BOA. CB, no. 7769.

[20] BOA. CB, no. 4397. Sometimes Jewish ironsmiths were employed in the cutting of nails. In order to complete a galleon under construction in Bodrum quickly, two Jewish ironsmiths were demanded on 4 August 1791 from the Kadi of Gelibolu and Ayan of Gelibolu Seyyid Mustafa, to replace the ones who had fallen ill. See BOA. CB, no. 8070.

filed when necessary.[21] Bolts were used in the construction of galleons as well. Ironsmiths utilised pine coal for this purpose. This coal was provided from Midilli, Molva and Kalonya for a galleon being constructed in Midilli in 1793–94 at its current value.[22]

Among the types of nails and bolts produced were *mismâr-ı basdika-i sağîr* (nails for snatch blocks of small size), *mismâr-ı basdika-i kebîr* (nails for snatch blocks of big size), *mismâr-ı mesâmîr*, *mismâr-ı kostanyola*, *cıvata-i piraçol* (bolts for fastening knees), *cıvata-i karîne* (bolts for the bottom of a ship), *kavilye* (treenails, pegs), *mismâr-ı atîk* (nails removed from old ships),[23] *mismâr-ı üstâdiye*,[24] *mismâr-ı yâş*,[25] and *mismâr-ı nühâs* (copper nails).[26] Beside them, others such as *mismâr-ı kalafat* (caulking nails), *şumârî*, *şayka*, *çubuk*, *Trabzon*, *Samakov*, *Lofça*, *Zağra, şişe*, *büzürk* (big size), *meyâne* (medium size), *bölme*, *pedavra*, *taş* (stone), *kalafat-ı tulumba* (for caulking conduits), *zevrak* (boat), *kayık* (boat), *baskı-i kayık*, *kalay* (tin), *mertek* (beam), *gevele-i tahta*, *gevele-i körpe*, *gevele-i kuşak*, *sağış-ı büzürk*, *sağış-ı meyâne*, *taban* (base), *çatı*, *sağrı*, *meyâne-i hurda* (scrap nails of average size) and *çâr-kûşe* (square) can be mentioned (Bostan 1992, 125).

Raw copper (Nühâs-ı Hâm)

Copper was used in the construction and equipment of the Ottoman ships in a variety of ways. In the late eighteenth century, it was mainly used in the cladding of ships against shipworms, for the nails and some joints of the ships, and for onboard equipment[27] such as pots and pans and other kitchen utensils and the cans for storing gunpowder and paints. It was also used in the production of cannon-loading tools such as cannon ladles (*kepce-i top*) and ramrods (*harbe*). It was processed in a *haddehâne* (processing house) before use. Beside domestic sources, raw copper was provided from foreign locales. We know that it was occasionally purchased from Russian traders when the need arose.[28]

Lead (Kurşun)

Stored in the *mahzen-i sürb,* the *Cebehâne* (Armoury) or the Imperial Mint, *kurşun* was used as raw lead, or bullion or plates after being processed and cast in moulds . It was mainly used in the making of the hawseholes of chain cables (*gomana delikleri*), as complementary material to the copper cladding of the ships, in the making of tools and equipment, in producing the sets for naval flags, in the construction and mending of the outer gates of the big dry dock, in producing the touch-hole of muzzle-loaders (*falye deliği*)[29] and in making bullets for rifles (Bostan 1992, 1269).

Lead plates were used in the holes of the chain cables (*gomana delikleri*) of galleons and frigates as well.[30] For that purpose, 3,023 *kıyyes* (80 *akçes* per *kıyye*) of 200 lead plates were bought and delivered to the *mahzen-i surb*.[31]

Regarding the casting of lead in the circular shapes (*göz kurşunları*) for the holes of chain cables (*gomanas*) of the naval galleons, 627 *kuruş* were paid as the casting cost for 9,947 *kıyyes* of lead in 1801–02.[32]

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[21] The copper nails produced in 1796-97 according to the methods of Le Brune were different from the previous ones. Since they were smaller, they needed filing after casting and therefore required more workmanship. BOA. CB, no. 4436.

[22] BOA. CB, no. 5747.

[23] BOA. CB, no. 7013.

[24] BOA. CB, no. 1261.

[25] BOA. CB, no. 7021.

[26] BOA. CB, no. 4436.

[27] BOA. CB, no. 7769.

[28] BOA. CB, no. 9258.

[29] BOA. KK, no. 5724 (1790-91).

[30] BOA. CB, no. 7356.

[31] BOA. CB, no. 1418.

[32] BOA. CB, no. 7274.

Sailcloth (Kirpas)

Sailcloth was a type of cloth woven from canvas and used in the production of sails and awnings of sailing vessels. The province of Gelibolu, the Dardanelles (Çanakkale), the island of Negroponte (Eğriboz), Egypt, the Aegean coasts, Benefşe and Cyprus were the main sources for the raw materials of sailcloth in the seventeenth and eighteenth centuries (Bostan 1992, 154; Genç 2000, 248). The transition from the traditional oar-powered galley type ships to the galleon type sailing ships created a huge demand for sailcloth. Mehmet Genç shows clearly that this demand increased from 140,000 *ziras* in 1774 to 300,000 *ziras* in 1803 (Genç 2000, 251).

Ottoman archival documents of the eighteenth century often mention the names and types of sailcloth. For instance, a document of 1790–91, with the title '*der sefîne-i trabago süvari-i Sinan oğlu Hasan Reis*' ('A trabacco ship commanded by Sinan Oglu Hasan Reis'), states that green sailcloth was used in the stern part of the ship. It is apparent from the same document that the ship in question carried 40 used (*müstamel*) sailcloths as back-up. In '*defter-i sefine-i trabago süvari-i Salih Reis*' ('A trabacco ship commanded by Salih Reis'), another type of green sailcloth used in the stern part of a ship as well as 40 spare ones are mentioned. Green sailcloth in the stern and 40 spare ones also appear in *'sefine-i trabago süvari-i Ülgünlü Yusuf Reis'* ('A trabacco ship commanded by Ülgünlü Yusuf Reis'). In '*defter-i pirgandi-i Mahmud Paşa süvari-i Ahmed Reis*' ('The register of Mahmud Paşa ship commanded by Ahmed Reis) lists green sailcloth for the stern and two types of spare ones: five *kirpas-i bogaz* and ten *kirpas-i beyaz* (white sailcloth)[33]. Some other documents also mention the use of sailcloth on ships. In '*defter-i mühimmat-ı Cabbâr-ı Bahrî süvari-i Fettah Kapudan*' ('The register of the inventory of the ship *Cabbâr-i Bahrî* under Fettah Kapudan's command') of 6 July 1790–91 green sailcloth is mentioned, and among the ship's spare equipment were 60 *kirpâs-i kârhâne* (sailcloth of sailhouse), ten *kirpas-i buhar* (sailcloth of steam), 30 *kirpas-i beyaz* (white sailcloth) and 30 *kirpâs-i mustamel* (used or second-hand sailcloth).[34]

TERMINOLOGY OF CAULKING (KALAFAT) MATERIALS

Pitch (*zift*) and tar (*katran*) were among the materials necessary for caulking (*kalafat*) ships. They were mostly provided from Midilli as well as the Edremid and Gümrü regions of Kapudağı.[35] Sometimes pitch and tar was purchased from local and foreign traders at current market prices.[36] Sinop also provided these materials in the middle of the eighteenth century. Both pitch and tar were generally used in putting on the *iskarmoz* (tholepin/futtock)[37] and the head of nails during the caulking process (Güler 2003 35).

Ottoman documents indicate the preparations for the construction of a pool for storing tar (*katran havuzu*) at the *Liman Mahzeni* within the naval arsenal in 1804–05. The cost for such expenses as mounting the gate of the pool and materials such as stakes, timbers and the examination of a suitable place for laying the foundation was expected to be 7,553 *kuruş*. In order to meet the cost, 5,000 *kuruş* in cash was requested from the *Hazîne-i Âmire*.[38]

It is understood that for the flags and banners of *Arslan-i Bahri*, boarded by the *Kaptan Pasha*, and of some other ships, a certain amount of paint (*boya*) was needed. Expenses for

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[33] BOA. KK, no. 5724.
[34] BOA. KK, no. 5726.
[35] BOA. CB, no. 5747.
[36] BOA. HH, no. 57599.
[37] A pin or thole inserted vertically into the sides of a boat to allow the oar to be fastened. Kahane and Tietze, 1988, 572–73.
[38] BOA. CB, no. 1549.

paint, silk and sewing amounted to 1,339 *kuruş* in 1795–96.[39] Eleven barrels of red paint were purchased from a Swedish ship at 25 *kuruş* per barrel in 1796–97.[40]

Coloured dyes were used for drawing some patterns and embroideries on the ships as well. The total money spent on *elvan boya* (coloured dyes), *ruğan-i bezîr* (linseed oil), *altın varak* (golden sheets) and some other materials to be used in adorning and decorating the naval ships for three months amounted to 6,187 *kuruş* and 9 *para* on 14 November 1802.[41]

Another caulking material, tallow *(don yağı/revgân-ı pîh)*, was produced via melting and then freezing the internal hard fats of animals. It was mostly used for manufacturing candles and soaps as well as for greasing of ships during the caulking process (Bostan 1992, 133). It was used in a mixture, together with soap, to coat the hull during cleaning (Chris Ware 1994, 75) and to light candles and clean the pitch from caulkers' hands (Imber 1980, 235). In the late seventeenth century, 600 *kantars* of tallow were provided from Boğdan as *ocaklık*.

Resin (*reçine*) is a thick, sticky substance produced by pine trees. It was used for hardening the pitch, for caulking and for spreading on the part of the ships below the waterline in a mixture with tallow. It was provided from Mediterranean islands such as İskiri, İskolar, İşkeron and İşkopolos in the second half of the seventeenth and early eighteenth centuries. In 1702–03 people living on İşkopolos island were ordered to prepare 1,000 *kantars* of resin per year to be used during the caulking process of ships (Bostan 1992, 135).

Beside these places, Eğriboz (the island of Negroponte, Evvoia) and Çamlıca produced resin (Hayati Tezel 1973, 6129). On 19 October 1792, 3,000 *kantars* of resin were demanded from Eğriboz and neighbouring areas. The judge of Eğriboz sent 800 *kantars* of resin on the ship of a foreign merchant. When it arrived in Istanbul, 44 *kantars* were missing. The remaining 756 *kantars* of resin were put into the *mahzen-i sürb*. One hundred and fifty *kuruş* were paid for 750 *kantars* of resin.[42]

Raw hemp (*ham kendir*) was used mostly for producing rope (*ispavli*). The Aydın region was an important supplier of raw hemp. Two thousand and five hundred *kantars* of hemp were ordered from the governor of Aydın, Hüseyin Bey, on 17 February 1793.[43] Raw hemp coming, for instance, from Aydın, was processed in a place called *Darağacı* (Gallows) by workers called *resenci* and *alatcı esnafi* (rope makers), and then was sent to the specified storage facilities on 28 September 1794.[44]

There was a class of artisans working on the production of *resen or ispavli* (rope) at the Imperial Naval Arsenal. They usually worked in the empty sheds near *Darağacı* and processed raw hemp and other raw materials to produce various kinds of rope for the ships.[45] In 1797–98, rope makers in the Imperial Naval Arsenal, were paid a further 3,000 *kuruş* in addition to the previous 2,000 *kuruş* in return for their production of *tel-i Frengî* (wire of foreign production) and rope.[46]

Wire was generally produced in Canik or bought from traders. A document of 1792–93 states that *ocaklık tel* (wire obtained through the method of indirect taxation) was a bit thicker and of mediocre quality, while that of the traders was thin and of good quality. When the workers were asked what the reason for this difference was, they cited low wages. Therefore, the authorities ordered the balancing of the wages between the producers of the two types in

[39] BOA. CB, no. 6229.
[40] BOA. CB, no. 1297.
[41] BOA. CB, no. 5209.
[42] BOA. CB, no. 2494.
[43] BOA. CB, no. 6056.
[44] BOA. CB, no. 4398.
[45] BOA. CB, no. 4398.
[46] BOA. CB, no. 2246.

order that all wires be of the same durability.[47] In short, rope and wire were used in the repair, caulking and rigging process in various capacities.

Sulphur (*kükürt*) was one of the chemical substances used in greasing ships. It was usually stored at the *mahzen-i sürb*. On 23 January 1790, there were 33,000 *vukıyyes* of sulphur in *Cebehâne-i Âmire*.[48] Since there was no sulphur left in *mahzen-i sürb*, 2,000 *vukıyyes* of sulphur were demanded from the *Cebehâne* in 1797–98.[49]

Oakum (*üstübî*), a caulking material, consisted of flax, hemp and pieces of worn-out rope and was used to fill gaps between the timbers of hulls before the process of tarring and applying pitch (Kahane and Tietze, 577–78; Bostan 1992, 146; Zaloğlu, 385).

In addition to the storage facilities at the naval arsenal,[50] Cairo was one of the most important sources of oakum in the late eighteenth century. In 1791–92 the Porte demanded from Egypt 250 *kantars* of oakum for the construction of a galleon in Bodrum.[51] Mahmud Raif Efendi also stressed the importance of oakum for caulking. Because of negligence in previous years, Ottoman ships had constantly taken in water. Therefore, the *Kaptan Pasha* had 200 trained caulkers brought from Egypt. He had a large barracks constructed for them and supplied them with food and clothes. This import of expertise was successful, since the ships stopped taking in water, even if they stayed at sea for three or four years.[52]

Heath (*Funda*), consisting of various types of small trees, was burned to dry out boats, galleys and galleons when their hulls were first constructed. It was also used during the caulking process. Towns such as Üsküdar, Çengel, İstavroz and Kuzguncuk were among the main suppliers of heath (Bostan 1992, 121). There were more than 500 kinds (Katip Çelebi 1973, 308).

Ballast (*safra*) is a load of such materials as stone, sand and mine that is put into the bilges of sailing ships to provide balance. In Ottoman times, it was loaded on and emptied from the holds of ships through a porthole called a *safra lumbar* (Pakalın 1993, 90).

TERMINOLOGY OF NEW NAUTICAL MACHINES, TOOLS AND EQUIPMENT

Navigational Books and Devices

The tradition of keeping logbooks (*seyir defteri* or *seyir jurnali*) started in 1796–97. During this time, logbooks covering naval and navigational regulations (*kavâid-i bahriye*) were given to the ships. All the captains carried Pirî Reis' *Kitâb-ı Bahriye* (the Book of Sea) as a guidebook, and they were responsible for completing and commenting on this precious book according to their own observations (Alpagut and Kurtoğlu 1936, 48; Işın 2004, 152).

Additionally, the crew of a warship had to carry navigational equipment in order to find their route and geographical locations and to sail the ship into the intended country in safety. Among this equipment were compasses (*pusula*), sounding leads for measuring the depth of the sea (*iskandil*) (Zaloğlu, 347) and hourglasses (*saat-i rîk/kum saati*). Most of this equipment can be found in the inventory of the frigate Fettah Kapudan.[53] Beside these instruments and books, some other tools were employed on naval ships. It is known that the Kapudan Pasha (the Grand Admiral) ordered Alexan, a Russian trader, to provide newly invented maps,

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[47] BOA. CB, no. 6056.
[48] BOA. CB, no. 1337.
[49] BOA. CB, no. 4513.
[50] For the demand of oakum from the *Tersâne-i Âmire* on 8 July 1792, see BOA. CB, no. 9360.
[51] BOA. CB, nos. 2229 and 12193
[52] *Mahmud Râif Efendi ve Nızâm-ı Cedîd'e Dâir Eseri*, p. 57.
[53] BOA. KK, no. 5726 (6 July 1791).

compasses and Frenk *fuğlas*[54] on 2 April 1801. In order to meet the expenses, 4,001.5 *kuruş* were paid from the *İrâd-ı Cedîd Hazinesi*.[55]

Some tools and instruments left by the late Râtıb Efendi (Selim III's envoy was sent to Vienna in 1791) and bought by the state for the Mühendishâne Library on 23 November 1801 include navigational devices as well. On a list published by Beydilli, we find *rub' tahtası* (quadrant), *gemi pusulası* (ship compass), *gönye maa tahta* (set square with wood), *çâr kûşe pusula* (square compass), *pergâr-ı tâm* (a pair of compasses), *musavver kebîr kürre-i semâ* (big illustrated celestial globe)*, akrebli ve ibreli basîte-i âfâkî* (elevation wood with hand and needle), *müteharrik nemçekârî pusula* (moving compass of Austrian type) and many other tools, along with maps including the fortified and strategic sites, and books related to navigation, shipbuilding and maritime commerce.[56]

New Cranes and Mast Mounting Machines

Among the improvement works of the Ottoman navy in the aftermath of the Chesme Disaster, in 1770 , when the Ottoman navy was destroyed by the Russian navy, French officer, Baron de Tott supervised the construction of a 120-*kadem* workbench for masts in the Imperial Naval Arsenal. Under Selim III, two new mast machines were constructed and put into operation in the arsenal in 1795. It has been documented that their construction increased the speed and efficiency of the operations by which masts were prepared for ships (Shaw 1969, 224). This information is partly verified by Mahmud Raif Efendi's mention of a certain tool used for erecting masts into the ships and being in good working order in the arsenal in 1798 (Mahmud Raif Efendi 1789, 29). The information given by Mahmud Raif Efendi accords with that in an Ottoman document dated 28 July 1802. The document talks about the need for repair of a crane (*macuna*) formerly used for fitting masts onto imperial naval ships. On that date, the crane was damaged; its floor sank into the sea to the extent of one *zira* and the pillars of the crane collapsed. It was decided that refractory stone (*seng-i âteşî*) of one *zira* would be placed on the floor of the crane in order to get a solid footing. Plans were made to replace the pillars with massive, solid supports reinforced by iron and lead ties after proper examinations. The estimated cost was 1,800 *kuruş*.[57] On the same subject, Hovennesyan mentions a wheeled and multi-cogged crane of foreign invention before 1794 and says that thanks to that machine galleon masts were easily erected (Hovannesyan 1997).

Newly invented fire pumps/conduits (Ateş Tulumbası)

Before the period under examination, fire pumps were used both on land and in ships to put out fires. When they became worn out, they were repaired or replaced. In general, in addition to ships having pumps to discard the water that had penetrated the wooden-hulled ships,[58] there were many ships of the time that carried a pair of elm pumps placed just forward of the main mast. The suction principle was essential for the operation of these pumps, which drew water directly from an inlet at the side of the ship up through holes bored via single trunks of the elm tree. Hence, these pumps were not for removing water from the bilges, but to draw water from the sea, which was then delivered, under pressure, through outlets on the upper

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[54] *Fuğla* means lookout post on the foremast (see Kahane and Tietze, 489). However, when it is spelled *fula*, it means 'hand glass' (a kind of sandglass). See Zaloğlu, 141.

[55] BOA. CB, no. 10123. Newly invented compasses and oil lamp with rotating glass of English production (*İngilizkârî devir ayna camlı fânus*) all together cost 2223 *kuruş* and 30 *para*. See BOA. CB, no. 11181 (12 April 1798).

[56] For a full account of the lists, see Beydilli 1995, 374–77.

[57] BOA. CB, no. 3883.

[58] When they got old, wooden ships tended to strain and leak, and rain-water also penetrated the decks. Therefore, chain pumps were fitted. Beside them, common hand pumps were mounted on the ships to supplement the chain pumps (Naish 1957, 484).

deck or the lower deck for putting out fires or washing the decks (Winfield 1997, 101). In all likelihood, the Ottomans too used similar fire pumps on their ships.

In 1793–94, 14 fire pumps and 15 hoses, onboard Ottoman ships, became worn out and some needed repair while the rest needed replacement, according to the *Tersâne-i Âmire tulumbacıbaşısı* (the chief official in charge of supply and delivery of the pumps and related equipment). Among the items of 15 fire pumps were *prinç tas*[59] (brass bowl), *prinç çatal* (brass fork), *prinç burmalı mesarlar*, *prinç pulları* (brass washer), *lehim için nişadır ve kalay* (ammoniun choloride and tin for soldering), *prinç ağızlıklar ve eklemeler* (brass mouthpieces and accessories), *kavisli* (curved hose), *demir-i ham* (raw iron), *kömür* (coal) and *sandık*[60] *ayak ve kolları* (legs and levers of coffer/pump). The total cost for the pumps and hoses was 3,269 *kuruş*.[61]

The authorities, anxious to avoid accidents, were opposed to using these different pumps in the place of the ones to which there had been accustomed. Therefore, on 8 November 1797, the fire pumps formerly misused or those requiring repair were fixed, arranged properly and readied for an emergency. Fire pumps provided from the *Tulumbacı Ocağı* (Fire Department) to the naval arsenal only (not the ones on the ships or the ones required during the caulking process) were to be used in the case of fires on land. The hoses and pipes were also to be fixed, or renewed if necessary.[62]

Nonetheless, documents show that the Ottomans were in search of new fire pumps to be used in naval services. They seemed keen to adopt newly invented fire pumps from foreign countries. Engineer Selim (formerly Baily) was commissioned by Kaptan Hüseyin Pasha and during the administration of the governor of the Imperial Naval Arsenal, Aziz Efendi, to go to England in 1803–04 and learn about the construction and manufacturing of a newly invented fire pump (*ateş tulumbası*), for the gates of the large dry dock at the Imperial Naval Arsenal.[63]

The construction of a stone furnace for casting bronze bearing pintles and sheaves

An order issued in 1796–97 states that bronze bearing pintles (*tunç inecikler*) and sheaves (*tunc zebanlar*), which were used for imperial galleons to be sheathed with copper, were to be melted in a pot and manufactured in a hearth (*ocak*) where copper planks were produced.[64] Because of the lack of a separate furnace (*furun*) particular to this process, they were first cast in the form of a few pieces and then assembled and manufactured in the above-mentioned hearth located at the Imperial Naval Arsenal. It is reported that these equipments proved dangerous in use. Further, the new three-decker galleon under construction was quite a large one, so the small bronze sheaves (*tunc makara zebanları*), which had been manufactured previously for smaller galleons, would not fit. It was therefore deemed necessary to build a new separate stone furnace for a constant and perpetual application of the art for bulky pieces.[65]

An examination book (*keşif defteri*) commenting on the feasibility of the construction of the stone furnace was prepared after some research. In the book, the excavation of the construction site in question, the measures and specifications of the construction and separate parts of the building, and the materials required for the construction were all stated in detail. The building was to have a brick roof, a wooden floor, a small storage area for tools and equipment, and stonewalls. Additionally, such materials as refractory stones (*seng-i ateşî*),

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[59] This bowl was called *yangın tası*, meaning 'fire bowl', and was used as a helmet for protection from fire. The *Tulumbacıbaşı*'s bowl was made of silver, while the personnel's were of copper. See Uzunçarşılı 1943, 83.

[60] A fire pump was called *sandık* among people who used the pumps. See Pakalın, 532.

[61] BOA. CB, no. 1913.

[62] BOA. CB, no. 2421.

[63] BOA. CB, no. 4010.

[64] BOA. CB, no. 6792.

[65] BOA. CB, no. 1354.

küfegî stones, Swedish iron, slop, iron beams and Horasan lime were used in the construction of the furnace.[66]

Newly invented furnaces and hearths for the imperial galleons
A document dated 4 September 1801 indicates some copper equipment and other tools to be used in the newly invented furnaces (*furun*) and hearths (*ocaks*), which were put in order and delivered to the allotted places via the *Liman Reisi* and the *Kaptan Pasha* for the requirements of the imperial galleons. The document states that the cost of the production of the equipment and tools was 9,656 *kuruş*, exclusive of the raw iron provided by the *mahzeni sürb*.[67]

Iron equipment of new invention
Relating to the equipment of the imperial navy, a document dated 1803–04 refers to the manufacture of some newly invented equipment *(âhenî çilingirkârî mühimmat)* made of iron. It states that the total cost was 7,468 *kuruş*, excluding the raw iron from the *mahzen-i surb,* which cost 1,971 *kuruş*.[68] It seems that this new equipment was produced to be used in the construction of ship parts and various works at the Imperial Naval Arsenal. These materials were manufactured by the Ottomans on the foreign models.

Steels produced from Swedish Iron
From a *takrir* (official petition) by Mustafa Reshid Efendi, dated 1792–93, it is understood that a certain engineer (*mühendis beyzâde*, probably French shipbuilder Le Brun) produced a kind of steel from the Samakov, Swedish and Austrian (*Nemçe*) iron. When introduced to the Ottoman experts, it turned out that the steels produced from Swedish iron were handier and superior to the others because of the toughness of the Swedish iron.[69]

Newly invented ground gunstocks, mechanical cranes, new darağacı structures and blocks/pulleys
A document dated 1800–01 reveals that an urgent need had emerged for the construction of a mechanical crane (*macuna/maçula maa cerr-i eskâl*) to raise and lower the newly invented ground gunstocks (*zemîn kundakları*), which were used in transporting the cannons cast at the Imperial Cannon Foundry (*Tophâne-i Âmire*) and the Hasköy cannon foundry (*Hasköy Tophânesi*) to the Corps of Bombardiers (*Humbaracı Ocağı*); in lifting from the wharf and transferring the big shell mortars (*humbara havanı*) of 65 and 36 diameters; and in loading the same mortars (*havan*) on the gunstocks (*kundak*). It appears that the authorities believed that this construction would lessen the transport cost paid for the porters as well as make the process easier. The same document shows that an English-made mechanical crane,[70] which had been formerly received by the Porte, had been taken as an example in the construction of this new one. Two other cranes, which had been built by Ragıp Efendi in 1798–99, were also

[66] BOA. CB, no. 11292 (6 December 1797).
[67] BOA. CB, no. 6872.
[68] BOA. CB, no. 3365.
[69] BOA. HH, no. 9646.
[70] It is known that there was a new crane of 120 *ayak* (c. 40 meters) in height with a single crank in 1770. See Müller-Wiener 1992, 80.

reported.[71] Mahmud Raid Efendi wrote that the construction of a *maçuna* with perfect wheels had started and its completion was expected soon.[72]

For the construction dates of earlier cranes, various dates are given. According to the information given in the book titled *Hadîkatü'l Cevâmi* (The Garden of Mosques) written by Ayvansarayi Hafız Hüseyin Efendi, the construction of pillars called *macuna* had started in the middle of the month of Muharrem in 1189 (1775), down at the shore of the *Tersâne-i Âmire*, in a straight line with the *Zindan* (prison), and was completed in the same year under the supervision of Hasan Pasha (Kahane and Tietze, 283).

As understood from an inscription of Yesârîzâde Mustafa Izzet's, Hasan Pasha's crane soon became useless because its legs began to rot in water. Earlier cranes had been called *darağacı* in the Imperial Naval Arsenal (Alpagut 1941, 137-141). A *darağacı* was constructed in the time of Küçük Hüseyin Pasha, in 1794–95.

Ships, after being launched into the sea, were towed beneath them for rigging out (Tezel, 1972, 619). Earlier *darağacı* structures had been made of wood and had required replacement or fixing every eight to ten years. This meant high costs. Therefore, towards the end of 1794, all of the former *darağacı* structures were pulled down and three new ones made of stone were constructed for caulking side by side in the Imperial Naval Arsenal in Istanbul .[73] Another source indicates that the *darağacı*, which was a three-legged flitch beam used for transferring the heavy materials of ships such as guns and rigging as well as for tilting the ship hulls sideways during the maintenance of the bottoms of the ships, was replaced by a new *darağacı* composed of three legs of iron pipe on 2 August 1794 (Işın 2004, 151).

French engineer Le Brun was reported to have built two new cranes that had hands as well. However, they are said to have been old-fashioned, operated with big pulleys (Müller-Wiener 1992, 83–84).

Tezel, without giving any date, but most probably referring to the middle of the eighteenth century, contends that there were a crane and a crane machine (*macuna makinesi*) in front of the Camialtı building. He adds that a crane was thought to exist in the late eighteenth century (Tezel 1973, 655). Tutel notes that the crane in Daragaci at the Camialtı Arsenal was built in 1790 (Tutel 1998, 152).

Regarding the blocks (*makara*) used on the Ottoman ships to lift heavy materials, they were mostly made of the trunks of ash (*dişbudak*), *kayacık* and elm trees (*karaağaç*).[74] The same types of trees were used in Europe in block making. The parts of the block were: the shell of elm or ash, the pin of lignum vitae (*peygamberağacı*), greenheart or iron, and the wheel of lignum vitae (Naish 1957, 581).

Various types of blocks with Santo sheave[75] were purchased from Galata traders to be used on the Ottoman galleons, for instance, the *Bâdi-i Nusret* in 1797–98.

The number of blocks used on ships changed varied from 399 to 940, depending on their size. For example, it was 940 for a three-decker galleon with 120 guns, and 848 for a frigate with 28 guns and a corvette with 18 guns (Güleryüz 2004, 1089.

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[71] Ragıp Efendi was in charge of constructing carriages at the *hâcegân-ı divan-ı Hümâyûn humbaracılar kışlası demirhanesi* (iron foundry at the barracks of the bombardiers of the Imperial Council) in 1213/1798–99. The total cost (raw iron, timber, blocks with bronze sheaves and others) for the construction of two cranes (*macuna*/*macula*) amounted to 986 *kuruş*. With regard to the types of timber in the construction of the two cranes, bent brace made of oak (*eğri meşe kemer*) and box for gunstocks (*kundaklık dolap*) were used. See BOA. CB, no. 2172.

[72] *Mahmud Râif Efendi ve Nızâm-ı Cedîd'e Dâir Eseri*, p. 57.

[73] *Mahmud Raif Efendi ve Nizâm-ı Cedîd'de Dair Eseri*, p. 57; Emsen: 'Selim III', p. 15.

[74] BOA. CB, no. 7720.

[75] Ismail Ferruh Efendi said that sheaves for pulleys (*makara dilleri*) in England were made from a tree called 'Limbo Santo', which was provided from America only. He further says that the 'Limbo Santo' was useful in manufacturing pulley equipment (*makara takımı*). See BOA. HH, no. 6085 (1799–1800).

A register book of various kinds of blocks with Santo sheave, which had been purchased from Galata traders via Idris Kapudan, elucidates the technical aspects and types of the blocks. Among 87 blocks of different types, costing a total of 283 *kuruş*, were *demir sabanlı üç dilli makara* (three-sheave block with iron stroop), *demir sabanlı iki dilli makara* (two-sheave block with iron stroop), *iki dilli kancalı makara* (two-sheave block with hook), *kancalı torno makara* (single block with hook), d*emir sabanlı makara-i bastika* (snatch block with iron stroop), *kancalı makara palanga-i güverte* (hooked block of deck tackle), *üçer dilli makara-i vasat* (middle block with three sheaves), *ikişer dilli makara-i vasat* (middle block with two sheaves), *makara-i torno* (single block), *iskota makara* (sheet block), *palanga-i borina-i makara* (bowline tackle block), *makara-i bastika* (snatch block) and *makara-i mütenevvia* (miscellaneous blocks).[76]

We come across information of sheaves for pulleys ordered from England in 1799–1800 as well. Ottoman documents refer to Ismail Ferruh Efendi's report about the Porte's demand for sheaves for pulleys from England. It is understood from his report that in England sheaves for pulleys (*makara dilleri*) were made from a tree called 'Limbo Santo', which was found only in America and was useful in manufacturing pulley equipment (*makara takımı*). Ismail Ferruh Efendi advised on and discussed the ways of transporting the material to Istanbul. In this context, he also mentioned possible insuring (*sigorta*) for secure transportation.[77]

The construction of the Nühashâne, Haddehâne and New Haddes

Regarding the copper sheathing of the ships, we have already mentioned a document dated 1 May 1796 that indicates the establishment of a new copper processing house (*Nühashâne*) within the body of the *Temurhâne*, which processed the copper to be fastened onto the hulls of the ships as well as to prevent the waste of copper formerly prepared in the *Humbarahâne*. This new copper-processing house was planned as a four-walled room with three furnaces. The process of the exploration and determination of the construction site was carried out by the chief architect (*Mimar aga*) on the instructions of the *Tersâne-i Âmire Emini*. It is traced in the construction notebook (*keşif defteri*) of 29 April 1796, written by Mehmed Arif Bey, *Ser Mimarân-ı Hassa*. The site chosen was near the *Temurhâne.* The building was surrounded by stonewalls on three sides and had a perfect roof. There was a high room inside the building for the residence of the workers. Beneath the ground floor, there were a shop and a coal cellar. The building had a large gate as well as the necessary tools and components. There were two foundry workshops between the *Nühashâne* and the *Temurhâne*. Its estimated cost was 4,470 *kuruş*.[78]

A document dated 30 June 1803 gives information about the *Haddehâne* near the *Âlât Meydanı* (the Rope Square) in the Imperial Naval Arsenal, stating that the chief gunpowder expert, Arakel, manufactured a pair of newly invented large iron *haddes*[79] to level copper plates for sheathing the imperial galleons in the time of Kaptan-ı Derya Hüseyin Pasha. Although the use of the first *hadde* machines is generally ascribed to the reign of Mahmut II, those manufactured by Arakel might be considered to have been the prototypes of the later

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[76] BOA. CB, no. 2287.

[77] '*...Makara dili yaptıkları Limbo Santo nâm ağaç Amerika'dan gelmekle gayrı mahalde bulunmayup fil vâki makara takımı imâlinde dahî bunların mahâreti müsellem görünür, her ne ise memuriyyet-i bendegânem üzre cümlesi bir an akdem tedârik ve irsâl olunmasına …ol tarafa gidecek beylik sefineleri zuhur edüb ona vaz ettirlir ise yahut tüccar sefînesi isticâr ve ona tahmil iderler ise …ve alel hesab bir miktar meblağ taleb ederler mi mühimmât-ı mezkûreyi sigorta etmek iktizâ eder mi ne vechile olacağı henüz mechûl-i bendegânem olmaktan nâşi...*' Ismail Ferruh Efendi's use of the words '*sigorta etmek*' (to insure) is interesting for the time. See BOA. HH, nos. 6085 and 6086 (1799–1800).

[78] BOA. CB, no. 1261.

[79] *Hadde* is the name of the machine used to produce thin plates and wire out of raw copper and iron. The first *hadde* was ordered from abroad under the reign of Mahmud II. See Pakalın 1993, 698–99. A *haddehane* operating by steam power was established in 1834 in order to produce copper sheet mills. See Müller-Wiener 1992, 85.

machines. Additionally, information showing that Arakel finished the *hadde* wheels to be used for gunpowder production at the Azatli Baruthanesi in 1803 supports this idea (Çetin 2001, 27). Unfortunatelly, it is not known if these *haddes* were fully manual, as in previous years, or semi-mechanical.

Regarding the later operations concerning the foundation of this *Haddehâne* building, the document states that an excavation was carried out and the foundation was reinforced with new pillars of washed black *küfegi* stones (*yunmalı seng-i siyah-ı küfegî*). New tools and wheels were constructed for better use of the *haddes*. The total cost was 8,828,5 *kuruş*. The above-mentioned document also refers to the reconstruction of the foundry, which was in a state of disrepair at the time. In the foundry, near the *Âlât Meydanı*, a stone hearth (*kârgir ocak*) had collapsed. Therefore, under this stone foundary, a stone-grilled quay (*kârgir ızgaralı rıhtım*) of two *ziras* was filled and encircled by a wooden fence on three sides. Its interior walls of refractory stone (*seng-i ateş*) were connected with iron beams. Brick, pure mortar and whitewashed copper were applied. Its measures were three *ziras* in length, 2/60,000 in area, seven *ziras* in height and two *ziras* in foundation. The structure was encircled with walls of refractory stone (*seng-i ateş*) and whitewashed with slop (*çömlekçi çamuru*), and its measures were two *ziras* in length, 2/7,200 in area and 1,5 *zira* in height. It is understood that the 480 columns and 600 units of woods for the construction of a roof over the mentioned furnace were required. In this foundry, a small furnace (*ocak*) for casting bronze nails was constructed, roof tiles, new rafters (*mertek*) and girdle (*kuşak*) were provided, and a balcony (*balkovan*) was fixed. Expenses for porterage and the transport crane, along with other expenses, amounted to 6,000 *kuruş*.[80]

New shipbuilding forms and new sheds for gunboats

Two new shipbuilding forms were built at Hasköy and two at Ayvansaray, allowing simultaneous construction or repair[81] of nine large ships in Istanbul and its vicinity. New sheds were also constructed in the late 18th century at Kağıthâne to store the gunboats and other small craft of the fleet and protect them from the elements when they were inactive (Shaw 1969, 224).

The construction of the sailhouse (Kirpâshâne/Yelkenhâne)

As a natural result of the transition from oared to sailed ships at the beginning of the eighteenth century, a sailhouse, or *kirpashâne*, was established within the body of the *Tersâne-i Âmire* in order to make high-quality sailcloth in large quantities for the Ottoman galleons, whose number had increased dramatically. This facility underwent repairs and restorations in the 1760s and was enlarged in 1770 (Genç 2000, 249). During the reign of Selim III (1789-1807), a new and larger sailhouse was constructed by İsmail Hulûsî Efendi in 1795–96 in Darağacı at the Imperial Naval Arsenal (Işın 2004, 153).

Construction of the first dry dock (kuru havuz/havz-ı kebir) in the Naval Imperial Arsenal

Built between 1797 and 1800 on the Golden Horn, the first dry dock (today known as dry-dock no. 3) allowed the ships to be floated by flooding the operation area once the repair and construction for the ships were completed on a dry platform. As a new construction, it made available a new technology and became the reason for the introduction of new terminology. This can be seen more clearly in relation to the materials used in the construction of the dry dock. It seems that the main building elements were timber from *Kidros* (pine), pine from *Cide*, oak from *Misivri* and *Ayholu*, hornbeam from *Iznikmid*[82]; stone (*tomruk taşları*) from the

[80] BOA. CB, no. 1888.
[81] BOA. CB, no. 6506.
[82] BOA. CB, nos. 1169 and 9501.

quarries in Istinye (black, unhewn and rough-hewn stone blocks[83] from Balta Limani); lime mostly from Pendik; and iron. Also, *boçlana* (a type of soil) was used in its construction. This was a kind of soil that was provided from Italy, (Bostan 1992, 76–78), the Santron Islands, and Değirmenlik in the Mediterranean.[84] The puzzolana mortar/soil, which was a durable material for underwater constructions, was used in the dry dock (Aksoy 1982, 73). It must have been the same material as *boçlana*. Puzzolana mortar (*puzolan harcı*) was composed of puzzolana[85] and lime. It quickly hardened under water. In fact, this material (also called 'Roman cement') had long been used widely in underwater construction before the introduction of cement (Aksoy 1982, 73), especially in European hydraulic architecture during the eighteenth century (Merino 1985, 47).

The front side of the construction site was cleaned via drag at the *Halic Tersanesi*. Wooden sheet piles were driven into the shore to prevent the seawater from entering the construction pit, which was dug at 37.50 m by 75.00 m and 10.50 m in depth. Water was constantly pumped out to make work in dry conditions possible (Aksoy 1982, 72). Although at the beginning of the construction the sea front was sealed to prevent the water from coming inside, water began to seep from the sides and front into the excavated area, caused by the muddy and loose soil under the buildings used by store administrators (*ambar eminleri*) on the landfill. An imperial edict was issued ordering the demolition and rebuilding in a different place of these buildings. Additionally, plans were made to build two wooden wells on the two sides of the dry dock. One of them was completed easily, while the second required careful work during the foundation excavations in order to avoid damaging the nearby wall of the granary. Following the completion of the main building, a wall was built around it and new storage areas (*mahzen*) were constructed. Expenses amounted to 800,967 *kuruş* (1,617 purses of *akçe* and 467 *kuruş*), which was a far smaller figure than the estimated cost (3,000 purses of *akçe*) at the beginning of the project. The construction of the first dry dock in the Ottoman Empire started in February 1797 and was completed in May 1800 (Bostan 1992, 78–79).

Later, a ladder was constructed in the big dry dock at the *Tersâne-i Âmire*. The cost of stone and other materials required for the construction of the ladder, amounting to 613 *kuruş*, was met by the *Tersâne-i Âmire Hazinesi*.[86]

A kind of underwater glass (*sualtı dürbünü*) was manufactured and used by Swedish dry-dock engineer and officer Rhode for observing the construction activities under water. Rhode's earlier tutelage under engineer Thunberg, who used underwater glass and later on invented a diving tube into which a man could go and observe underwater life, supports this thesis.[87] Two wells fitted with treadmills were constructed at the two sides of dry docks

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[83] For the extraction of *tomruk taşları* (rough-hewn stone blocks), mining (*lağım*) with gunpowder was necessary. The required gunpowder was provided from the *Cebehâne-i Âmire* in 1796. See BOA. CB, no. 1683.

[84] BOA. CB, no. 10103.

[85] Puzzolana is composed of active silica and a certain amount of active alumina, and when it is used together with lime it becomes binding. See Akman 1992, 41.

[86] BOA. CB, no. 5315.

[87] The original statement in the document referred to by Aksoy is '*deniz dürbinlerinin ẕîrine vaz' olulan iskele ve ücret-i kadem: bahâ-i tel, ücret-i kadem and baha-i câm 1100 para*'. Aksoy 1982, 15. The document also mentions *mismâr*, *ağaç*, *kırmız, şem-i sorh*, *şem-i ruğan*, *sancaklık*, *ıhlamur yeke*, *tunç boru* etc. among the tools and equipment purchased for the construction of a model dry dock and underwater glass and gives the total cost as 3,220 *paras* ('*Havuz resmi ve deniz dürbinleri inşası lazıması içün mübayaa olunan eşya bahası*'). Additionally, the cost for the *kürek-i âhen* (iron shovel) and *örs-i âhen* (iron anvil) to be used in *Demürcü Ocağı*, reconstructed in Âlât Meydanı, was 2,600 and 3,010 *paras* respectively. For the travel allowance of Said Çavuş commissioned to bring *boçlana* soil from Değirmenlik and Santron Adaları, 6,000 *paras* were paid. The *Demürciyân-ı Tersâne* and *Demürciyan-ı Françelû*, who worked in the production of iron tools and equipment for the dry dock, received 12,780 *paras*. Materials such as *seng*, *çelik*, *seng-i bileği* and *eğe-i kol* were used by the *demürciyân* for the production of iron tools, and 400, 5192, 400 and 232 *paras* were spent, respectıvely. The *lağımcıyân*, *ser-lağımcıyân*, *çavuş*, *mutemed*, *rençberân*, *hammâlân-ı kereste*, *neccâr Manol* and his assistant were employed in the

(including the one constructed later on in the time of Mahmud II) in the Golden Horn and that water was emptied via these wells. A type of chain pump (*sonsuz ipli kovalı tulumba*) was used in the construction of the dry docks at the Imperial Naval Arsenal, since such a device had been in use in the eighteenth-century dry docks in Europe. The use of chain pumps in the constructions of dry docks in the *Haliç Tersanesi* continued until 1856, after which time steam-driven pumps were used.[88] Correspondence between the Porte and England about the specification of a steam engine to be used in the dry dock at the Imperial Naval Arsenal in 1805 is an important indicator that at least the knowledge of a steam engine had already reached the Ottoman Empire at the beginning of the nineteenth century.[89]

The document also describes the difficulties of the exploration and feasibility of the dry dock, stating that it was still uncertain if the construction would be done like the previous one or with iron wings and lead due to the rocks, some on the sea surface and others in the sea. It is understood that there was a belief that no problem would appear with respect to the wages of divers (*sömbeki*), workers, as well as tools and equipment such as pontoons (*tombaz*) and drags (*tarak*). The workers, sellers and the payment required were to be provided by the construction administrator (*bina emini*). The supply of the required oak and hornbeam suitable for use, as stakes did not seem possible from Istanbul, would have to be provided from the countryside. The construction administrator was to pay the wages and the *Tersâne-i Âmire* was to help with the felling and transportation process.

Consequently, the construction of the first dry dock (Tutel 1994, 137) between 1797 and 1800 was an important turning point for the Ottoman naval technology. Not only did it become the base for the construction of various kinds of ships under the reign of Selim III, but it was also taken as a model in the construction of two later dry docks. Names of some of the materials such as puzzolana mortar and underwater glass were brought into the Ottoman world to complement the already existing terminology. Also the term *kuru havuz* (dry-dock) was first introduced at that time.

Copper Sheating (Nühas Kaplama) of Warships

Ottomans seem to have been aware that copper sheathing technique, which it first appeared in Europe in the second half of the eighteenth century, had offered significant advantages. Among them were protection from wood-eating worms; creation of a surface on which external weed and shellfish could not grow; an increase in sailing speed which not only reduced voyage times, but made navigation easier, since if a vessel could move in light winds it was less liable to drift on ocean current; the applicability of copper sheathing to any shape or size of hull; providing an outer skin of copper protected the hull to some extent; holding caulking materials in position; and reducing maintenance costs between voyages.

On the other hand, some disadvantages, such as high material and application costs, the risk of galvanic action and the deterioration of iron fastenings, and the fact that a coppered vessel could not be grounded in harbour without considerable risk to the sheathing and thus was restricted to harbours with water at all tides (Rees 1971, 93) could not prevent the Ottomans from adopting this technology. However, some of these disadvantages were unknown to the Ottomans initially. Ottomans learned about them as a result of prolong naval experiences. Thanks to academic work from the 1950s onward, the nature, type and properties of the

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construction of the gates of the dry dock on 30 August 1795 and they received 32,635 *paras* in total. Beside these workers, there were a *Tavşan* and a *Nakkâşân* working in the manufacture of the modal dry dock and underwater glass, who received 22,640 *kuruş* and 80 *paras*, respectively. In a nutshell, it seems that the total cost for all kinds of expenditures amounted to 2,255 *kuruş* and 9 *paras* on 30 August 1795. See BOA. CB, no. 10103.

[88] Aksoy: 'Osmanlı Döneminde Kullanılan Eski Su Boşaltma ve İnşaat Araçları,' vol. 3, p. 49; and also Aksoy 1982, 19.

[89] PRO. FO 78/46, pp. 242-244.

molluscs and crustaceans hazardous to the timbers in the seas surrounding Turkey have been identified (Bobat 1994, 23-259).

TERMINOLOGY OF NAVAL GUNS AND WEAPONS

Types of naval cannons in the Ottoman navy

In the time of Selim III, cannons began to be cast out of iron. On 12 November 1805, the *Hasköy Tersânesi* was attached to the Imperial Naval Arsenal in order to cast naval guns (Alpagut and Kurtoğlu 1936, 45). Some needs voiced by the ship captains and crew give an idea of the types of cannons used on them. In a document written by Rahtuvânî Hasan Aga, dated 17 October 1790, a quantity of cannons capable of throwing shells of seven, five and three *kıyyes* were ordered for 30 sloops, and 20 *dubas plenks* in Tuna.[90] Additional data provide information on the use of newly invented cannons. A document from 1790 tells about newly invented *beş çakmaklı ve beş mehtaplı* (cannons with five flints and cartridges), which were fired at Kağıthane. An imperial edict ordered these cannons mounted on the appropriate galleons and frigates. In the document, the preparation of chained cannonballs (*zincirli gülle/plankete*) was also ordered.[91] In another document, dated 1799–1800, referring to the previous year, it is recorded that for the requirements of galleons, two mortars, 22 in diameter (throwing a projectile of 22 pound), and four mortars of 14 in diameter, were needed. In 1799–1800, the number of English shells to be used on the galleons amounted to 300.[92]

Some cannons were used in land wars only, while others were used in naval wars and on ships. *Şâhî*, *cehrin*, *saçma/çarha*, *misket*, *eynek/enik*, *darbzen*, *prangı* (mortar), *bacaluşka* (basilisco), *kolomborno* (culverin) and *şayka* (battering gun) appear among naval cannons as well as land ones (Bostan 1992, 177; Aydüz 1995, 416). Some of these guns were already in use in the fifteenth and sixteenth centuries. For instance, *şayka*, *baş topu* (guns fitted into the prow), *darbzen*, *kebîr* (big size), *sağîr* (small size) and *prangı* were among the guns used on such ships as *barça* (bargia), *ağribar*, *kadırga* (galley), *kalyata* (galete) and *kayıks* (caique) in 1488. The total number of guns given to these ships was 137. It is striking that 83 out of them were for *barça* and 29 for *ağribar*, both of which were warships (Aydüz 1995, 415). Also, Selman Reis' fleet in the Red Sea in 1526 had a powerful artillery of seven *bacaluşka*, 13 y*an-top* (side cannons), 20 *darbzen*, 29 *şayka*, 95 iron pieces and 97 *prangı* (İnalcık 1975, 203).

The *darbzen* was a light gun with a small diameter, seven *karış* in length. It could fire small projectiles (50–100 dirhem/160 g). The weight of the gun was 56,5 kg. It was relatively quick despite its small diameter and cannonball (Erendil 1988, 70; Bostan 1992, 84, 85, 96, and 174). It is reported that two huge *darbzens* firing iron cannonballs of 27 *okkas* (a measure of weigth equal to 1.288 kg) each were prepared at the *Tophâne-i Âmire* and mounted on *mauna* ships in 1517 (Tekindağ 2001, 28). *Bacaluşka* (basilisco) was the metaphorical name given to the large cannon widely used in the Mediterranean in the sixteenth century, which witnessed extensive use of this type of gun on ships (Kahane and Tietze 1988, 99–100). Being bigger than the *prangı*, it was a siege gun. It fired iron shots of seldom four, generally 11, 14, 16, 18 and 20 *okkas* in weight, ranging in length between 9–10 and 18–20 spans, and made of wrought iron at the beginning of the sixteenth century, but mainly of cast bronze in the wake of the reign of Suleyman the Magnificient (Agoston 1994, 39–40).

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[90] BOA. HH, no. 9792.

[91] BOA. HH, no. 11753.

[92] BOA. D.BŞM TRE, no. 15328.

*Prangı*s were generally used in siege wars as were both field and naval cannons. They were often mounted on small ships, such as *şayka* (saika), and *firkate* (frigate), operating on rivers. The term *prangı* appears in combination with *deve prangısı* (*deve* meaning camel) in some sources. Among the military supplies provided by the *Cebehâne-i Âmire* on 21 May 1522 to a ship heading probably for Rhodes under the command of Mustafa Pasha were 16 *deve prangısı* with gunstocks (*prangı-ı şütur ma'a kundak*) (Aydüz 1995, 417; Erendil 1988, 70–71).

The *kolomborno*, on the other hand, had a long gunbarrel. Therefore, it was used in navies when a need for a horizontal projectile path appeared. It was usually mounted on the bow or on stern gunports. It could fire cannonballs of three, five and seven *okkas*.

Şayka was the name of the big boat with a flat bottom operating on the Danube and other rivers. The cannon in question took its name from the ships upon which it was mounted. The *şayka* was used both on ships and land wars during the siege of fortresses, and came in small, middle and large types. There were some with 16-*karış*-gunbarrel lengths capable of throwing cannonballs with 22 *okkas* (29 kg) in weight.

Other types of cannons formerly used in land wars were also in operation in the Ottoman navy (Erendil 1988, 70–71). In addition to these cannons, the *poca/boça* appears as a missile used in naval artillery in both the seventeenth and eighteenth centuries (Kahane and Tietze 1988, 110).

Some others, such as the *kebir*, the *obus*[93] and the *balyemez*,[94] were also used on the galleons built at the *Tersâne-i Âmire*, Rhodes and Gemlik, Sinop, Bodrum, Kemer and the Danube. Cannons weighing between three and 44 *kıyyes* and being between eight and 16 *karış* in length were used in 1791–92. The length of the galleons to be equipped with the above-mentioned cannons was between 35 and 55 *zira*. Another important piece of information that can be deduced from an archival document is that these cannons were cast and manufactured at the Hasköy cannon foundry and the *Tophâne-i Âmire* in Kârhanesi. For casting cannons, raw copper, tin and raw iron were needed. In the same year, for 81 *obus* and *balyemez* cannons, 2,320 *kantars* of raw copper (*nuhâs-ı hâm*) and 232 *kantars* of tin (*kali*) were bought, and 1,160 *kantars* of zinc (*ruy-i maye*), 120 *kantars* of which were provided from the *Tophâne-i Âmire* and 10,000 *kantars* of which from the *Tersâne-i Âmire*, and 29 *kantars* of raw iron were provided from the *Cebehâne-i Âmire* to cast cannons in the foundries for the galleons. The total cost was 29,000 *kuruş*.[95]

The Ottoman navy, and especially the galleons under construction and those that were near completion, often demanded cannons from the *Tersâne-i Âmire/Mamûre Kârhânesi*. Sixty-eight cannons were demanded in 1797–98 for a three-decked galleon under construction at the *Tersâne-i Âmire*. Chief founder Ismail Ağa was in charge of casting these cannons. The cost of casting 68 cannons amounted to 33,440 *kuruş*. Twenty-seven thousand five hundred *kuruş* out of this amount were paid up on the above-mentioned date. The remaining 5,940 *kuruş* were paid earlier.[96]

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[93] As understood from the regulations for *Humbaraci* class in 1792–93, newly invented *obus* guns were to be used to fire projectiles during military campaigns when there was no proper location to manufacture *humbaras* (mortars). See Esencan 1946, 62. It is understood from an edict dated 23 March 1791 that the casting of 50 *obüs* and *sürat* guns in the *Tophâne-i Âmire* was demanded for a *trabago* and some other ships constructed at the *Tersâne-i Âmire*, and that for casting these guns, 72 *kantars* of *kali-yi İngilizî* (British tin) were required. See BOA. CB, no. 1454.

[94] A long-range battering gun. Three hundred *kantars* of copper were needed to make this cannon in 1782. This cannon was also made from bronze and could fire balls of 24 *okkas* each in 1694. See Kahane and Tietze 1988, 99–100.

[95] BOA. CB, no. 1474.

[96] BOA. CB, no. 12282.

Regarding the calibres of the cannons to be mounted on the galleons, a document of 1789–90 reports that the *Kaptan Pasha* was going to go aboard the new galleon *Bahr-i Zafer*. Therefore, it was ordered that four big cannons of 66 *vukıyyes* calibres each, which had been cast, manufactured and readied at the *Tophâne-i Amire*, be mounted on the ship.[97]

Projectiles

Marble (*mermer*),[98] granite[99], heavy stones[100] and metal shells (*mâdeni yuvarlak*),[101] chain shots/shots joined together by an iron chain (*madenî plankete*),[102] bar shot/iron bars (two balls joined together by an iron bar), cartridge bag/grape shot (*salkım*) or canister (*sakolya/sakuleta/sakulta*), shells with five holes/carcass (*beş delikli paçavra*)[103] and scissors of metal shells (*maden toplu mikrazlar*)[104] were used as projectiles in the cannons of Ottoman ships. We encounter almost all these types of projectiles in 1790 as part of the ammunition on three separate *trabago* ships led by Ülgünlü Yusuf Reis, Salih Reis and Sinan oglu Hasan Reis, as well as on a *pirigandi* called *Pirigandi-i Mahmud Pasha*, led by Ahmed Reis[105], on a frigate called *Cabbâr-i Bahri*, led by Fettah Kapudan[106], and finally on a frigate bought from England and led by Osman Kapudan.[107] Iron bars, and shells with five holes (*beş delikli paçavra*), shells with two bars or rings, howits/howitzer shells, grape shells, common shells and round shots also appear in the list of ammunition to be purchased from England in 1793. The list seems to have been prepared by the Ottoman authorities according to the contract signed between the two countries.[108]

Gunpowder for naval guns

As for the gunpowder required for the naval guns, an imperial edict dated 1789–90 presents several important issues. First, it points out that each naval cannon was allotted 50 cartridges

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[97] BOA. HH, no. 55529.

[98] In 1790–91 stonemasons in the Marmara region were ordered to cut, prepare and send 610 large marble cannonballs for naval guns. Five hundred and fifty *kuruş* were paid just for workers cutting marbles. See BOA. CB, no. 6143 and 5848.

[99] During the British expedition under the command of Duckwoth to pass through the Dardanelles in 1807, the Ottomans used mortars that could throw huge cannonballs made of marble and granite. These cannonballs were made from the columns of Greek and Roman temples. One of the cannonballs was brought back to Portsmouth as a trophy because of its epic quality. A stone ball of 800 pounds cut through the mainmast of the *Windsor Castle* and another, two feet and six inches in diameter, caused a fire and explosion in the *Standard*, killing eight and wounding 47. See Pocock 1998, 203–04.

[100] The Ottomans, for instance, used them during Napoleon's siege of the town of Acre on 9 May 1799. See Nicholas Tracy 1998, 24.

[101] In addition to the marble shells of different diameters, metal shells with diameters of 18, 9 and 5 were also used in naval cannons. The document dated 4 January 1793 shows that the manufacture and cast of 200 metal shells of 18, 400 of 9 and 400 of 5, which amounts to 1,000 metal shells in total, were demanded from the *Humbarahâne* and the *Tersâne-i Atik* for a galleon almost completed. See BOA. CB, no. 6381.

[102] BOA. HH, no. 11753.

[103] In a document dated 11 September 1800 the manufacture of shells with five holes, common shells, and grape shot was ordered by an imperial edict. See BOA. CB, no. 7163.

[104] As revealed by a document of 1801-02, scissors of metal shells (*maden toplu mikrazlar*) made of mortar metal were also used in the cannons of Ottoman ships. See BOA. CB, no. 3609.

[105] BOA. KK, no. 5724.

[106] BOA. KK, no. 5726.

[107] BOA. D.BŞM TRE, no. 15211.

[108] PRO. FO 78/14 (22 February 1793), p. 78.

(*hartuc*). Second, both black gunpowder originating in Istanbul and Gelibolu, and English gunpowder were used in the Ottoman and Algerian navies. The amount of black gunpowder given to the navy during that period is known to have been 8,440 *kantars*. The amount of English gunpowder supplied to the navy was not cited in numbers, but referred to as 'a certain amount'. Furthermore, the document mentions that the present quantity of the English gunpowder in the imperial armoury was, according to the *Defterdar Efendi* (Treasurer), 3,880 *kantars*. The document points out that despite the good quality of the Ottoman black gunpowder, it was not of as high a quality as that of the English type (*Ingiliz perdahti*).[109]

In 1792–93, in order to store the amount of gunpowder required for the cannons on the galleons, copper pots were produced with copper of 20 *vukıyye* each, and 40 *akçes* were paid per *vukıyye*. *Hark-i nâr* (a kind of hot substance) was not included in this amount.[110] Copper for the cannons mounted on the ships came mostly from Ergani and Keban through Amasya, Sivas, Tokan, Samsun wharf and Iznikmid.[111]

Regarding the exchange of gunpowder between Ottoman and English navies, the English naval ships operating in the Mediterranean against French forces requested 500 barrels (250 *kantars* and each *kantar* for 45 *kuruş*) of good-quality Ottoman black gunpowder from the Porte in return for money. The Ottomans, after considering that England was their ally, decided to meet the demand free of charge. It is understood that the value of the gunpowder granted to the British fleet was 12,000 *kuruş* (24–25 purses).[112]

Secondary equipment related to naval guns

The loading, mounting, manoeuvring and limitations of recoil of the guns on the ships required some tools and materials that were crucial for the efficient use and firing of the guns. These secondary materials included cannon wagons (*top arabası*), iron rings of bolts and screws for these wagons (*ahen halka-i civata-i araba*), hooked blocks or pulleys of deck tackle to lift and locate the guns (*ahen kanca-i makara-i palanga-i top*), iron cordage for the guns (*ahen paranga-i top*), ropes, iron hooks (*ahen kanca*) and rings (*ahen halka*) to secure the guns on the broadsides, iron hooks for lifting gunports during firing (*ahen kanca-i lumbar*), cartridge bags (*hartuc kağıdı*), copper funnels (*bakır huni*), Egyptian wicks (*fitil-i mısri*), gun levers (*manivela-i top*), halberds (*harbe*), white felt for cannons (*beyaz top keçesi*), scoops for loading gunpowder to guns (*kepce-i top*) and cannon drill (*top burgusu*) and such to load and clean the guns.[113]

Regarding the secondary equipment, some other needs arose from time to time. In 1801, a new sheltered space (*sundurma*) for the protection of the cannon carriages (*top arabası/kundağı*) on the imperial galleons from rain, snow and other bad weather conditions, and a manual workbench (*çark/destgâh*) for the construction and manufacture of the tenon equipment of wagon axles (*araba dingili zeban takımları*), as well as a suitable place for this purpose were urgently needed. A French engineer, possibly Le Brun, was commissioned to construct and manufacture the above-mentioned workbench and the tenon equipment of wagon axles. In an imperial edict, the *Kaptan Pasha* ordered the *Liman Reisi* (commander of the port of Istanbul)*, mimar aga* (chief architect)*, usta* (foreman)*, kalfa* (assistant) and other relevant personnel at the Imperial Naval Arsenal to research the feasibility and conditions of proper places for this aim. As a result of their search, the estimated cost for furnace and shed for the gunstock of cannon wagon appeared to be 5,742 *kuruş*, while the estimated cost for the

[109] BOA. HH, no. 8024.
[110] BOA. CB, no. 2357.
[111] BOA. CD, no. 2921 and CA, no. 48831.
[112] BOA. HH, nos. 1592 (1799-1800) and 6644 (3 July 1799).
[113] BOA. KK, no. 5724, 5726 and D.BŞM TRE, no. 15211.

workbench and an appropriate place for the construction of wagon axles was 1,098.5 *kuruş* (noting that due to its unfamiliar type, this figure could change). The total amount came to 6,346 *kuruş*.[114]

The furnace mentioned above is related to the need for the manufacture of bronze sheaves (*tunc zebanlar*) for the imperial galleons, stated earlier. In addition, four separate building projects were planned, as far as can be understood from an inspection book of 24 October 1801. The first building was a shed in which the gunstocks of cannon wagons would be stored for protection. The second one was an appropriate place for the production of wagon axles. The third one was a European type of annealing furnace (*tavlama ocağı*) with brick walls. The last was a workshop for the manufacture of workbenches and hand wheels for the production of iron pins and wagon axles with movable arms. Among the materials used in the constructions were stone, worn-out anchors, bricks, roof tiles, oak timber, iron screws, bolts and rings.[115]

CONCLUSION

The late eighteenth century witnessed many changes in almost every aspect of naval technology. In this period, shipbuilding began to undergo a shift from a craft to a semi-scientific pursuit. The change can be considered 'semi-scientific' since it did not dwell upon pure scientific theories and kept traditional methods to some extent. In other words, the discrepancy between the theory and practice of ship-building continued to exist. However, it was a milestone in the sense that it paved the way for the beginning of a resolute transformation in the Ottoman mentality of adopting new scientific ship building methods and tools. In order to observe a change in the real sense, one would have to wait until the first half of the nineteenth century, when the first steam ships were introduced in the Ottoman world.

Ottoman archival resources are rich enough to give an idea of the sate of nautical technology of the era as well as of the innovations that were introduced and adopted. It is understood that nautical technology came to the Ottoman world (or produced within) with its *sui generis* terminology, which ranges from terms used to describe the various technical instruments and tools to constructions.

[114] BOA. CB, no. 1354.
[115] BOA. CB, no. 11292 (24 October 1801).

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