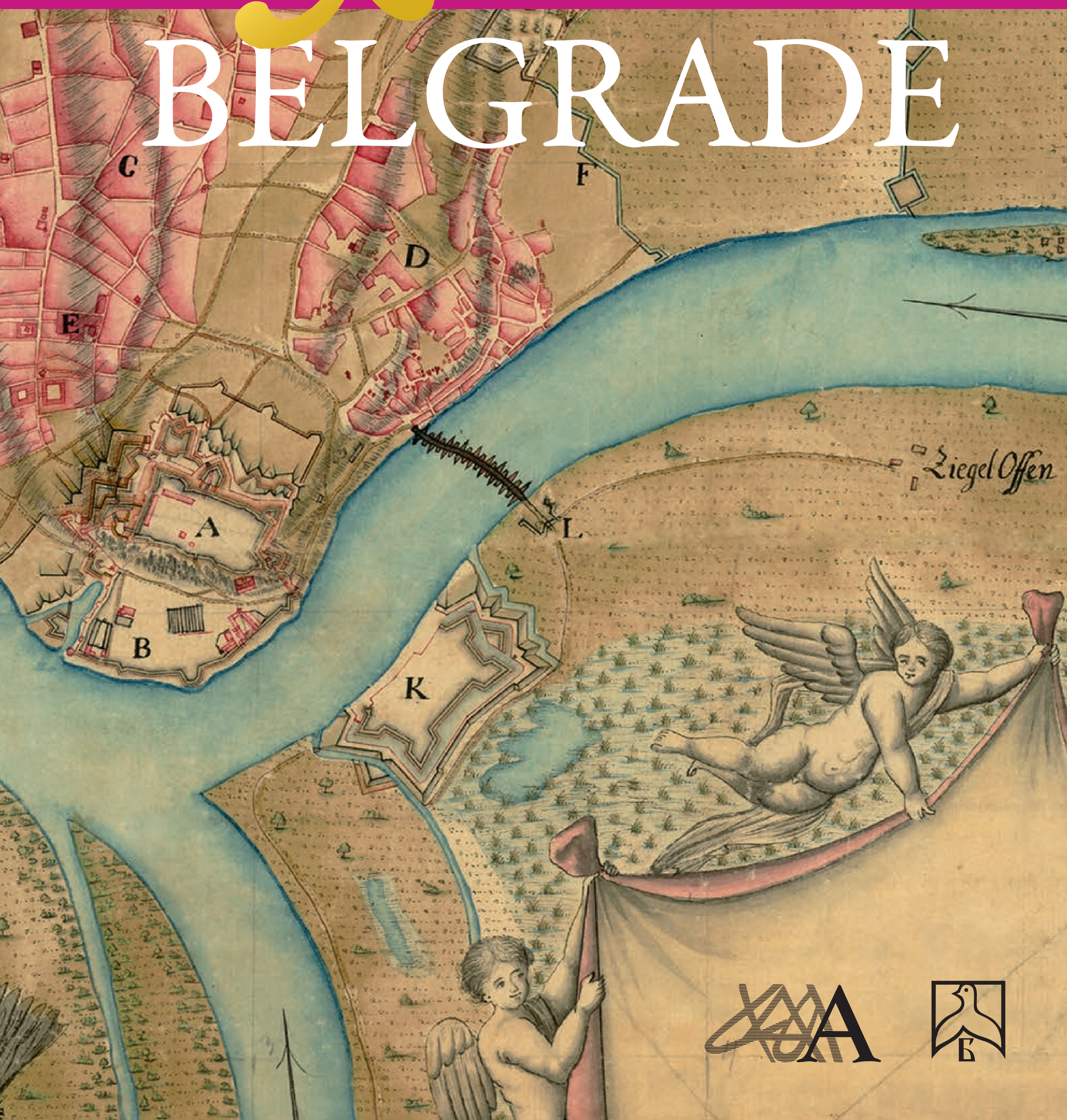
BAROQUE BELGRADE



BAROQUE BELGRADE

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BAROQUE BELGRADE

TRANSFORMATION 1717–1739

Belgrade 2019

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Contents

Foreword

THE RECEPTION OF THE BAROQUE HERITAGE IN BELGRADE IS A VERY intriguing question for the very fact that what has remained of it is extremely modest from the material viewpoint and concealed under layers of later building projects and spatial planning conceptions. For the few experts who research the different phenomena of Baroque culture and art in our country, this short-lived but extremely important period under Habsburg rule, at the beginning of the eighteenth century, represents a crucial step towards the creation of a modern Belgrade. It was a city in transformation, where the Oriental, mercantile *şehir* gave way to the European monumental Baroque in a large-scale reconstruction of its urban structure and buildings. The new shaping of space, designed according to the template of fortified Baroque cities, the pivot of which was the regular urban matrix with visual markers – monumental barracks, palaces and squares – was to convey the Habsburg Monarchy's cultural and political messages in the newly conquered territories, in other words, connect Belgrade to the Central European culture and idea of the Baroque.

In spite of unquestionable town planning and architectural evidence, some experts are cautious when using the term 'Baroque' with the city's name, because it is almost impossible to see 'the real' Baroque in the nature and tissue of Belgrade, perhaps more so because of the fact that it was a Baroque city in the making, commenced in a grandiose manner but never completed. In the estimation of the renowned professor, Pavle Vasić, in its day, 'the Baroque in Belgrade was rather uneven because the buildings ranged from outstanding examples of the Baroque style to stylistically almost expressionless structures, in which functionality was closer to the hearts of the architects than beauty, serving a practical military purpose rather than decorative splendour. The mixture of various elements, Baroque towers and the domes and minarets of mosques increased the disparities even more and, with Belgrade's outstanding location, contributed greatly to its picturesque appearance.' It is in the unique combination of the already existing and the new that the Baroque in the main Austrian frontier fortress facing the Turks reveals one of its many faces. Consequently, the research of Belgrade's cultural history under Austrian rule is a process full of challenges and constant re-examination.

On the path of learning about the Austrian Baroque in Belgrade, the direction of which was laid out by those who initiated the study of the Modern Age history of the city (Mihailo Valtrović, Teodor Stefanović Vilovski, Dragoljub Pavlović, Radoslav Grujić, Dušan Popović, Pavle Vasić, Rajko Veselinović, Radovan Samardžić, Željko Škalamera, and Marko Popović), valuable contributions have been made during the past few decades, but no comprehensive studies have been produced. The opportunity for a turnabout came with the systematic archaeological investigations, performed during 2008 and 2009 under the leadership of Marko Popović for the Institute of Archaeology's Scientific Research Project on the Belgrade Fortress, and carried out on the south-eastern rampart of the Upper Town, in the area of *Prolom*, a 'breach' in the rampart that occurred during German air raids in April 1941. Along with the discovery of a fortified structure with a subterranean vaulted chamber – the so called *blockhouse* – the investigations brought to light an extraordinarily important group of objects used by the Austrian army stationed in Belgrade between 1717 and 1739.

The extraordinary archaeological context provided not only the necessary stimulus to refocus the theme to research of the city's cultural history, but also an opportunity, by means of a comprehensive visualisation, to bring Belgrade closer to its Baroque appearance in the measure in which it was planned and partly realised in the early eighteenth century. A several-year programme of activities was planned with this purpose in the Institute of Archaeology, which in 2017 became the project under the heading 'Baroque Belgrade – the transformation of urban structures and everyday life (1717–1739)'. The result of the project, carried out by the Institute of Archaeology in partnership with the Belgrade City Museum, is this publication and the exhibition accompanied by a catalogue of a matching conception and content.

The present monograph is the product of an effort by a group of experts, specialists in the various aspects of the Baroque heritage in Belgrade and Serbia, viewed in the key of political history and social and cultural phenomena at the beginning of the Modern Age. The framework of the narrative of Baroque Belgrade, and its main protagonists, is laid out by Isidora Točanac Radović, introducing the reader to the volume and character of the transformation of the Ottoman urban settlement into an Austrian fortified city, according to the modern architectural principles of the European Baroque. Introducing the architectural transformation of the city during the period of Austrian rule is a study by Marko Popović, based on a highly detailed analysis of the original material, plans and projects, mainly from the holdings of the Vienna War Archives, and also on archaeological investigations he took part in or headed during his prolific career. The realisation of the project of Colonel Nicolas Doxat de Morez, which encompassed a thorough reconstruction of the fortress, as the heart of the defence system, and the fortified parts of the outer city with its institutions, can be clearly followed through the restitution plans of Belgrade before and after Austrian rule, produced especially for this occasion. Bringing Belgrade and the Austrian Kingdom of Serbia onto the European public scene through the metaphor of the 'war theatre' (*theatrum belli*) is the theme of the respective contributions by Vladimir Simić and Marija Marić Jerinić. Seen through the eyes of artists, copperplate engravers and medallists, Belgrade was the stage of the famed Austrian conquests (1688 and 1717) and its heroes, Prince Eugene of Savoy and Emperor Charles VI, but also a unique means of political propaganda. The theatricalisation of characters and settings, characteristic of the Baroque culture, referred to all the participants in the public life of Belgrade, such as representatives of the administration and the military, dignitaries of the Catholic Church, monastic orders and Orthodox Christian metropolitans. Ana Milošević deals with the self-representation of the dignitaries of the Metropolitanate of Belgrade and Karlovci, which was reflected both in public – in their apparel and behaviour – and in the appearance and furnishings of the Metropolitan's Residence, in keeping with the idea of *magnificenze* and the protocols of Baroque representation.

The architecture of Baroque Belgrade is a theme of three contributions. Marko Popović discusses the appearance and design solutions for the interior spaces of the oldest Baroque style buildings, such as the infantry barracks and the Main Guard (*Haubt Wacht*) building in the Upper Town of the Belgrade Fortress. Particular attention is paid to the already mentioned blockhouse. Besides the monumental fortifications with new gates – triumphal arches, and the rock-cut Big Gunpowder Magazine, the Great ('Roman') Well certainly represents one of the most significant and innovative engineering ventures, which was to contribute to the grandeur of the main fortress of the Habsburgs in the newly conquered regions. The text by Vladan Zdravković discusses the models followed by the builders of the Austrian well and sheds light on the achievements of Marshal Vauban's school of engineering.

Marina Pavlović deals with the urban concept and architectonic features of the space in the newly designed German Quarter. Besides the barracks of Prince Carl Alexander of Wurttemberg, the residential-military building which dominated the city, and the Masons' Barracks, erected for the needs of the engineering corps, the appearance of the German part of the city on the Danube-facing slope was enlivened by Waldfortner's house (subsequently the Bishop's Residence), the buildings of the Main Salt Storehouse, the Imperial Chamber's Brewery, a row of houses belonging to artisans and merchants – of which only one has survived to this day, at 10 Cara Dušana Street – the building known as the 'Black Eagle' tavern, sacral buildings, schools and hospitals.

Two contributions from the domain of material culture complete this book. The Europeanisation of Belgrade at the beginning of the eighteenth century is visible in the objects that its inhabitants used each day and on special occasions. In the judgement of Vesna Bikić, the accessibility of consumer goods, regardless of ethnic and social affiliation and financial status, made it possible for Belgrade not only to become part of the Habsburg Central Europe but also to adopt the (multi)cultural concept of a modern European city, into which it was supposed to be ultimately transformed. Josip Šarić discusses the development of light infantry weapons and the system of firing flintlock muskets from the perspective of making usable flints by chipping/flaking, a technology that originated in prehistory.

Each scientific undertaking is a joint effort, and this one has been finished thanks to the support and assistance of colleagues and friends. Over time, in the 'Soldiers' Kitchen' in the Lower Town of the Belgrade Fortress, a division of the Institute of Archaeology that houses the documentation centre of the scientific research project on the Belgrade Fortress, a dynamic atmosphere of study and dialogue was created, to which Marko Popović gave his unique imprint in the course of the decades. His dedicated, inexhaustible spirit of research was also built into this book in many ways.

Stefan Pop-Lazić, Uglješa Vojvodić and Vladan Vidosavljević contributed to the illustrated part of the book. Bojan Kovačević introduced us at the appropriate moment to Tihomir Dičić who enriched the book with technical drawings and reconstructions of buildings. Besides the Belgrade City Museum, other cultural institutions supported the project and this publication by providing illustrative material and objects from their collections, for which we owe them a debt of gratitude.

We are also grateful to the institutions that enabled the realisation of the several year long research of the Modern Age history of Belgrade and this publication. They are the Secretariat for Culture of the Belgrade City Assembly, the Ministry of Culture and Information and the Ministry of Education, Science and Technological Development. The Deloitte d.o.o. Belgrade company and its general manager, Mr Miloš Macura, also gave us much needed support at a crucial point.

We hope that, thanks to these contributions, the spaces and spirit of Baroque Belgrade, the way they were conceived at the Habsburg Court and created in the twenty-odd years of Austrian rule of the city, will become clearer, more palpable and appreciated than until now.

The Editor

MIROVA
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STEINMETZHÜTTEN
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D. RAITZEN STADT
E. GOUVERNEMENT
F. LINIE WORMIT DIE ZWEY STÄDTE EIN= GESCHLOSSEN
G. NEU ANGELEGTE REDOUTE
H. NEU ANGELEGTES CRONWERCK
I. TÜRKISCHE SCHANTZ IN DER DONAU INSUL
K. NEU ANGELEGTES HORNWERCK
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ZU BEFÖRDERUNG UND AUFKOME DES KÖNIG REICHS SERVIEN
auf befehl Einer Hochlöb: Kayserl: Administration Zu Bellgrad durch Veranstaltung des
Haubtmans Ammans Vermittelst der allda anwesenden Jüngen Mathematicor:
als Andr: Zernitz, Fridrich Moltan v: Frantz Keyser
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Türkische Approchen

TURCKISCHE APPROCHEN
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HOHES GERICHT
HOSPITAL
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KLEINER THIER GARTEN
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GALLEEN FLEISCH HACKERS MEYER HOFF
HERRN INSPECTOR VON TEKLINOSKRONG MEYER HOFF
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Rohr und Morast - 1652½ Joch
Wald - 5381 Joch
Busch - 1804½ Joch
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Vladan Zdravković

The Great Military ('Roman') Well in the Belgrade Fortress

As an all-comprehensive branch of military science, fortification design in the time of Marshal Vauban (1633–1707) included not only a study of new military strategies and construction technologies necessary for the erection of military installations, but also a close study of logistics related to accommodating troops and supplying them with food, materiel and safe drinking water on a regular basis, as well as to accommodating and feeding animals, removing manure, etc. This simultaneous study of the above aspects is very similar to the practices of twentieth-century schools of engineering design, which only goes to prove how rapid the development of military engineering in the sixteenth and seventeenth centuries was, particularly in view of the fact that this branch of engineering had been neglected for a long period. In that context, the water supply systems introduced in West European fortresses in the seventeenth century represented the main logistic resource without which long-term defence of a fort or fortified settlement would have been impossible. The majority of these systems involved construction of hydrotechnical structures with all the accompanying installations, most notably cisterns and wells. Concurrently with the beginning of the development of the new fortification system, much attention was given to the design of high-capacity water supply facilities. The reason why there was this increased need for water lay in the fact that there was also an increase in the number of soldiers in standing armies and consequently in the number of their garrisons and regiments.

Wells also witnessed some improvements in digging and masonry techniques as well as in their accessibility. Some of the best examples are related to designs produced by Marshal Vauban and the designers of cisterns and wells in France under his command. The Great Well in the Belgrade Fortress (Fig. 48) was designed in 1720, that is, after the time of Marshal Vauban and the wars in Western Europe in the seventeenth century, but did not emulate the so-called *Grand puits* (castle wells). Thus the castle well in Belgrade did not follow the traditional line of development of this military utility, but rather represented an attempt to introduce this important fortress feature into Austrian bastioned fortresses as superior to its predecessors because its hydrotechnical instal-

Fig. 48. Entrance structure of the Great ('Roman') Well in the Belgrade Fortress
(PE Belgrade Fortress)

lation incorporated a number of novel solutions and did indeed play its part well in the overall military system of the Belgrade Fortress in the early eighteenth century.

Rational warfare

A first theoretical articulation of the role of the military engineer, which served as a model followed when national military schools were being established, was succinctly expounded in articles on mechanic arts in Diderot and d'Alembert's *Encyclopédie*, compiled in the early eighteenth century. According to this famous work, engineers are classified into three main types: one for warfare, specialising in the knowledge of attacking and defending military positions; one for the sea, specialising in the knowledge of naval construction; and one for civil work, that is the building of roads, bridges and water works.[1]

The vast number of fortification structures erected in France during the reign of Louis XIV by Marshal Vauban served as the main theoretical and practical foundation for the establishment of military engineering *grandes écoles* (great schools). Schools for training military officers, including military engineers, existed as private institutions before the establishment of state-run great schools. However, these were mostly restricted to instructing members of the aristocracy and, as a rule, had a limited syllabus. Already in the early sixteenth

[1] Diderot et al., *Encyclopédie*. As the oldest organised and bureaucratised engineering institution, L'Ecole des Constructeurs de Vaisseaux, founded in Nantes in 1672, aimed to train naval engineers.

century, the Habsburgs commissioned prominent Italian military engineers to fortify Austria's major cities.

The Holy League succeeded for the first time to make an inroad into Ottoman Serbia by briefly conquering Belgrade in 1688, where it also tried to modernise the existing medieval and Turkish fortifications.[2] Following the next Austrian conquest of Belgrade, by Eugene of Savoy in 1717, the fortress was refortified in accordance with the principles set by Marshal Vauban. Most of the fortifications previously erected by Cornaro were demolished, even though the existing medieval ramparts were retained wherever it was possible.[3] As many as ten years before the Austrians conquered the city, Eugene of Savoy complained of the dire shortage of capable military engineers and the nonexistence of a well organised engineering corps. In a letter to the emperor of 1710, he states: 'I do not have a single engineer who knows how to build a proper fortress. The engineers have either been broken by misery and hardship, or they have deserted in order to avoid their imminent ruin. That is why we have been unable to fulfill our project of setting up an engineering corps and a school of military architecture of the sort on which all the other princes lavish so much money.'[4] Several years passed before not only a competent military engineer but also design projects befitting the military doctrine of the Habsburgs in the part of Serbia under their control were found.[5] By 1720, when Alexander of Württemberg became governor of Belgrade and Serbia, projects drawn up by Colonel de Boeff and his successor at the post of chief fortress engineer, Major Nicolas Suly, had started being implemented. During the implementation of Major Suly's project, several major engineering undertakings were completed, such as the construction of the Big Gunpowder Magazine in the Lower Town, a rock-cut structure built in only three years (1718–1721).[6] The sinking of the Great Well in the Upper Town probably began at approximately the same time. Austrian diplomat and travel writer Gerhard Cornelius von den Driesch expressly states that the well in the Upper Town had already been completed, but the well is not shown on the detailed plan produced by Captain Amman in 1722. The well is next mentioned as late as 1731, when a water drawing system was installed.[7] The construction of the Great Well (*Der Grosse Brunn*) was an important infrastructure project, as complex as the Big Gunpowder Magazine (*Großes Pulver Magazin*), because both are subterranean structures. It is very likely that, in view of what had happened during the attacks on the Turkish fortress in 1717, when most of the buildings in the Lower Town were devastated in the explosion of the Turkish gunpowder magazine, Major Suly, together with Colonel de Boeff, addressed the very sensitive issue of gunpowder storage. For this reason, they opted for the safest, albeit most expensive solution, which involved building two rock-cut chambers of the gunpowder magazine at the foot of the limestone cliff in the Lower Town. The inspiration for the construction of the Great Well, a likewise exceptional and innovative engineering feat, came from several quarters.

[2] Поповић М., *Београдска тврђава* (друго допуњено издање), 183–188.

[3] Ibid., 226–248.

[4] Duffy, *The Fortress in the Age of Vauban and Frederick the Great*, 25.

[5] Поповић М., *Београдска тврђава* (друго допуњено издање), 211–226

[6] Ibid., 262.

[7] Idem, *Велики бунар Београдске тврђаве*, 31–37.

[8] A century later (1746), in the reports on the condition of the Longwy Fortress, immediately after the one on the inspection of the fortifications, there is a report on the condition and yield of the wells and cisterns. Langins, *Conserving the Enlightenment*, 152–153.

Military engineering and hydraulics

The French model of training military engineers involved studying and mastering the knowledge of defensive fortifications and the skill of laying effective sieges to cities and fortresses. The curriculum did not comprise the study of hydrotechnical engineering and, for this reason, the designs for water works and sanitation systems were normally produced by civil engineers. During the construction of one of the most successful bastioned traces at Longwy (*Fortification de Longvuic*), when Vauban submitted a memorandum with a bill of quantities and a detailed estimate of expenses relative to fortification works together with a design project for the sanitation system and latrines next to the barracks, he proposed that two good master stonecutters (*appareilleurs*) and a specialist in water supply (*fontainier*) should come from Paris.[8] The latter quite certainly had to do with the establishment of a unit that would be charged with constructing the famous wells at Longwy, of which the so-called Siege Well (*Le puits de siège*) (Fig. 49) was a public well supplying the civilians in the city. This testifies to well advanced standardisation of bill of quantities

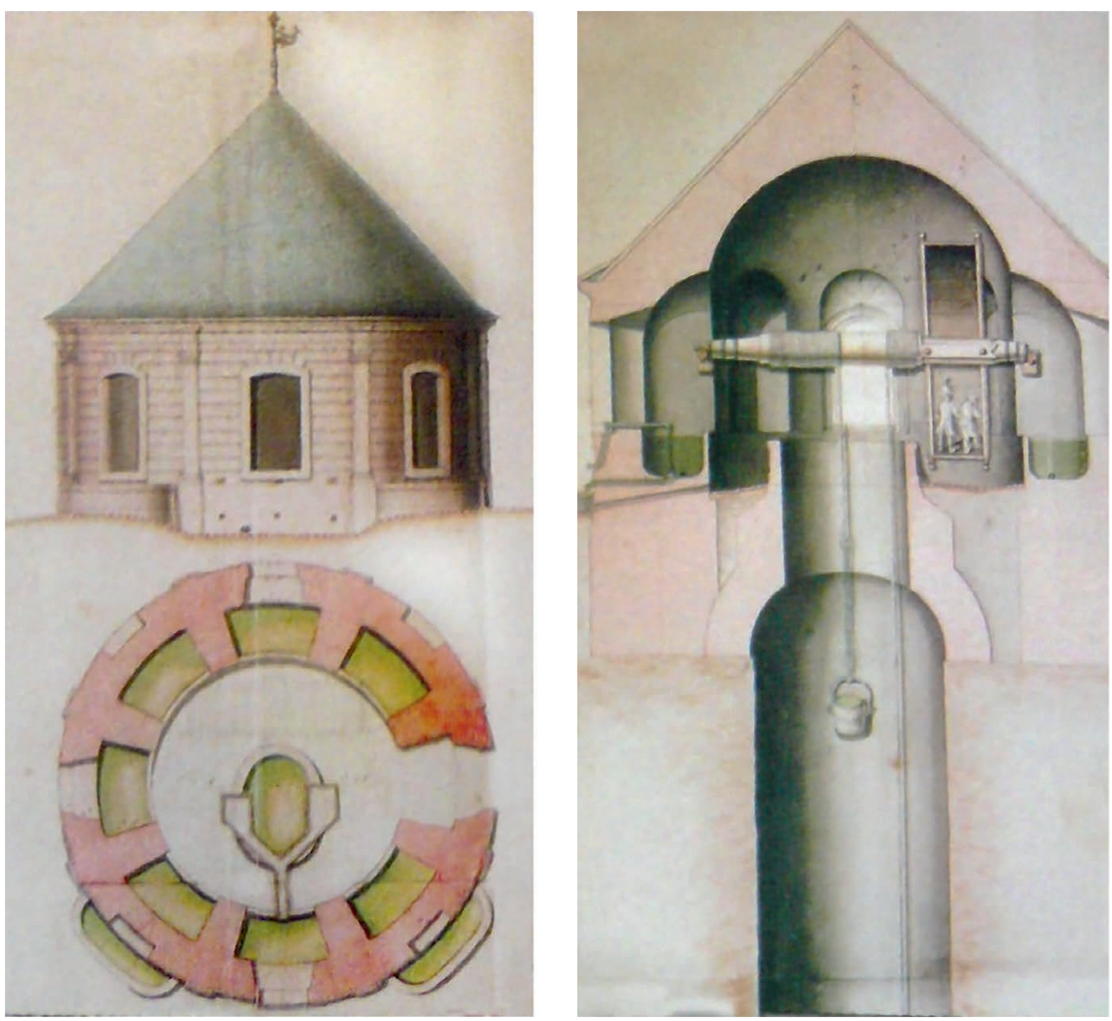

Fig. 49. Vauban's Siege Well (*Puits de Siège*) in the *Place d'Armes* at Longwy – plan, external elevation and cross-section (http://www.mairie-herserange.fr/mes-loisirs/culture/office-de-tourisme-du-pays-de-longwy/)

items relative to planning and building water intake structures.

Vauban's ingenious water supply system applied at Longwy involved transporting water from distant springs at the foot of the plateau on which the fortified city stood through covered channels running from the springs through the rock mass. The shafts of the five wells, each intended for a different group of users, accessed the channels around 60 metres below the city pavement.[9] Easily recognisable in this concept is the old water supply system called *qanat*, which spread to Europe from the Middle East through the water supply systems used in the cities of the medieval Umayyad Caliphate in Spain.[10] Vauban's solution at Longwy represents an improvement of the *qanat* system used in medieval Siena, where regular shortages of potable water were all but eliminated owing to a system of water channels, known locally as *botini*.[11] Vertical air ducts and well shafts complemented this system, which, by its structural features, belongs more to medieval *qanats* than to Roman aqueducts. The majority of fortress wells in France and Germany conceptually belong among traditional medieval water supply facilities, some of which were greatly improved, particularly those in several of Vauban's fortresses (Besançon, Longwy, Luxembourg, Fort de Joux).[12] Wells in medieval German castles were over 150 metres deep, but in the context of new warfare technologies, such deep wells were less impressive compared to those that allowed for efficient drawing of sufficient quantities of fresh and unpolluted water.

In order to ensure strategic quantities of water, cisterns were built as well to catch rainwater and melted snow. In peacetime, they were used to water animals, for washing and personal hygiene. River water was used for drinking only in wartime if there was no other permanent supply of fresh water. Therefore, construction of a well was also undertaken in the Belgrade Fortress in order to provide the defenders of the Upper Town with fresh water in full siege conditions and in case of a breakdown of the existing city water supply system. Namely, the former water supply system in the Turkish settlement was repaired in the course of the major Austrian reconstruction of Belgrade and the well known water supply line running from Terazije to the Sokollu Mehmed Pasha's drinking fountain was quickly operational again.[13] In addition to this branch, which transported water under the Great Ravelin and the Sahat Gate to the tank of Mehmed Pasha's drinking fountain, there was also the Holy Spring (of Saint Paraskevi) in the eastern suburb, which was used even more, perhaps for cultic purposes, as Driesch, in his travelogue of 1720, reports on the great popularity of the water from this spring among the citizenry.[14] Besides these two sources of potable water, the latter also being of insufficient yield, which made the water supply system vulnerable during sieges, there was no other option for the Upper Town to be supplied with satisfactory quantities of water but to excavate a deep well and build cisterns to catch rainwater. Regarding the latter, the fact that no cistern was ever built has its justification in the fact that the city is embraced by two big rivers, whose water could be used as technical water, very much like rainwater.

[9] The best known Longwy well, the so-called 'Siege Well' (*Le puits du siège*), took eleven years to build (1679–1690) and its purpose was to supply the civilians in this garrison city with water. It was 58.5 m deep and fed with water from a spring in the Marchand Forest (*Fontaine du Bois de la Marchande*). Courbon, *DE CORDES-SUR-CIEL (Tarn) A KYFFHAUSER (Thuringe)*, 5.

[10] Kucher, *The Water Supply System of Siena*, 48–58.

[11] Pulselli et al., *An emergy evaluation of a medieval water management system*.

[12] Courbon, *DE CORDES-SUR-CIEL (Tarn) A KYFFHAUSER (Thuringe)*, 6.

[13] Ćorović, Blagojević, *Water, Society and Urbanization in the 19th Century Belgrade*, 53–59.

[14] Милошевић, Крајновић, Вацић, *Како су се лечили београдски митрополити*, 435–447, нап. 16.

The decision to sink a fortress well of great depth may have been made because there was the spring in the eastern suburb indicating presence of water on the rocky Belgrade promontory. However, everything points to the fact that the author of the design for the Great Well wished to furnish the new Baroque-style fortress with an innovative and prestigious hydrotechnical resource that, along with other engineering feats, such as the Big Gunpowder Magazine and the magnificent bastioned traces, would spread the fame of the grandiosity of a Habsburg fortress throughout Europe. All the more so, because, seen in isolation, the fortress well did not have to be an organic part of the fortifications, that is, it could have been conceived and designed as a totally separate facility.

The Great Well in the Upper Town of the Belgrade Fortress – the origin of the concept

It does not suffice to say that the Great Well was just another fortress facility. This water intake structure was initially conceived as a narrow and very deep fortress garrison (rather than public) well, with spiral brick staircases in a double helix. The intended purpose of the well was to draw water from a presumed spring located at a great depth inside the rocky Belgrade (Kalemegdan) promontory without installing any water drawing mechanism or supplying any eventual system of conduits in the Upper Town with water. Given that this was to be a garrison well, water was to be drawn by men at regular intervals and as need arose. In all likelihood, the sinking of the well was approached with great self-assuredness, without drilling any test bores that would prove the presence of water in the rock mass of the *Tašmajdan Miocene shelf*. This is evident from the choice of the site of the Great Well, in the best sheltered part of the Upper Town, well protected from bombardment by bastioned ramparts. Besides, its entrance is several metres lower than the Upper Town plateau, as it is situated in the former moat of Despot Stefan Lazarević's castle. Another hydrotechnical facility, the Sokollu Mehmed Pasha's drinking fountain,[15] was also built in the same moat, in its eastern part, because there the low invert level of the medieval moat suited the gravity flow necessary for transporting water through the Terazije aqueduct.

Structurally, the Well consists of three parts: a subterranean entrance with a strong roof structure as protection against bombardment; an upper, wider well shaft with spiral stairwells; and a lower, narrower cylindrical reservoir (Fig. 50). Variants of the structural elements used in the construction of the Great Well were utilised in the construction of a small number of big wells and edifices in Europe. The origin of the concept of deep fortress wells with a spiral staircase that provide access to water at great depths dates from no earlier than the High Middle Ages. The first and oldest such well was sunk outside Europe, in the Cairo Citadel of Sultan Salah ad-Din (r. 1169–1193), the famous *Bir Yusuf* (also known as 'Well of Joseph' or 'Saladin's Well'), as part of large-scale fortification work and construction of the new Cairo fortress, which began in 1176.[16] It was followed by two deep wells in Italy, the more famous one being at Orvieto *(Pozzo di San Patrizio),* sunk between 1527 and 1537, and the somewhat later one at Turin, called *Cisternone* (*Il Pozzo Grande della Cittadella di Torino*), excavated in the centre of the Turin Citadel in 1565–1567.[17] Saladin's Well, a masterpiece of Islamic hydraulic engineering, must have made a strong impression on his contemporaries. The reason why we do not encounter more such structures in Moslem

[15] Поповић, М., *Чесма Мехмед-йаше Соколовића*, 71–83.

[16] Lyster, *The Citadel of Cairo*, 5–7.

[17] Bearzi, Bearzi, *Architettura degli impianti*, 93.

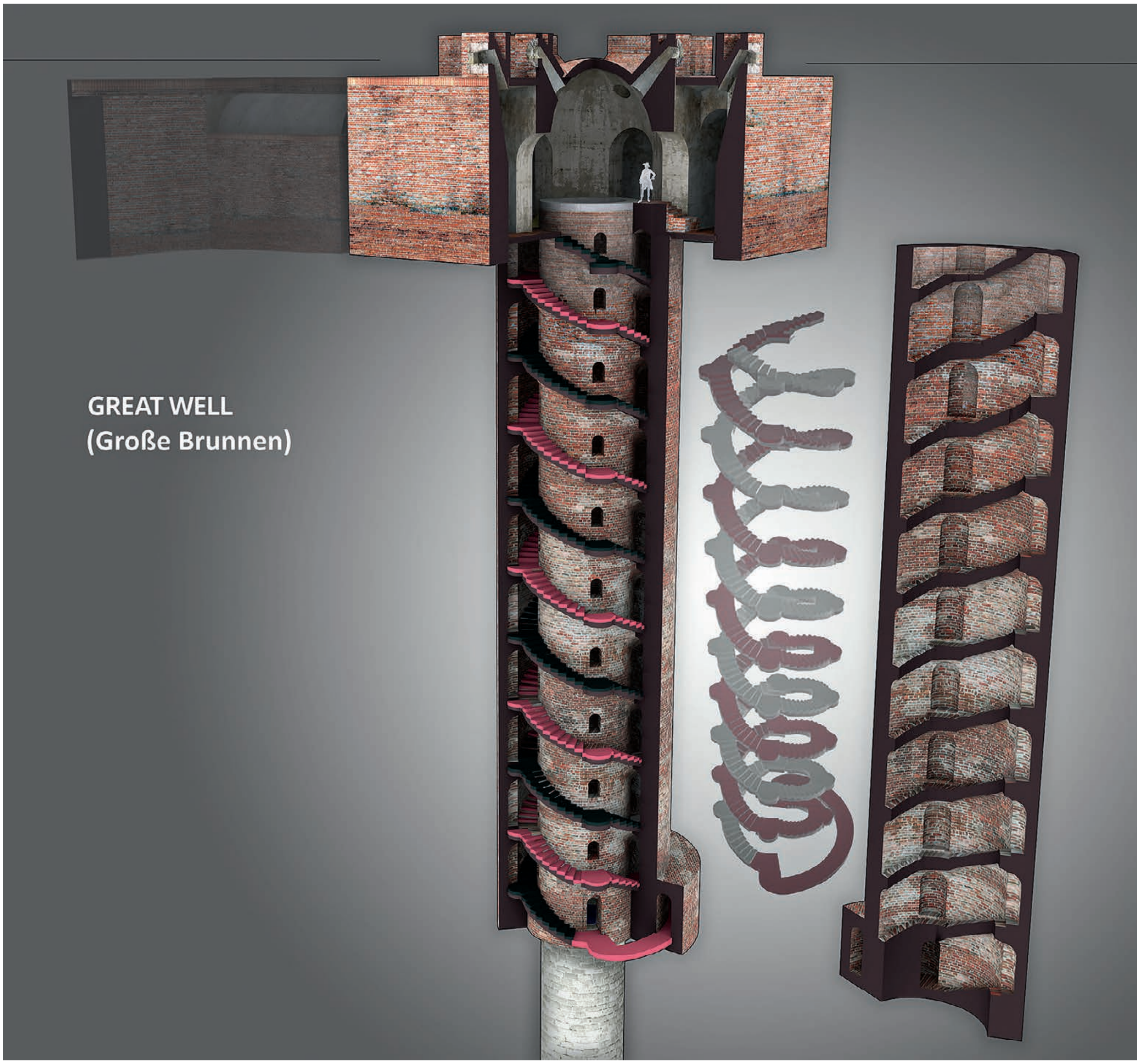

Fig. 50. Cross-section of the Great Well in the Belgrade Fortress
(author: architect Vladan Zdravković, 2019)

cities and very few of them in Europe at a much later date does not lie so much in the complexity of the enterprise and the utilised water drawing technology, but rather in the rarity of such a topographical and hydrological site as the one at the Muqattam Hills, on one of whose promontories the Cairo Citadel was erected. Likewise, siting a fresh water spring of sufficient yield to justify the huge effort involved in deep excavation through rock masses has always been a big challenge and, for this reason, it was not uncommon to complement low-yield wells with additional accumulation surfaces.

Of the four said deep wells, which constitute a unique type of well, it is the oldest among them, Saladin's Well in Cairo, that is superior in almost every respect – from the quality of excavation work and the design of the entrance, to the efficient but simple water drawing

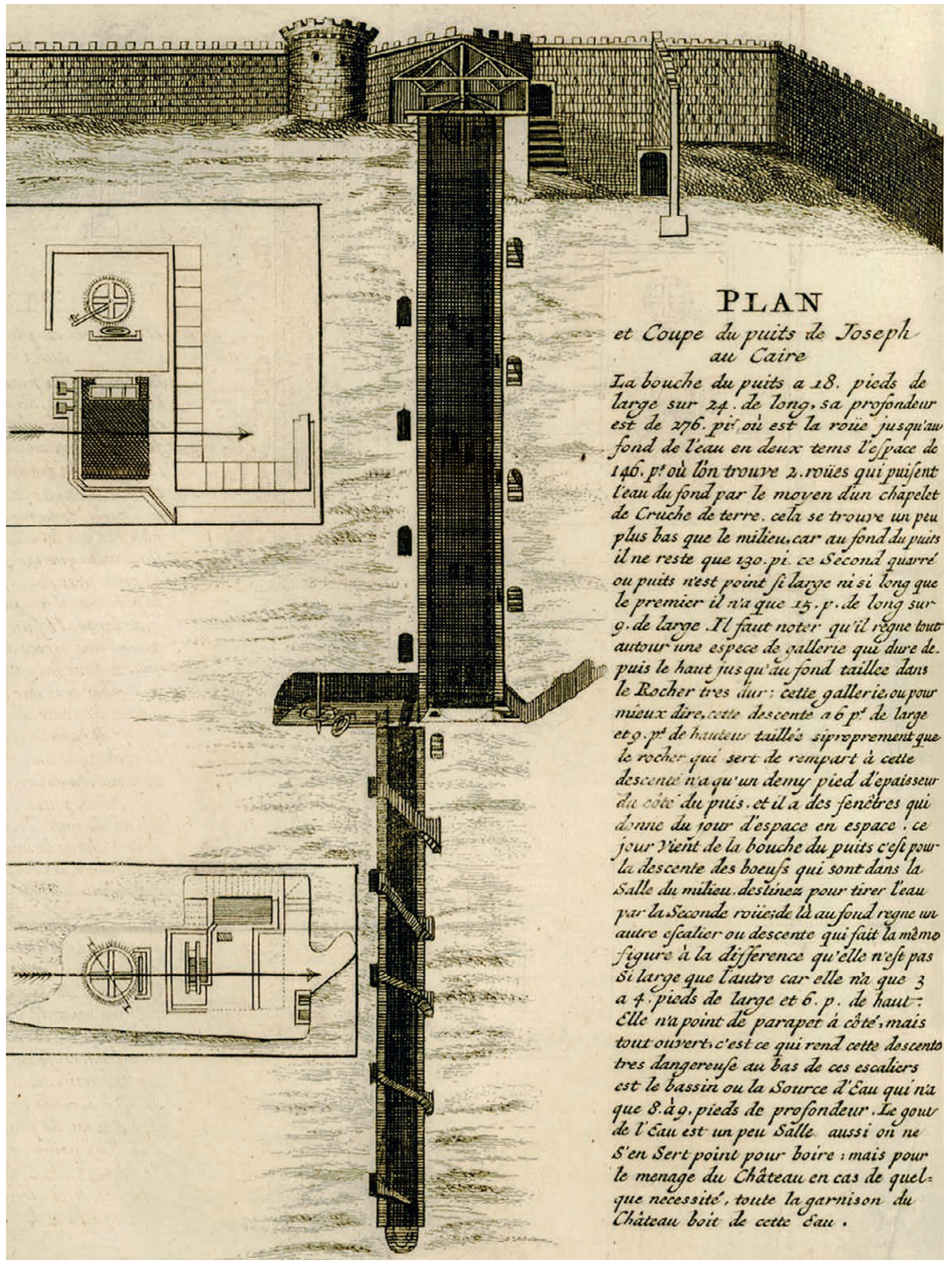

Fig. 51. Paul Lucas, Drawing of the Well of Joseph (*Bir Yusuf*) in Saladin's fortress in Cairo, 1720 (http://eng.travelogues.gr/item.php?view=45384)

method, to the connection of the well to the irrigation system in the citadel. The management of fresh water in semi-desert conditions of the Nile Delta and the region of Mayrut was constantly being improved throughout Antiquity until it received its final form. This was primarily achieved by combining several technical elements in a single mechanism, such as that utilised in the ancient castella wells in the greater area of Alexandria, which combined ancient *sakîyas* – water wheels and *noria*, mounted on wells, and reservoirs for producing gravity flow necessary for transporting water, mostly to public baths. [18] *Sakîyas* and

[18] Better conceived mechanisms featured *norias* – large-diameter wheels driven by ox-powered *saqîyas*, the same as in *Der Große Doppelbad* castellum and the palace at Abu Mena. Plans 37, 38 and 39: Oleson, Greek *and Roman Mechanical Water-Lifting Devices*.

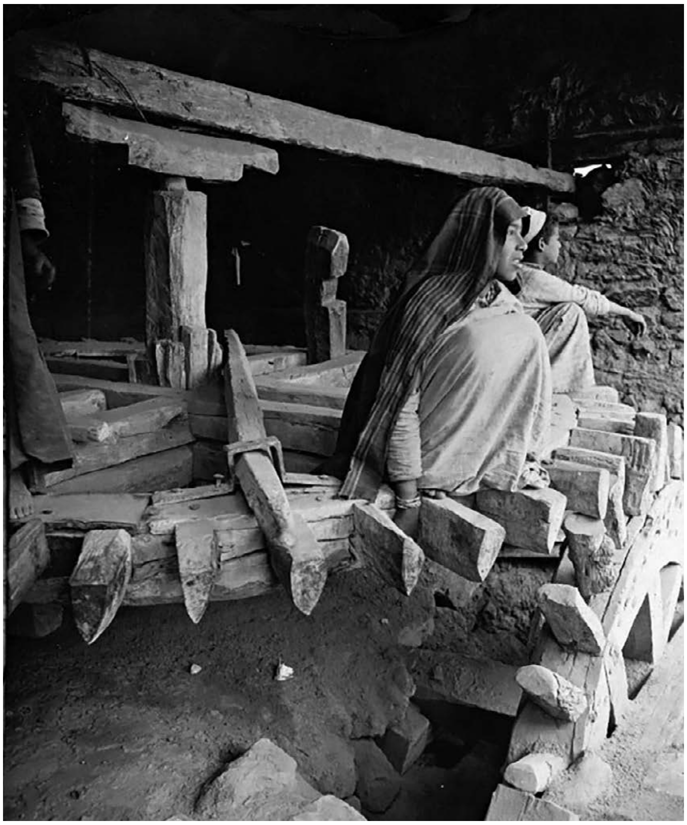

Fig. 52. Horizontal wheel of a *sakîya* at Saladin's Well (*Bir Yusuf*) in the Cairo Citadel (University of California, Keystone Collection; UC Riverside, California Museum of Photography, https://calisphere.org/item/ark:/13030/kt8489r2b0/)

wells with cisterns are the main methods of obtaining supplies of water in the area of Lake Mareotis and it is, therefore, not surprising that as many as two *sakîyas*, driven by two teams of three oxen each, were mounted on Saladin's Well (Fig. 51). The lower *sakîya* was mounted approximately halfway down the well, which is 87 metres deep, and this lower unit drew water with a closed set of pots that emptied into a reservoir at the same level where oxen turned the wheel of the *sakîya*. The *sakîya* at the top of the well drew the water from the reservoir in the same manner and emptied into the fortress aqueducts (Fig. 52). The wider spiral staircase allowed for bringing oxen to the lower *sakîya*, whereas the narrower, also spiral staircase provided access to the water itself.[19] However, this undertaking did not go without surprises at the very end, either, as the water was brackish, which required the installation of water wheels of the *noria* type on the banks of the Nile to transport water from the river to the system of aqueducts, whereas the well served as a source of water of inferior quality in times of crises.[20]

Three and a half centuries later, Antonio da Sangallo the Younger of Florence built a large public well in the city on the rock, Orvieto, in the course of ten years (Fig. 53). News of Saladin's well must have circulated among Christians in the west of medieval Europe rather early, even though Europeans had had no access to the Citadel until at least the sixteenth century.[21] It was certainly much earlier than the renowned reports on Cairo by Pellegrino Brocardo that the Cairo well, into which oxen were led, was known in Italy, but it is uncertain how Renaissance innovators understood this information, as neither Orvieto or Turin wells featured any kind of mechanical device that would replace manual labour and make drawing water more efficient.

Da Sangallo decided to build a large public well in Orvieto after he had completed the restoration of *Pozzo della Cava*, an ancient well in another part of the city. Because of its low yield and poor accessibility, the latter well

[19] The spiral stairway that enveloped the rectangular shaft along its entire height inspired the well's other name, *Bir Al-Halazun* – the well of the snail or spiral well; cf. Lyster, *The Citadel of Cairo*, 6.

[20] That the Cairo Well was built by Arab engineers was long dismissed in the West by claims that it was actually built during Antiquity. See Brewster, *The Edinburgh Encyclopaedia*, 213–214.

[21] The first news of the well may have come from the Spanish travel writer Ibn Jubayr, who reported in 1183 on 'countless captive Crusaders' digging a ditch around the Citadel, but also in later reports, such as the travelogue of Pellegrino Brocardo, who went on a pilgrimage to the Holy Land by way of Egypt in 1556. Micara, *Alexandria, Egypt*, 271–276.

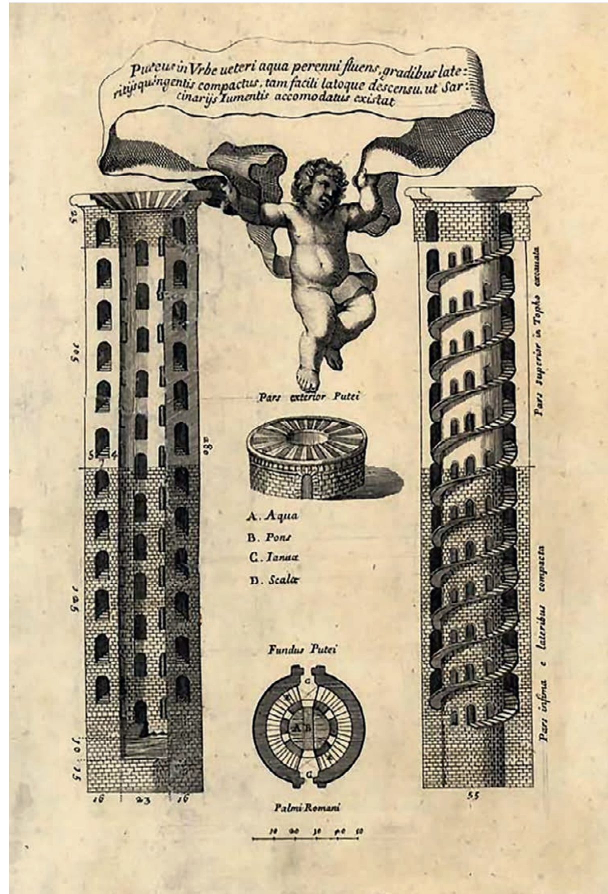

Fig. 53. Fortress well in Orvieto – view towards the water at the bottom of the dry shaft surrounded by spiral staircases
(http://www.inorvieto.it/pozzo-di-san-patrizio/)

Fig. 54. Filippo Bonanni, External elevation and cross-section of the fortress well in Orvieto, 1699
(*Orvieto*, 42–43)

was not a reliable source of water for the citizens in times of crisis. The sinking of the cylindrical shaft of the 'Fortress Well' (the first name of da Sangallo's well is *Pozzo della Rocca*), with a base diameter of 13 metres and around 54 metres deep, in the rock mass mostly composed of soft tuff, began only after conducting hydrogeological tests in order to find a site where it would be possible to reach the layer of clay with a water vein.[22] Two spiral ramps in a double helix provided access for beasts of burden that carried the water that had been drawn and transported it throughout the city (Fig. 54).

Sangallo's concept is in every respect medieval but efficient in the sense that it met Orvieto's needs for water and safety of its citizens in case of siege. The structure over the entrance of the well, called *bocca*, was left open to the sky, allowing for rainwater collection in the reservoir and also for natural light to reach the bottom sections of the shaft. The double

[22] Riccetti, *Antonio da Sangallo il Giovane in Orvieto*, 76–85.

helix ramps allowed for unobstructed descent and ascent. The access to the water for manual drawing is totally medieval and reminiscent of the well known city fountains and horse-watering basins (*fonti* and *guazzatoi*) of medieval Siena,[23] the covered pools of water whose utilisation was governed by strict regulations.

Thirty years after the building of Sangallo's well, military engineer Francesco Paciotto of Urbino, applied the same concept to building a well in the Turin Citadel that was a little more advanced and exclusively military in character. He built it at the behest of Emmanuel Philibert, Duke of Savoy, who moved the capital of his duchy to Turin in 1559. The shaft of this well/cistern (Fig. 55) is a little wider than that in Orvieto (11.3 m in diameter and 22 m deep) and surrounded by more comfortable ramps intended for bringing teams of horses to the water and leading them out by the other helical ramp.[24] The two-storey structure over the *bocca* of the well is open to the sky, allowing for rainwater collection.

The imposing entrance structure, whose rooms were used for storing military materiel, was the target of artillery fire during all sieges of Turin, and was, therefore, damaged many times, even though it sustained the severest damage, as did the Citadel, in the explosion of 78 tonnes of gunpowder in 1698. It was expo-

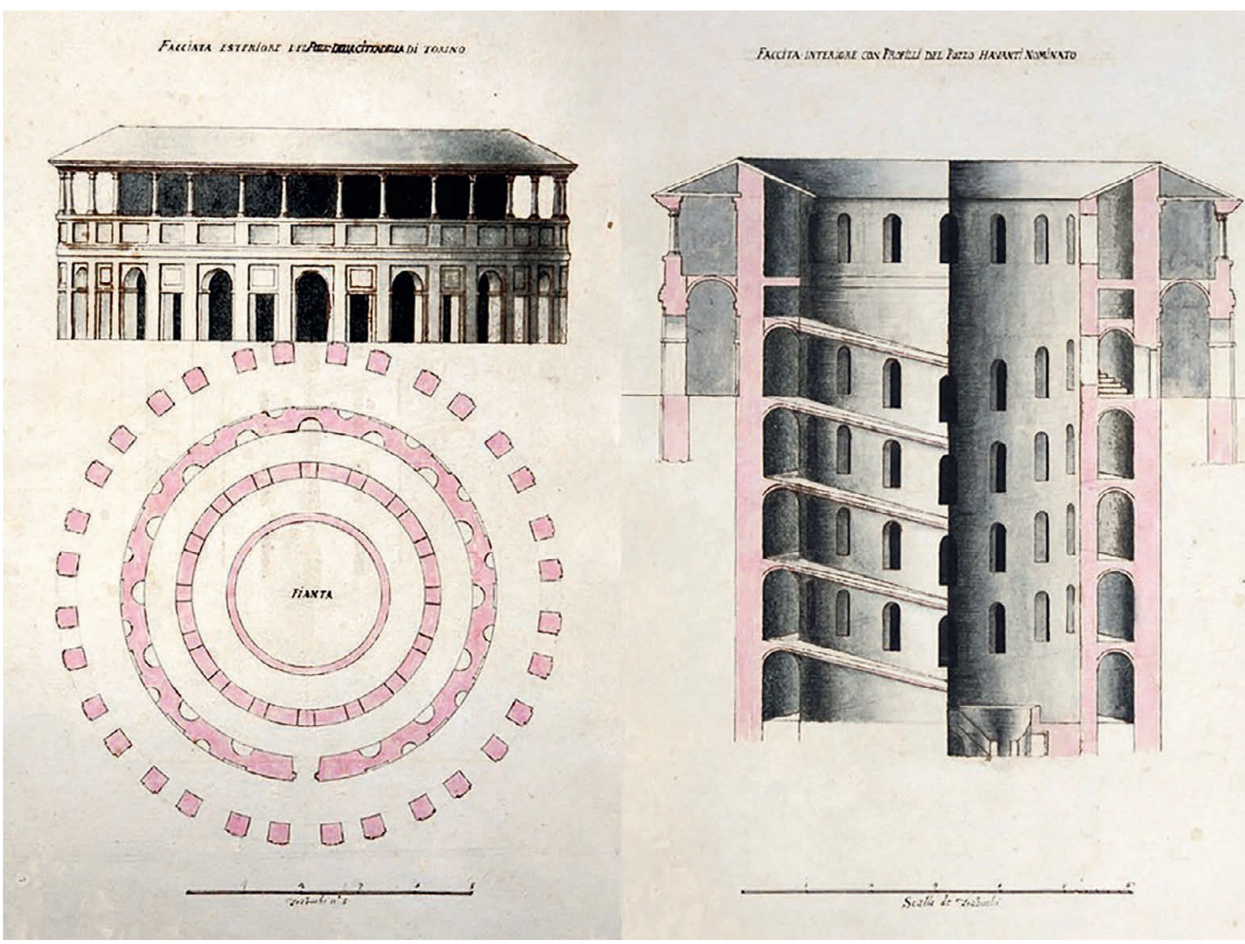

Fig. 55. Morello, External elevations of the fortress well in Turin (*Pozzo Grande della Cittadella)*
(Istituto Storico e di Cultura dell'Arma del Genio di Roma, BB.ICO.951/D.8858,
http://www.museotorino.it/view/s/ca7f360517df46928fdaa89895a8fc36)

sed to bombardment because it was in the centre of the *Piazza d'Armi*, the very heart of the Citadel, whose architecture followed the principle of geometrical symmetry of a star-shaped citadel rather than military doctrine. Because it was an easy target, and also failed to provide any protection for the well, the entrance structure was not restored after the siege of 1706.[25]

Unlike the Italian Renaissance wells with ramps, Marshal Vauban viewed wells as unavoidable resource structures that are part of a larger, well-conceived water supply system in bastioned fortresses and fortified cities of the seventeenth century. He did not start a technological revolution in the utilisation of wells, but each of the wells built by Vauban's *fontainiers* following his water supply design projects were designed rationally, and in some cases, such as Longwy, even ingeniously. The so-called 'Siege Well' in Longwy (1679–1690), even though it was built, following the Renaissance custom, in the very heart of the ramparted city, that is, in the centre of the *Place d'Armes*, the same as the *Cisternone* in Turin, it was uncommonly well protected from bombardment by a closed, circular entrance structure. This veritable bunker over the well (with 2.55 m thick walls) withstood all artillery attacks, including heavy bombardments in both World Wars.

Traditionally, as in the case of most other large wells in France, water was drawn by manual labour utilising large treadwheels called 'squirrel cages' (*cage d'écureuil*) (Fig. 49), within which one or two well attendants would wind a rope by treading and thus raise buckets filled with water from great depths (at Longwy from a depth of as much as 60 metres). Other attendants would then take the buckets and empty them into innner troughs or pools, which were radially positioned around the well shaft, whence water was transported by pipes to the taps on the outside of the entrance structure. Thus, not even at Longwy was human power replaced by a more advanced system of drawing water. Overall, however, the water supply system had been ingeniously conceived, as fresh water was transported by underground conduits and the protective entrance structure over the well was exceptionally sturdy.

Der Große Brunnen in the Belgrade Fortress

The creator of the design for the Great Well in the Belgrade Fortress, built in the early eighteenth century, must have been well acquainted with the abovementioned large fortress wells and sinking techniques. It is evident from the very concept of the Great Well in the Upper Town of the Belgrade Fortress that the design also met safety requirements, because a sturdy protective structure was erected over the entrance to the well, a feature evidently borrowed from Vauban's comprehensive military doctrine and the Longwy well (Fig. 56). Well sinking techniques were not substantially different from country to country. They primarily depended on the terrain and the geology of the ground in which

[23] The design of the large well in Orvieto was commissioned by Pope Clement VII at the time when he had fled Rome and took shelter in Orvieto in 1527. The design and early works can by all means be attributed to Sangallo, but the well was completed only as late as 1543, during the papacy of Pope Paul III and under the supervision of Florentine architects and sculptors Giovanni Battista da Cortona and Simone Mosca. Ray, *Seven Partly Underground Rooms and Buildings*, 19.

[24] The referential plans of the Turin well (*Pozzo Grande della Cittadella*) are the engravings by Michelangelo Morello in *Theatrum Statuum Regiae Celsitudinis Sabaudiae Ducis*, I, Amstelodami, Blaeu, 1682. Collezione Simeom, N 1) integrated into Manzo, Peirone, *I GIORNI DELL'ASSEDIO*, 6; changes to the plan are recorded by the same author in Michel Angelo Morello, Facciata esteriore del Pozzo della Cittadella di Torino / Facciata interiore con Profili del Pozzo havanti nominato, Istituto Storico e di Cultura dell'Arma del Genio di Roma, BB.ICO.951/D.8858. (http://www.museotorino.it/view/s/ca7f360517df46928fdaa89895a8fc36)

[25] Gariglio, *1706, l'assedio di Torino*, 176–178.

the well was to be sunk and also on the availability of skilled manpower.[26] By all accounts, by the time of the construction of the Great Well in Belgrade such specialist undertakings had involved organised logistic operations, such as recruiting a team of men who would do the job. It stands to reason to conclude, at least in the case of the sinking of the well in the Upper Town, that the task was performed by the same master builders and pioneers who had built the Big Gunpowder Magazine in the Lower Town under Major Suly, as both of these structures involved rock excavation. The construction team must have been very similar to the team of the French *fontainiers*, which was comprised of specialists such as rock diggers (*rocteurs*), carpenters (*charpentiers*), who put up the scaffolding, bracing (*pleyons*) and formwork, stonedressers (*tailleurs de pierres*), who produced ashlars and other stone profiles, stonemasons (*maçons*), bricklayers, and, finally, well diggers (*puitiers ou puisatiers*), who did the work on the shaft. A military engineer organised and supervised the work. His responsibilities and tasks are described in more detail by Bélidor in his treatise, *La science des ingénieurs dans la conduite des travaux de fortification et d'architecture civile*, from 1729, wherein he lists Vauban's instructions for the work of engineers.[27]

The well-digging technique was described in several subsequent treatises, as the manner

Fig. 56. Great Well in the Belgrade Fortress – working platform over the dry shaft in the protective entrance structure
(PE Belgrade Fortress)

of sinking narrow well shafts had not changed much. The dangers to which the workmen were exposed were the same in the Middle Ages as in later times and mostly included the perennial threat of shaft walls caving in, embolism and accumulation of toxic fumes and gases.[28] The diggers and labourers who were lowered to the lowest level of the well had to be secured with ropes and rope ladders so that they could quickly be pulled out in case there was an increased concentration of harmful fumes. As a rule, the only indication of this was when the candles which they took into the shaft with them extinguished. In order to ensure a constant flow of air in deep and narrow bores, a duct was installed vertically along the shaft and fire was lit at one of its ends to produce a difference in pressures that enabled air flow in order to prevent asphyxia (*anoxic asphyxia)*.

The most prominent feature of the Belgrade well is its spiral staircase in double helix surrounding the dry well shaft and enabling unobstructed descent to the reservoir and ascent to the exit of the well (Fig. 57). As the well had been conceived solely as a water intake structure for the needs of the garrison of the Belgrade Fortress and not for public use, the Great Well was not equipped with a water drawing mechanism that would facilitate its use and enable more efficient exploitation. The designer had certainly calculated the quantity of water drawn by human power, that is by teams of soldiers, which could obviously draw sufficient quantities of fresh water in a short time. It was for this exact purpose that the two spiral staircases were constructed, utilising the geometry of a double helix, in order to make possible one-way descent to the water and ascent to the exit of the well for the soldiers carrying buckets (Fig. 58). Spiral staircases in a double helix were not unknown in Europe at the time of the construction of the well in the Upper Town. Thus, their construction inside a military hydrotechnical facility suggests that the architect in charge was highly educated. Such staircases were first used in Central Europe during the High Gothic period, in the Cathedral of St. Elisabeth in Košice (*Kassa,* 1430–1440), and the less well known ones in Graz (*Die Grazer Burg Dopelwendeltrepe*, 1499–1500). Their purpose was to enable an unobstructed flow of pilgrims in the former and segregation of classes, that is, to prevent any encounter between aristocrats and ordinary citizens in the castle, in the latter. The best known helical staircases are the ones in the Château de Chambord, built in the early sixteenth century. Their construction is often attributed to Leonardo da Vinci, mostly because of his sketch of a double helix intended for Renaissance fortifications. However, other Renaissance innovators also experimented with twisted staircases. Perhaps the most important among them was Donato Bramante, whose helical ramp, constructed in 1505 in the palace of Pope Innocent VIII, probably served as inspiration for Sangallo when he decided to construct staircases in a double helix in the Orvieto well.[29]

It was possible to produce the final design for the Great Well in Belgrade only after the

[26] The method of digging under the bottom of a brick cylinder was used in deep wells being sunk into soft and loose ground, and this required a greatly experienced designer and workmen in charge of preventing cave-ins, which was a huge practical challenge when no geological and hydrotechnical sounding of the ground was performed. This method is still used when the first concrete cylinder, which represents the so-called 'knife', is dug under. See Војиновић, *Техничар*, 606–607. In the chapter on cisterns and wells, Bélidor classifies such wells as *puits forés* – bore wells, as this digging method can be applied only in the case of soft ground, but he does not address the issue of the so-called 'great wells' (*grand puits*): De Bélidor, *La science des ingénieurs*, 82.

[27] Ibid., 35.

[28] Debauve, *Procédés et matériaux de construction,* 289–361.

[29] Riccetti, *Antonio da Sangallo il Giovane in Orvieto*, 76 – includes Sangallo's original sketch of the helical coil. See *6. Antonio da Sangallo il Giovane, Pozzo dela Rocca o di S. Patrizio, ca 1528. Firenze, Uffizi, 1242Ar.*

Fig. 57, 58. Great Well – the dry shaft and spiral stair flight
(PE Belgrade Fortress)

depth at which the water vein lay had been established. This piece of information was necessary primarily to minimise the effort invested in the excavation of the wider, upper well shaft with staircases, which was probably not immediately sunk to its present size. An unpleasant surprise for the builders of the well came when they did not reach the water vein, even though the narrower, lower shaft had already reached a depth of over 60 metres, measured from the entrance above, that is around ten metres below the bank of the Sava River (Fig. 59).[30] According to some researchers, a lateral tunnel, which was started at the depth of 50 metres in order to compensate for the absence of groundwater at the bottom of the well by conveying water from the Sava, was never completed because of unfavourable geology, but the more likely reason is that the reservoir of the well started filling with water that was seeping through cracks in the rock mass from the top of the so-called ‘Belgrade ridge’. This filtered water was caught in the reservoir of the well, which thus became a cistern. Evidently, the water column in the submerged shaft/cistern fluctuated in height, that

[30] Поповић М., *Београдска тврђава* (прво издање), 169, сл. 63.

Fig. 59. Submerged well shaft serving as a cistern (PE Belgrade Fortress)

is, in the volume of water over the year, which presented additional problems to the builders.

By all accounts, the construction of the spiral staircases was undertaken immediately after the height of the water column stabilised at 25 metres (spot level 73.12), which suggests that the builders did not expect it to fluctuate significantly between spring and autumn. However, the inflow of water during rainy months and when snow melted in the spring caused an increase in the water column, which thus submerged nearly one third of the height of the upper shaft and the staircases, making it impossible to use the latter as originally conceived. Because of these seasonal inflows, the engineers had to install a water drawing mechanism in 1731,[31] which made it possible to keep the level of the water at the bottom of the staircases. Some of the surplus water drawn by pump was stored in a reservoir built next to the entrance to the well. The reservoir was later remodelled, quite certainly due to the experience drawn from its utilisation before and after the installation of the pump, when the volume of drawn water that needed to be stored increased.

Pump installation in 1731

There is no precise data on the pump installed in the Great Well, but there are strong indications about the type of device, particularly after the discovery of a drawing of one such installation in the Matica Srpska Library.[32] Even though the drawing refers to pumps installed in deep wells, that is, without specifying whether the pump was intended for the Belgrade Well or another one, the pumps described are piston pumps that have predominantly been utilised in West European mines since the seventeenth century to drain groundwater.

The widespread use of the system began after the publication of Georgius Agricola's famous treatise on pumps and mining,[33] wherein this innovator proposed an improved version of the ancient piston force pump invented by Ctesibius as a solution to the

[31] M. Popović quotes T. C. Виловски, *Беоīрад, 1717–1739*, 343; Vienna War Archives, HKR, 1731 dezember 612 P. Ex., in Поповић М., *Велики бунар Беоīрадске шврђаве*, 31–37.

[32] Ibid., 20.

[33] The last two types of Agricola's pumps, marked as VII and VIII, would correspond to mining pumps powered by the *Stagenkunst* in West European mines and the pump installed in the Great Well in Belgrade. Agricola, *De re metallica*, 184–187.

burning issue of groundwater in mines (Fig. 60). Mines in France, German principalities and Austria[34] were comparatively quickly equipped with this innovation, which, over time, developed into the complex drainage adit systems, including the one utilising the flatrod system powered by the kinetic energy of water streams (*Stagenkunst*) over long distances. These adit pump systems were rather unreliable because of frequent breakdowns, as wooden pipes were used for a long time. It was in the mid-seventeenth century that Agricola's mining pumps were supplanted by improved piston pumps with metal pipes and other component parts.

Therefore, the pumping system installed in the Great Well of the Belgrade Fortress in 1731 most probably belonged to the group of somewhat modified mining drainage installations that essentially followed Ctesibius' (and subsequent Heron of Alexandria's) basic system with two pipes, which allowed the pistons to lift water no higher than 24 feet, i.e., around six metres,[35] the usual height of a mine gallery. This means that the installation in the Belgrade Well had at least five levels, each fitted with a container from which water was drawn to the level above it. The propelling power was again human. Also, given the early date of the installation of the pump (1731), it is very likely that the pump featured wooden pipes and a few metal (bronze) parts on the body, in which case it had to operate almost without a stop, as wooden pipes change their gauge during longer periods of disuse, which requires their replacement.

However, the utilisation of this installation was short-lived, as Belgrade, as well as the entire Serbia under Württemberg's administration, was ceded already in 1737. It is unlikely that the pump was relinquished to the Turkish garrison after the newly constructed parts of the fortress had been demolished as provided in the peace treaty, even though the plan of demolished structures shows the Great Well among those that had been spared.[36] After Laudon's conquest of Belgrade in 1789, the plan of existing fortifications also contains a plan of the Great Well, with an accompanying description stating that it was a usable well with spiral staircases, but there is no mention of a pump (Fig. 61).[37]

Given the well-developed water supply system in Ottoman Belgrade, with one high-yield branch running along the Terazije ridge to Sokollu Mehmed Pasha's drinking fountain, the Great Well remained a secondary source of

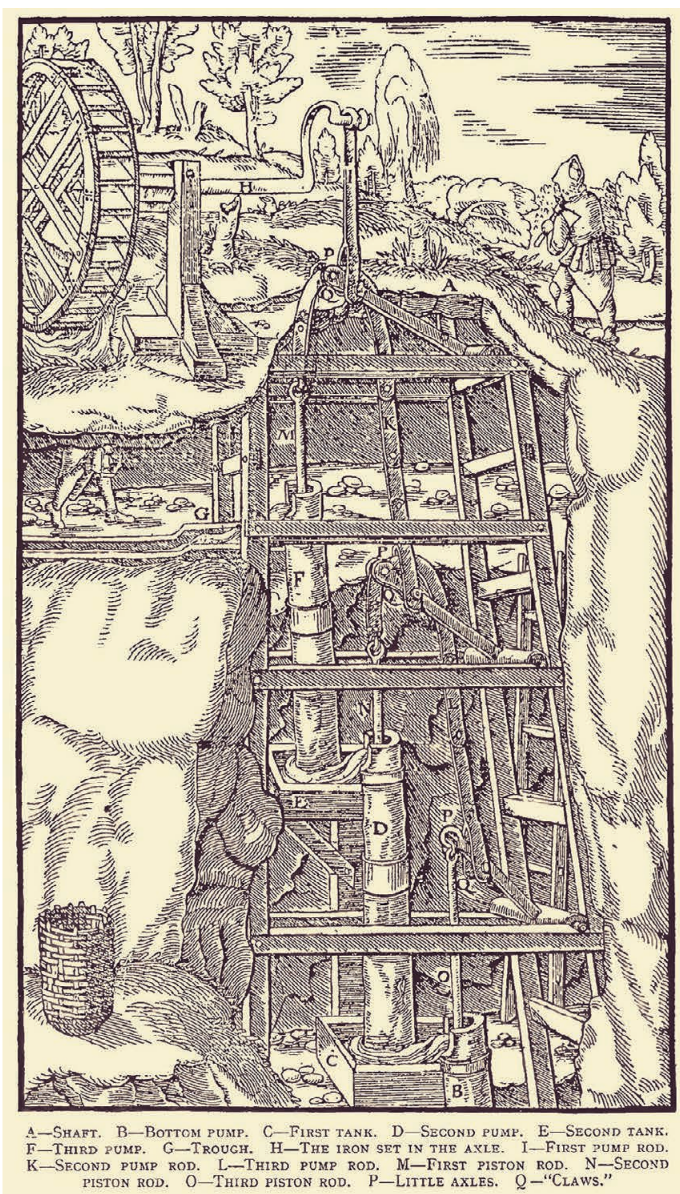

Fig. 60. Agricola's drainage piston pump, Type 7 (Agricola, *De re metallica*, 185–189)

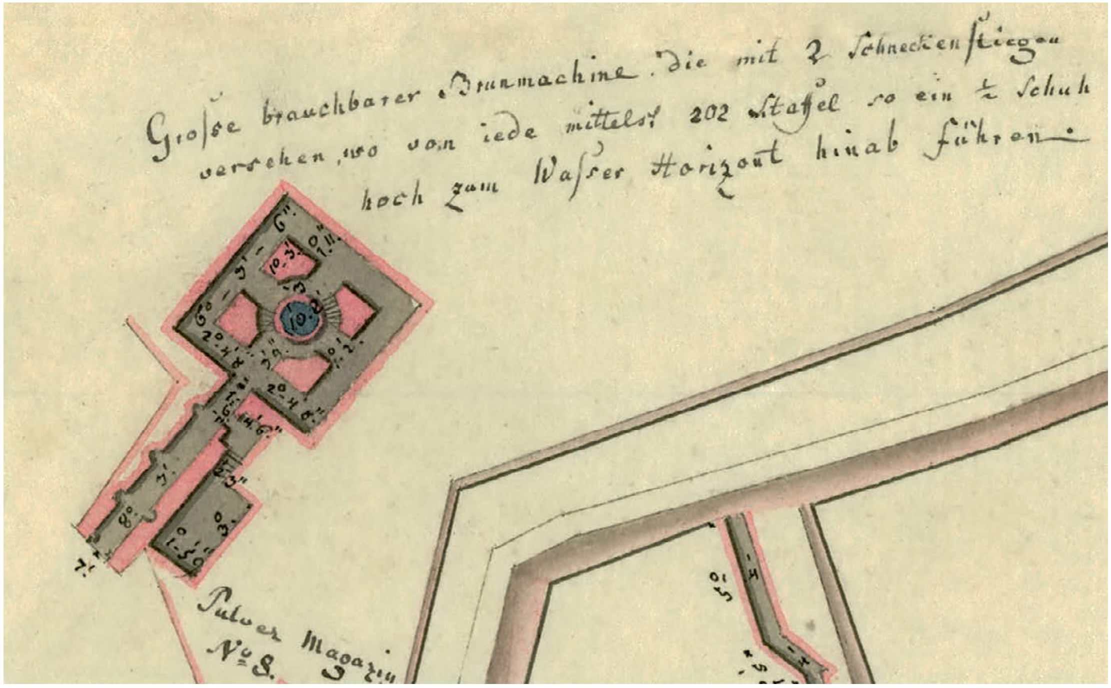

Fig. 61. Ground plan of the Great Well – magnified detail from the ground plan of the fortress from 1789 (Vienna War Archives, sig. G I b 40–3)

potable water in the Upper Town, more or less used in subsequent times as well. No other water drawing mechanism was installed in the well after 1739, but this military installation was never abandoned by any military authority as long as the Belgrade Fortress was of any military importance.

Concluding assessment

By its original concept, the Great Well, built between 1718 and 1731 in the Upper Town of the Belgrade Fortress, belongs to the small group of deep fortress wells with stairways leading down to the water. Created in the early

34 The *Stagenkunst* system was first introduced in German mining region of Erzebürge on the border of Bohemia and Saxony in 1550–1565, mostly because of the need to make a transition from surface to underground mining, the latter previously being difficult due to groundwater. Kitsikopoulos, *Innovation and Technological Diffusion*, 55–57.

35 Agricola, *De re metallica*, 184.

36 On the orthographic plan of the organised demolition of Belgrade's bastioned traces, the well is captioned as '*der Große Brunnen*'. The entire plan is titled *Grund-Riß der rasirten Studt Belgrad mit der außwechsluns Cormonio daß Röm. Kaißerh: und Turkischen- Groß Boltschaffters* and dated June, 1740. Belgrade City Museum, Plan 146V4.

37 The translation of this description of the Great Well on the 1789 plan of the underground of the Belgrade Fortress ("*Souterains Plan: Von der Festung Belgrad, wie sich solche nach der Einnahme den 8[tch] October 789 vorgefüngen haben*" KAW) was done at this author's request by experts of the Vienna City Administration and the Vienna Water Works, Ing. Gerald Strof, Johann Schwungfeld, Thomas Hubmer and Christoph Turecek, in March/April 2018, and it reads as follows (with added comments): "*The big useful well (no machine but the description of a building surrounding the well) with 2 screwstairs (because of the circular running), with 202 stairs (for „Staffel" as in doorsill or threshold) of ½ Schuh (~ 15,8 cm) height going down to the water horizon of the well.*" *(Große brauchbarer Brunnmaschine = Der große Brunnen (heute würde man Brunnfassung dazu sagen, also das Gebäude um den Brunnen – offenbar Freispiegelbrunnen mit Grundwasser) Die mit 2 Schneckenstiegen versehen, wovon jede mittels 202 Staffel so ein ½ Schuh hoch = Also spiralförmig um den Brunnen herum 2 Stiegen mit 202 Stufen etwa 15,8 cm hoch (überwindet also ca. 3,2 meter in die Tiefe). Zum Wasserhorizont hinab führen = also zur Ebene des Wasserspiegels).*

eighteenth century, the concept of this hydrotechnical installation has never been repeated elsewhere, perhaps mostly because of the great risk of failing to find a water vein after investing huge efforts into deep rock excavation. Even though the Belgrade Well had an exclusively military purpose of providing the fortress garrison with sufficient supplies of fresh water in times of siege, its architect embarked on producing its design with a great knowledge of European sixteenth- and seventeenth-century fortress wells in an obvious attempt to turn a utilitarian hydraulic installation into a prestigious example of European military architecture.

The innovative character of the concept of the Great Well is primarily evident in the utilisation of the spiral staircases in a double helix as a means of access to the water and back up to the exit, that is, the concept of unobstructed one way movement that had long been known in Central Europe, but which had also been superbly utilised in Renaissance Italy, in the two famous wells, the ones in Orvieto and Turin. These two wells featured helical ramps, but the one in Belgrade had narrow staircases that were sufficiently wide for the movement of water carriers in file. This and the absence of any kind of mechanism that would replace human power, plus the bleak functionality of the architecture, reveal the rational stance of Habsburg military engineering in the period of Turkish-Austrian wars (Fig. 62). This is also how far the success of the Great Well in Belgrade goes, as the purpose of this facility was only to serve as a secondary source of

Fig. 62. General view of the dry shaft of the Great Well in the Upper Town of the Belgrade Fortress (PE Belgrade Fortress)

water for the military inhabitants of the fortress in times of crises. It had never been intended to provide water for the Upper Town by means of a water supply system, nor had there been any plans to fit it with a more efficient water drawing mechanism. The piston pump, which was installed in 1731, must have been a variant of the mine drainage pumps, widespread in Central and Western Europe, and this human powered mechanism enabled the well attendants to maintain the level of the water column below the bottom of the staircases during the rainy seasons, when they would normally have been flooded. Despite all the complications that accompanied its construction, the Great Well is a worthy example of an engineering feat, not only because of the huge efforts invested in the sinking of its shafts, but also because of the courage of its engineers and their taking the risk of designing and materialising a rare hydraulic concept.

Bibliography

Abbrevations

АЗОРУБСМ = Архивска збирка Одељења реткости Универзитетске библиотеке „Светозар Марковић” у Београду, Београд
АИСПКМ = Архив за историју Српске православне карловачке митрополије, Сремски Карловци
БГ = Богословски гласник, Сремски Карловци
ВСЦ = Весник Српске цркве
ГГБ = Годишњак града Београда, Београд
ГИАВ = Гласник Историјског архива у Ваљеву, Ваљево
ГМГБ = Годишњак Музеја града Београда, Београд
ГНЧ = Годишњица Николе Чупића
ГСКА = Глас Српске краљевске академије
ЗНМ = Зборник Народног музеја у Београду, Београд
ИЧ = Историјски часопис, Београд
JIH = *The Journal of Interdisciplinary History*
JMH = The Journal of Modern History, Chicago
ЛМС = Летопис Матице српске, Нови Сад
НП = Наша прошлост, Краљево
ПКЈИФ = Прилози за књижевност, језик, историју и фолклор, Београд
СС = Српски Сион
ССАД = Старинар Српског археолошког друштва, Београд
ССКА = Споменик Српске краљевске академије, Београд
ČP = Čovjek i prostor
УБ = Урбанизам Београда, Београд

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