EUROPEAN DISCOVERIES:

FROM THE NEW WORLD TO NEW TECHNOLOGIES

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UNLOCK THE DIGITAL TREASURES

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INTRODUCTION

EUROPEAN DISCOVERIES: FROM THE NEW WORLD TO NEW TECHNOLOGIES

The idea of 'discovery' - of exploring the unknown, of finding and attempting new things, of creating new objects and artefacts, of innovative challenges to the conventional - has been constant in the history of Europe and humankind. It remains one of the most common and permanent traits of European history and culture, uniting the lands and the peoples of the various European nations in common enterprises, throughout the centuries. The history of the development of science and technological progress is a prime example of international cooperation and a key chapter in the history of Europe.

Scientific and technological discoveries have been vital engines for the material progress and wealth of Europe. As such, they provided solid pillars for the development of societies. Although scientific pursuits are found in many other regions of the world throughout history, often with brilliant results, science in Europe, especially after the 16th century, took a specific form and a surprising trajectory, that tied it intimately with the modernisation of societies. Of course, science and technology have also been used to wage war and increase Europe's historical dominion in many regions of the world. But it would be wrong to be too cynical: as the passing of time confirms, Europe has had an uncommonly rich history of scientific creativity and technological innovation, and these scientific discoveries and technological inventions are one of the most enduring legacies that Europe has offered to the world.

This Exhibition tries to show not only the unrelenting pursuit of discoveries, but also the richness and multi-disciplinary nature of this very European passion. Above all, it tries to show that discoveries and inventions lie at the heart of Europe's cultural heritage. Archives in Europe abound with documents and materials that witness the constant desire to explore and to discover, and these documents tell thousands of different stories. The three Pillars of this Exhibition - Medicine, Energy/Industry, Transport/Navigation - are an attempt to provide a glimpse of the multifarious variety of stories, events and personalities involved in discoveries of many different types, during the long history of Europe. It is thus an Exhibition not only about the discoveries themselves, but also about their archival memory, recording one of Europe's most distinctive cultural traits.

At a very basic level, to discover is simply to find, to put in evidence something that was not known or to explain something that was not understood. But in the history of Europe, 'discovery' acquired much richer meanings as it became an all-encompassing term to designate achievements and pursuits of very different natures. Discovery can be related to a new scientific result; to the finding and exploration of a previously unknown land; to the observation of new phenomena or the solution of old problems; to the construction of new apparatuses, and also in other senses. This Exhibition is primarily concerned with discoveries in the scientific, technological and geographical realms, but the concept can also be used in literature, philosophy and even the arts. The passion for discovery is a consequence of curiosity and intellectual restlessness, two cultural traits that have a long story in Europe. The impetus for creation and exploration has stirred the imagination of European societies throughout the ages, shaping all cultural endeavours in Europe, be they scientific, technological, artistic, philosophical or literary.

As the documents in this exhibition demonstrate, discoveries occurred across Europe in the most diverse contexts, involving people from many different countries, in all historical periods: from isolated individuals to great collective and even national enterprises; from the silence and comfort of a library to the controlled chaos of a construction site or a mine; from princely courts to artisan's workshops. The protagonists and agents of these discoveries were a cross section of European society. One finds famous intellectuals and anonymous craftsmen; highly educated academics and almost illiterate sailors; aristocrats and workmen, people from every country and all levels of society. While some of these documents refer to celebrated episodes and people that have become famous, others report stories that are much less known and almost forgotten. The different types of documents in this exhibition also confirm the vast array of themes and contexts where the drive to discover was exercised. One finds letters, books, photographs, X-ray images, drawings, manuscripts, printed leaflets, maps, reports, patent applications, and many more, ranging from the early Middle Ages to the twentieth century.

The two driving forces behind discovery were - and probably remain - curiosity and the desire for an improvement in the conditions of life. Judging from the documents presented here, the practical desire for a better life was the dominant impulse and three themes appear to have been the more frequent: innovations in the fighting and controlling of diseases, improvements in transportation, and, thirdly, improvements in technological processes and industrial machinery.

These documents are not the result of mere intellectual achievements. Behind each of them are often very lively stories, filled with the passion and drama of human existence. These stories confirm the inventiveness and the intellectual brilliance of many of the discoverers, but at times they also show their physical boldness, stamina and determination to overcome all sorts of obstacles and difficulties.

To preserve the memory of the world of discoveries and inventions, of scientific progress and technological advances, is to protect one of the most characteristic traits of European identity and heritage.

01

MEDICINE

The history of medicine is almost as old as that of written records. Curiosity about the mysterious and fascinating workings of the human body, along with an endless fight against disease, have been a staple for humans for as long as we can recall. Even when societies had the most primitive notions about the i nner composition and the workings of the human body, there were already theories and procedures for the preservation of health and the mitigation of disease.

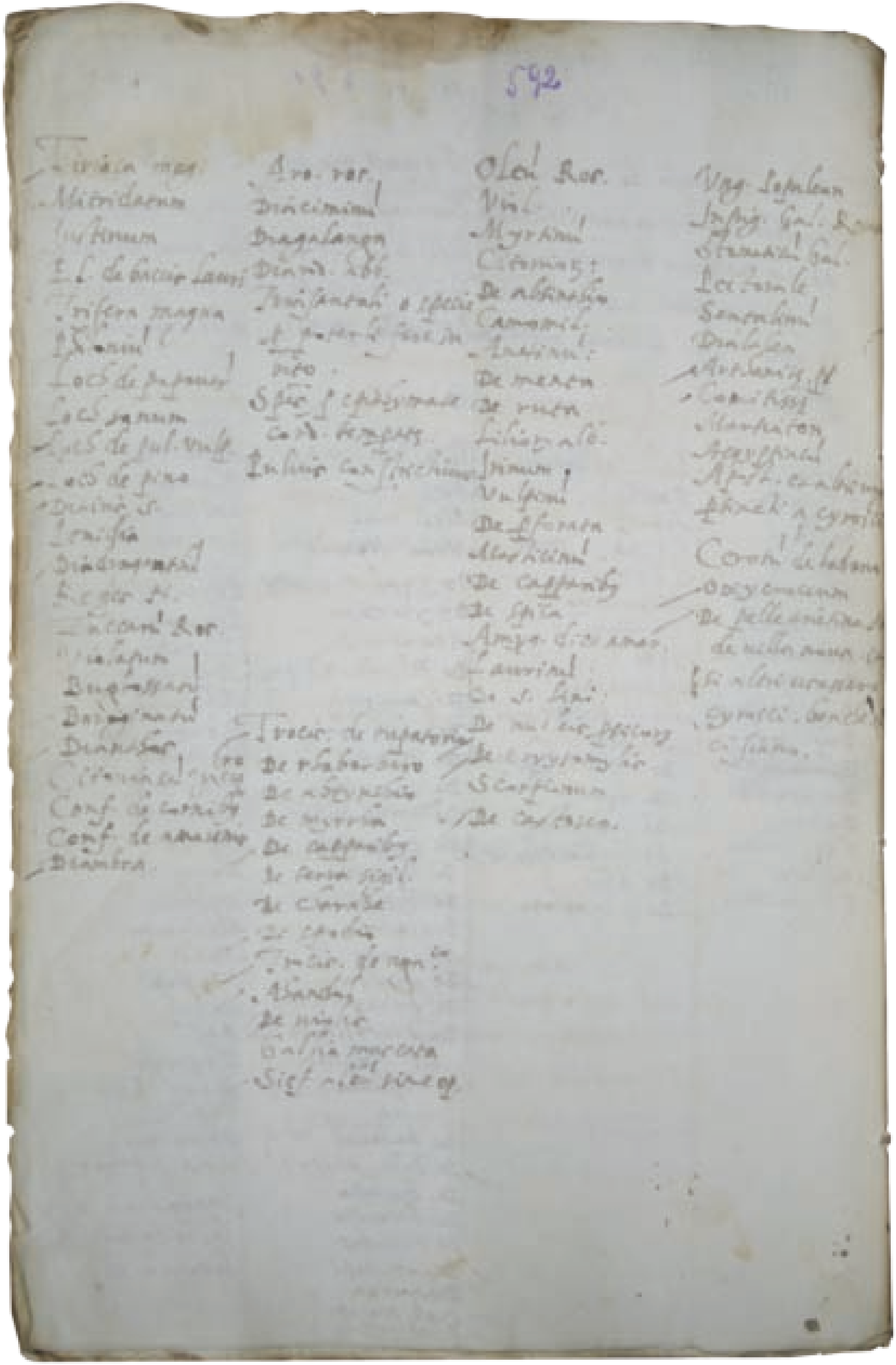
The documents presented here provide an overview of medical knowledge and medical activities throughout the ages in Europe. Medicine and medical activities have a very rich history in Europe, not only related to scientific discoveries, but also the improvement of medical care for the populations and general health conditions in society. Medicine is thus an important part of the history of the investigation of nature and the human body, and also a factor in the organisation of societies and the protection of citizens.

Some documents in this exhibition are related to remarkable medical discoveries; others have to do with the implementation of public health measures and the establishment of public health systems; certain documents have to do with general hygiene in saocieties; others are related to the production of medicines and pharmaceutical products; still others are connected to the medical and social aspects of fighting plagues and other threats to collective health. The variety of documents reflects two aspects, in essence: on the one hand the multitude of tasks and the complexity of the efforts required to understand the human body; on the other hand the efforts to improve the health conditions of the populations in Europe. These two aspects were never independent, of course, and they have historically progressed side by side.

Disease is not simply a medical issue. Some diseases, such as plagues and epidemics, have caused a terrible death toll in Europe, to the point of altering demography, and therefore profoundly altering the shape of society. The impact of such massive death rates has had enormous economic and social repercussions. Other diseases, such as leprosy (Hansen's disease), although with lower levels of mortality, have acquired a special place in the imagination of societies. The story of disease is not only a story of individual suffering, and sometimes death; it is also a story of human communities and a significant chapter in the history of countries.

Europe has a long history of planning and setting up measures to protect public health. These were particularly important in times of war or when epidemics hit regions in Europe. Some institutions and customs, such as Spas, while performing an essential social function, are also clearly related to traditions of hygiene and the preservation of health. As the documents in this Exhibition show, long before formalised health systems were established across Europe, measures were put in place, often originating at the highest levels of government, designed to improve the health condition of populations.

Medicine has also been a field of spectacular scientific progress and development. Some medical doctors, and other researchers working in themes related to the medical sciences, are among the most celebrated scientists in Europe. A number of the documents in this Exhibition are related to discoveries that provided great leaps forward in the understanding of the body and the improvement of medical treatments. Whether it was discovery and study of brain cells, the identification of pathogenic agents, or the invention of revolutionary imaging techniques, European scientists have a long history of outstanding contributions to the progress of medicine.



Medicines to fight disease

The document is a list of medicinal products by a town doctor in the city of Kotor, on the Adriatic coast of Montenegro. Dated from the year 1556, it is written in Italian and lists 176 medical products that doctors should possess.

Fighting disease has always been one of the great challenges faced by humankind. The struggle, which has been an issue for all cultures throughout history, has led to the development of medical knowledge along with pharmacology and several other disciplines.

The restoration of health involves the administration of specific products, and a plethora of medicines have been used throughout the centuries. Medicines were usually made from common herbs and domestic products, but more exotic and rare ingredients were often used as well. Pharmaceutical products circulated throughout Europe along trade routes and networks that crossed national borders, creating a rich and lively market.

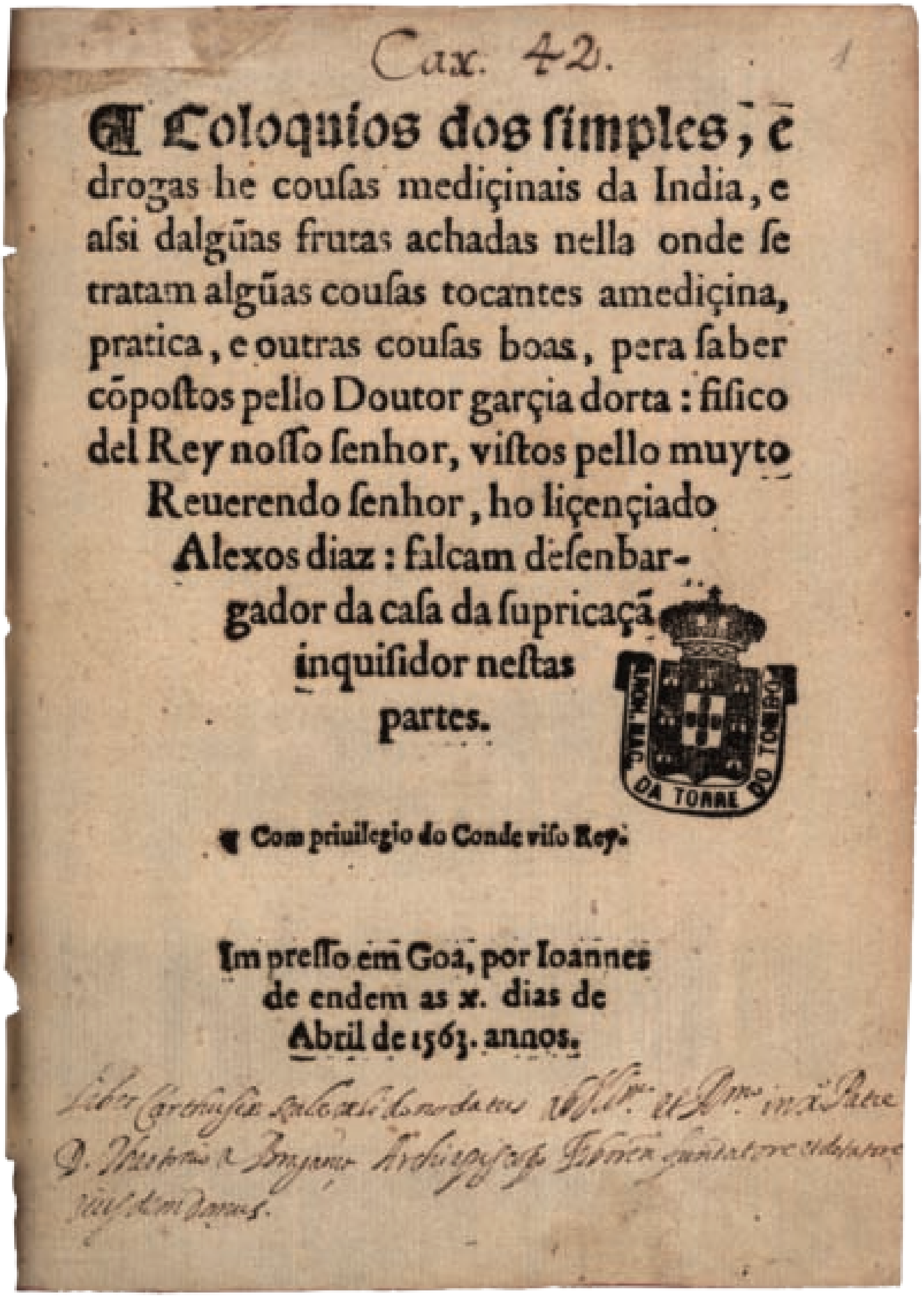
Members of the medical profession were tasked with administering medicine. Doctors worked in close collaboration with apothecaries and pharmacists and frequently made their own medicines. The more learned and scientific versions of medicine – inspired by the theories of Hippocrates and Galen and the pharmaceutical ideas of Dioscorides – contained well-developed doctrines on the use and benefits of different medicines and treatments. Traditionally, medical doctors were not the sole prescribers of medical products, with popular medicine and non-professional healers also playing a role in this area. However, over time, the medical profession claimed the exclusive right to prescribe medicines, in a slow and sometimes tortuous process, that some would argue is not yet fully complete.

List of medicines, 1556, Kotor (Montenegro)

1 page of a bound volume, manuscript on paper; 32,2 x 20,8 cm

State Archives of Montenegro

Ref Code: DACG IAK SN LV 591



Cax. 42.

¶ Coloquios dos ſimples, e drogas he couſas mediçinais da India, e aſsi dalgũas frutas achadas nella onde ſe tratam algũas couſas tocantes amediçina, pratica, e outras couſas boas, pera ſaber cõpoſtos pello Doutor garçia dorta: fiſico del Rey noſſo ſenhor, viſtos pello muyto Reuerendo ſenhor, ho liçençiado Alexos diaz: falcam deſenbargador da caſa da ſupricaçã inquiſidor neſtas partes.

DA TORRE DO TOMBO

¶ Com priuilegio do Conde viſo Rey.

Impreſſo em Goa, por Ioannes de endem as x. dias de Abril de 1563. annos.

Colloquies on the simples, and drugs and medicinal things of India and so some found fruits, touching medicine practice, and other good things to know, by Garcia de Orta, doctor of the king, 10-4-1563, Goa

1 bound volume, covers wrapped with brown leather embossed with drawings, 217 numbered pages, printed, paper; 20,5 x 15,5 x 3,5 cm

Torre do Tombo – The National Archives of Portugal

Ref Code: PT/TT/CF/088

The Richness of Indian Pharmaceutical Tradition

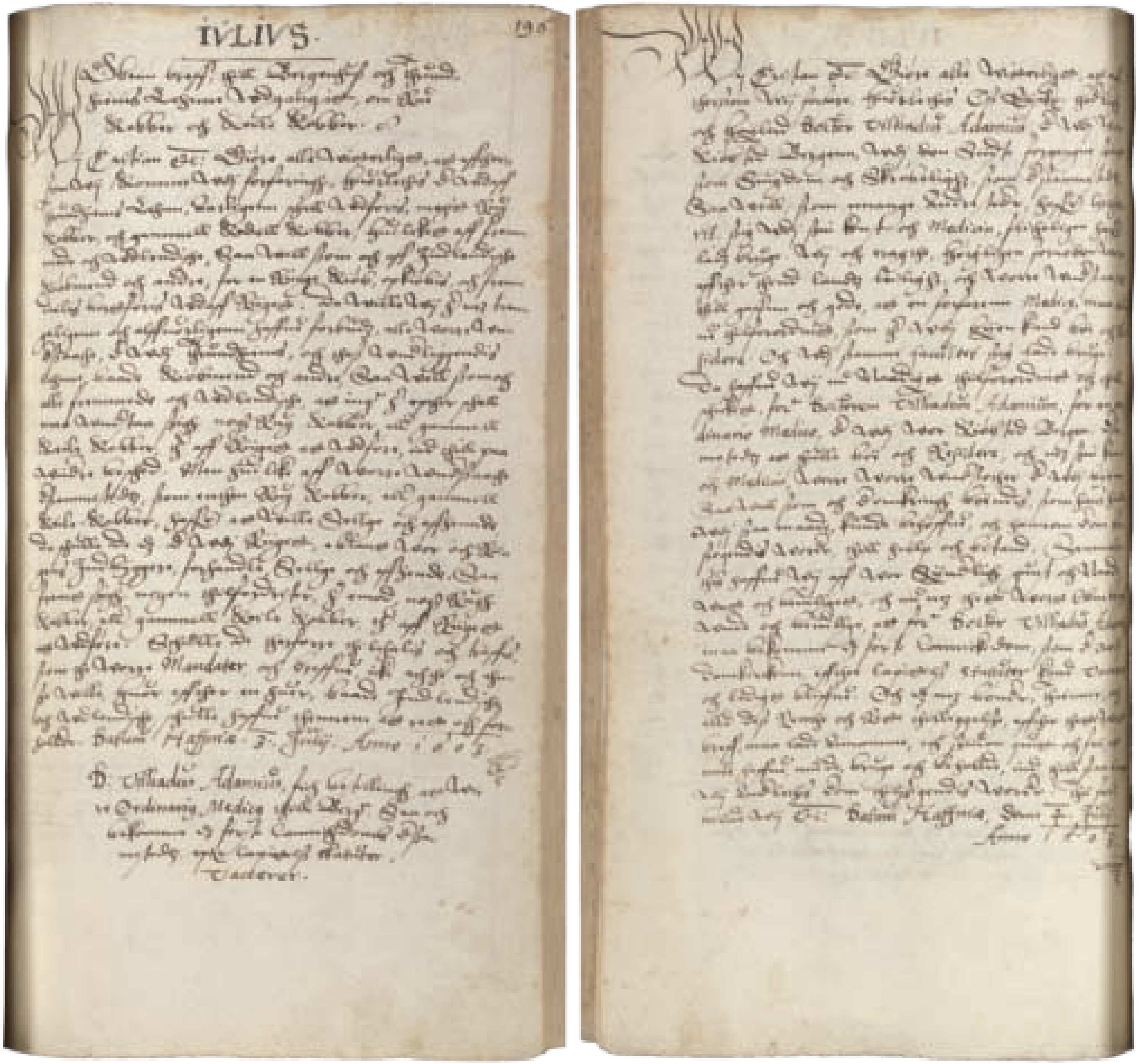
As European nations engaged in worldwide maritime voyages, they came into contact with diverse and previously unknown scientific traditions. *Colóquios dos Simples e Drogas da India* or Colloquies on the Simples and Drugs of India is testament to this, written in Goa in 1563. (Simples are plant based medicines.) It is the first extended description of botanical, pharmaceutical and medical products of the Indian subcontinent by a European author, the Portuguese doctor Garcia de Orta (1501?-1568).

The book draws from the three decades the author spent living and working in India. Written in the form of lively dialogues (Colloquies) between a scholar familiar with European traditions, and an acute observer of nature and the eastern world, it is the first authoritative work on drugs, spices, gems and the therapeutic products from the East. It mentions a great variety of spices, resins, gums, and oriental fruits; it discusses product names in different languages; it describes plants and their different parts – leaves, stem, flowers, fruits, their therapeutic applications and the respective administration – comparing them against their European counterparts; it also identifies their geographical origin.

In addition to botanical and pharmaceutical information, *Colóquios dos Simples e Drogas da Índia* contains abundant commentary on medical matters. The therapeutic or dietary properties of herbs and fruits are discussed, and the local uses of many drugs is described. Garcia de Orta observes and describes Asian 'Cholera morbus', distinguishing it from the mild form of the disease in Europe, recognising the need to combat the attack immediately, and prescribing external and internal medication. Each dialogue not only presents and discusses the medical knowledge and products of Indian tradition, but serves also to compare Western and Asian medical knowledge. Garcia de Orta is not shy of extolling the virtues and the knowledge of local Indian doctors and in affirming that Arab authors should frequently be trusted more than the Greeks, Latin, or even modern Europeans.

The book also has important digressions on the history of India, the customs and philosophies of the Hindus, the knowledge of their doctors, Chinese travels in the seas of India and the Persian Gulf, aspects of the history of Deccan, the description of the city of Goa, and so on.

Originally written in Portuguese, the book was translated into Latin by the noted naturalist Carolus Clusius (1528-1609) and published in 1567, with many other editions in the following years. Although Clusius made drastic changes to the text, for example, the dialogue form was abandoned, the many Latin editions promoted by him gave an enormous diffusion to Orta's original text. To the stunned eye of its European readers, the book revealed the unsuspected richness of Indian and other Asian medical products and practices, thus challenging the traditional knowledge of European medicine.



The Establishment of the Norwegian Healthcare system, 4-7-1603, Copenhagen

2 pages of a bound volume, manuscript on paper; 31 x 17 cm (page), 33 x 22 cm (volume)

National Archives of Norway

Ref Code: RA/EA-3023/F/Fcaa/L0003, page 196

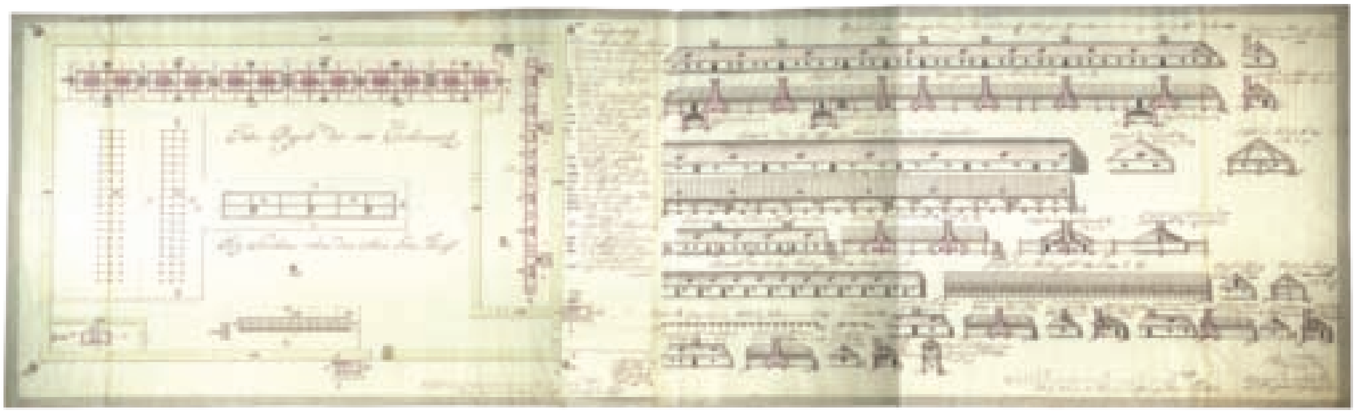
The Establishment of the Norwegian Healthcare System

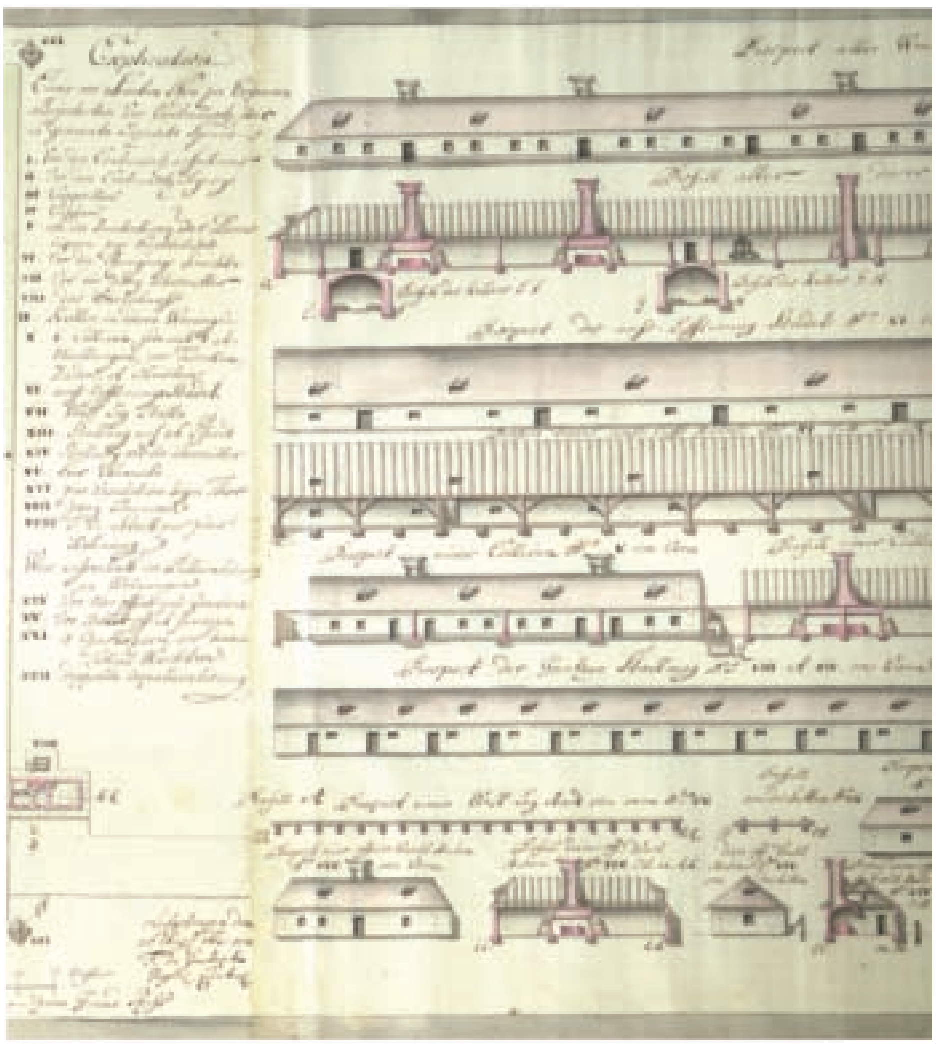
Universal medical care is a relatively new phenomenon. For many centuries, while royals and the higher levels of society had access to varying levels of professional medical care, the vast majority of the population relied on the medical care provided by religious institutions, as a form of charitable service, or by popular healers. By the early modern period, however, as more progressive, centralised forms of government were established in many European nations, new concepts and institutions devoted to public health began to emerge.

The public healthcare system in Norway can be traced back to the 17th century, when King Christian IV appointed the first public doctor, Villads Nielsen Adamsen [Vilhadius Adamius] (ca.1564 - ca.1616) in Bergen, in July 1603. The King assigned Adamsen as *ordinario medico* in Bergen, with the letter displayed here. This meant Adamsen would be paid from the public purse, as he was now allowed to dispose of some of the church's income.

Adamsen was the son of a Danish parish priest; he had studied in Padova, Rostock and Siena, focusing particularly on questions related to epidemics and public health. In 1599 he arrived in Bergen, where he established himself and started medical practice. At this time, Bergen was the most populous city in the Nordic region, with approx. 15,000 inhabitants served by only three doctors. In the year of Adamsen's arrival, a plague broke out in the city. Following the outbreak, one of the doctors escaped the country, while another hid inside his house. Adamsen, however, with the assistance of collaborators, helped the sick and dying, and valiantly served Bergen's citizens as plague raged in the city for two years.

We don't know for certain if Adamsen was the first doctor in the country to be paid as a public doctor, but he is the one about whom historians know the most, and therefore he is considered as the origin of the public healthcare system in Norway. The growth of the public system was slow and steady. In 1750 Norway had 5 public doctors; by 1834 that number had doubled.





Site Map of a Quarantine Station

The rate at which the Covid-19 coronavirus spread around the world reminds us how quickly and dramatically a disease can move beyond our control. The use of quarantine and social distancing to combat it echoed the ways in which humans have counteracted epidemics down through the ages.

In the early modern times, quarantine stations at borders served to prevent the spread of epidemics from one country to another. The site map presented here is of a quarantine station (*lazareto sporco*) in the surroundings of Zemun, in the year of 1762. The location of Zemun was strategically important: it lay on the banks of the Danube, just opposite Belgrade. The settlement was an important commercial centre and customs station of the Habsburg Monarchy.

The plan shows the new quarantine station, with buildings for disinfecting and aeration of goods, as well as accommodation for employees. A three metre high wall surrounded the quarantine area, cutting it off from the outside world. Anyone crossing the border had to be placed within this area, where they were separated from the fumigator staff and those who had already been disinfected. The site for infected people was also separated by high walls from the office buildings of the staff of the quarantine station, to ensure they were not in close contact with the infected. Everyone crossing the border was examined in the examination area, where the director was about a 190 cm distance away, protected by a dense, double-fence as he interrogated the travellers who wanted to enter the country. After that, the surgeon examined them, also at a distance. The examination checked for symptoms of the plague – limb and trunk pain, drowsiness, nausea, hoarseness, sweating. But it was also meant to gather other types of information, including general news, potential epidemic risks and any contact with people of suspicious behaviour.

Site map of a quarantine station (lazareto sporco) in the surroundings of Zimony,
30-8-1762, Zemun, today part of Belgrade, Serbia (Hungarian: Zimony; German: Semlin)

1 page, coloured drawing, manuscript on paper; 53 x 178,5 cm, scale: 20,7 cm

National Archives of Hungary

Ref Code: HU-MNL-OL – S 12 – Div. XII – No. 29:3


en la memoria
Pastillas de Carne de Vaca
Pastillas de Huesos de Vaca de las Caderas
Pastillas de Huesos de Articulaciones
Pastillas de huesos de Costillas
Pastillas de Huesos de Carnero
Pastillas de Huesos de Puerco
ARCHIVO GENERAL DE SIMANCAS
G.M. 6162
MPD, 39, 24

Food for the Troops

We have known that good health relies on good food since the early days of dietary theory. This relationship between health and food quality is critical when it comes to feeding troops.

The item displayed is a collection of 36 samples of jelly of bones, used in foodstuff for troops. These samples, or soup cubes, are enclosed with a manuscript report by the Professor of Chemistry in the Royal Laboratory of Segovia, entitled ‘Experiences on measures to increase the soldiers’ subsistence with no further charges to the Royal Treasure’, dated January 22th, 1791.

The author of the report was the distinguished French pharmacist and chemist, Joseph Louis Proust (1754-1826), considered one of the founders of modern chemical analysis. In 1796 the Spanish government, by recommendation of the noted chemist Lavoisier, and with an agreement between Charles III of Spain and Louis XVI of France, hired Proust to teach chemistry in Madrid. After a short stay in the capital he was assigned to teach chemistry and metallurgy at the Royal College of Artillery of Segovia, located in the city castle, a post he occupied until 1799. Proust is known mostly for his discovery of the law of constant composition in chemistry, but he was also interested in pharmaceutical and dietary topics, focusing on issues such as the sugars present in sweet vegetables and fruits.

Samples of jelly of bones for troops foodstuff, 22-1-1791, Segovia

1 page, manuscript on paper, with 36 samples; 31×21 cm
Spanish State Archives – General Archive of Simancas
Ref Code: ES.47161.AGS//MPD,39,14


Rendkivül való Toldalék

a' Hazai Külföldi Tudósításokhoz az Egésség állapotjában.

Treatment for cholera by János Morvai, a priest in Tiszabábolna, 3-8-1831, Tiszabábolna

2 pages, printed on paper; 21,7x26 cm

Győr-Moson-Sopron County Archives in Győr of the National Archives of Hungary

Ref Code: HU MNL GyMSMGyL – IV – 23 – 1 – 205

The first cholera pandemic to reach Europe

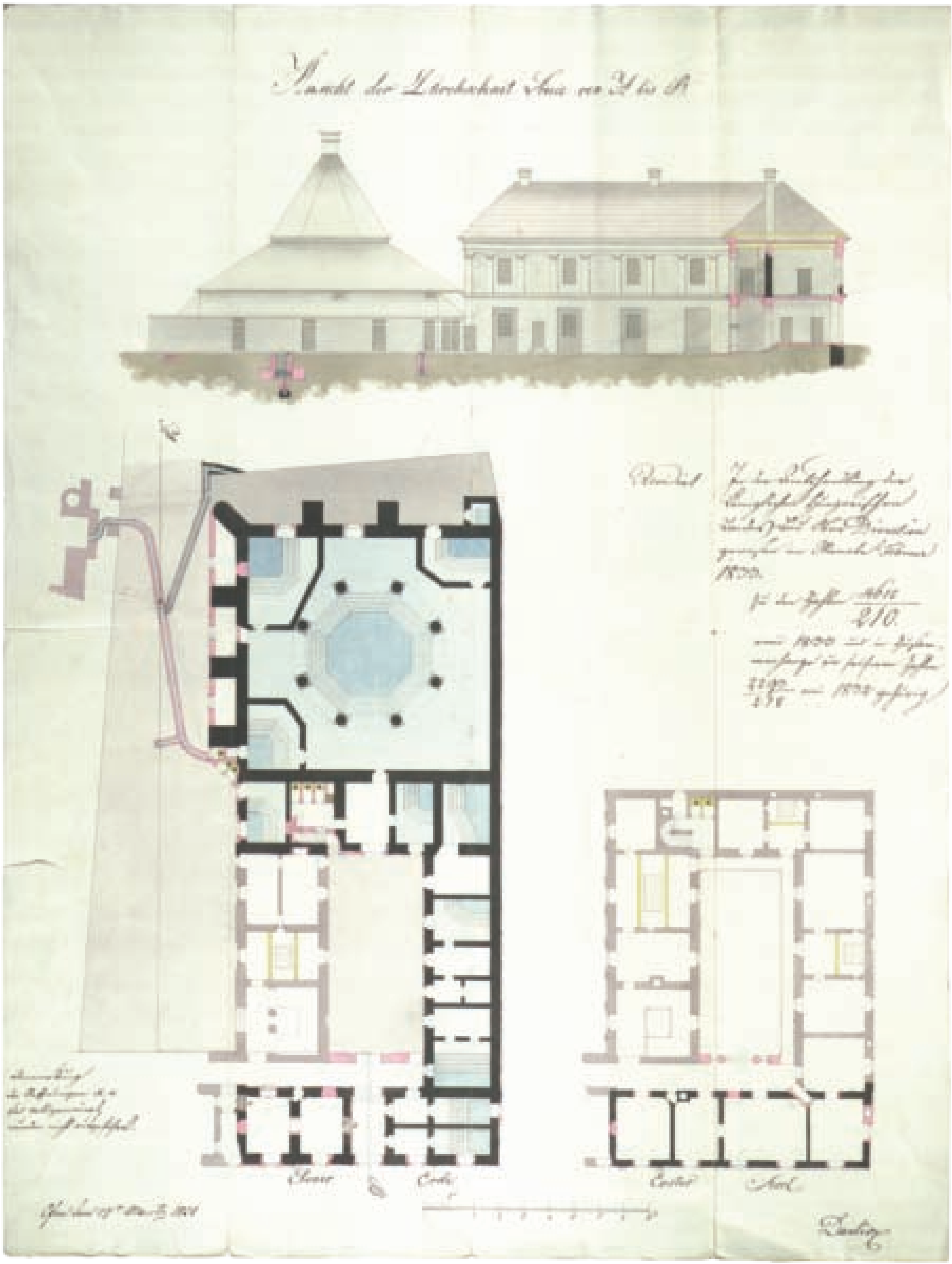
While the earliest mentions of isolated cases of cholera, or cholera-like diseases, indicate the existence of the disease in ancient times, it was only in the 19th century that large-scale cholera pandemics occurred. The first cholera pandemic originated in India in 1817 and rapidly spread to other regions in Asia, extending as far as China and Indonesia. This first pandemic disappeared in 1824 after killing several hundreds of thousands of people.

By 1829 a second cholera pandemic erupted and this time the disease hit Europe for the first time. It reached Russia in 1830 and passed to Finland, Hungary and Germany during 1831. In 1832 it reached London and Paris, and in the following year it arrived on the American continent. In addition to a dramatic number of deaths, the spread of cholera in Europe caused considerable social turmoil. Riots erupted in some towns as populations reacted against anti-epidemic measures such as quarantine, or when they suspected malpractice by the authorities and the medical class. A third cholera pandemic in 1846–1860 also hit Europe very hard, with further outbursts occurring during the 19th and 20th centuries.

Medical knowledge about the disease was very scarce during the first cholera pandemics. A variety of different treatments were used against the unknown and terrifying disease, some of which did not live up to expectations, while other procedures proved to be at least partially effective.

The document shown here is the proposal of a treatment for cholera suggested in 1831 by János Morvai, a parish priest of the village of Tiszabábolna, in north-eastern Hungary. The document was issued by the Health (Cholera) Board of Győr County, a county organisation that operated from July 1831 to January 1832, coordinating the efforts at local level to fight the cholera pandemic.

The author, János Morvai, developed a method that became the most widely used and widely recommended of all the applied therapies. He published his method titled *'Rendkívül való toldalék a Hazai Külföldi Tudósításokhoz az Egésség állapotjában'* or An extraordinary supplement to interior and foreign reports, regarding health conditions. The Health (Cholera) Board of Győr County endorsed Morvai's ideas and recommended the information contained in the document as a general guideline for those dealing with the disease.



Bathing in Buda – The Rudas Spa

The document presented is the plan for the renovation of Buda's famous Rudas Spa, in 1831. It comes from the Hungarian Royal Chamber, the national government body of economic and financial administration between 1528 and 1848, which operated under the direction of the central organs of Vienna.

Bathing in Buda has a long history, dating back to Roman times. Spas have played an important role throughout the centuries, both in terms of public health and as places for social interactions. The Rudas bath, however, is comparatively recent; it was built by the Turks, and its Turkish name was once the 'Green Column Bath' (Yesil Direkli Ilıca in Turkish), which was taken from one of the green columns of vaults above the spa pool. The name Rudas (Hidas Baths, Bruckbad) could refer to the pole of the ferry, which transferred the guests of the bath from Pest to Buda. After the recapture of Buda castle in the late 17th century, the Hungarian Royal Chamber donated the spa to the city. From the 19th century onwards, Rudas bath became a centre of social life, with an orchestra playing in the yard. The plan refers to the rebuilding of the bath that took place in 1831-1832, when it was reconstructed in a classicist style, based on the plans of the architect József Dankó. Its original and characteristic octagonal pool can be easily discerned in the plan. The city of Buda added a bathtub and stone bath to the old Turkish bath, and also set up a 15-room guest house, a kind of modern hotel with a huge dining room and a billiard room for lords.

Sadly, the classicist-style building complex shown on the plan was destroyed during the siege of Budapest in 1944.

Plan of Rudas Spa in Buda, 27-3-1831, Buda (today part of Budapest, German: Ofen)

1 sheet, drawings with handwritten notes on paper; 63×48 cm

Ref Code: HU-MNL-OL – T 62 – No. 898.

National Archives of Hungary

Treating Leprosy in Norway

Leprosy, also known as Hansen's disease (HD), is a long-term infection by the bacteria Mycobacterium leprae, which has been a part of human history for at least 3,500 years.

Leprosy has been associated with degraded living conditions and the lack of hygiene throughout the centuries. It was always a problem of the poor and remains a scourge in some parts of the world today.

Leprosy also frequently came with a degree of moral judgement and its transmission attributed to hereditary factors, but since the danger of contagion was also suspected, it often led to drastic social estrangement for the afflicted. Few diseases elicit such images of suffering and physical deformation as leprosy; even fewer attracted such severe practices of ostracism and the social rejection of patients.

In the 19th century, leprosy was discovered in coastal areas of Norway, in the western and northern parts of the country. Norwegian authorities took an interest in the problem at an early stage. The University of Oslo began training physicians in 1816, and leprosy soon became the focus of Norwegian medical science, with Bergen playing a key role in international leprosy research during the 19th century.

Indeed, it was a doctor in Bergen, Dr. Gerhard Henrik Armauer Hansen (1841-1912), who identified Mycobacterium leprae as the root cause of the disease, in 1873. This discovery was a major advance, proving that leprosy was infectious and caused by germs, and thus unrelated to hereditary transmission. Hansen's discovery was the scientific breakthrough that opened the door for the understanding and future treatment of the disease. In fact, despite initial opposition and even some lack of recognition, this new knowledge had a vital impact in the struggle against the disease. The Leprosy Registry provided Dr. Armauer Hansen with the scientific data to support his discovery, and he could point to the importance of isolating patients in order to stop the infection from spreading.

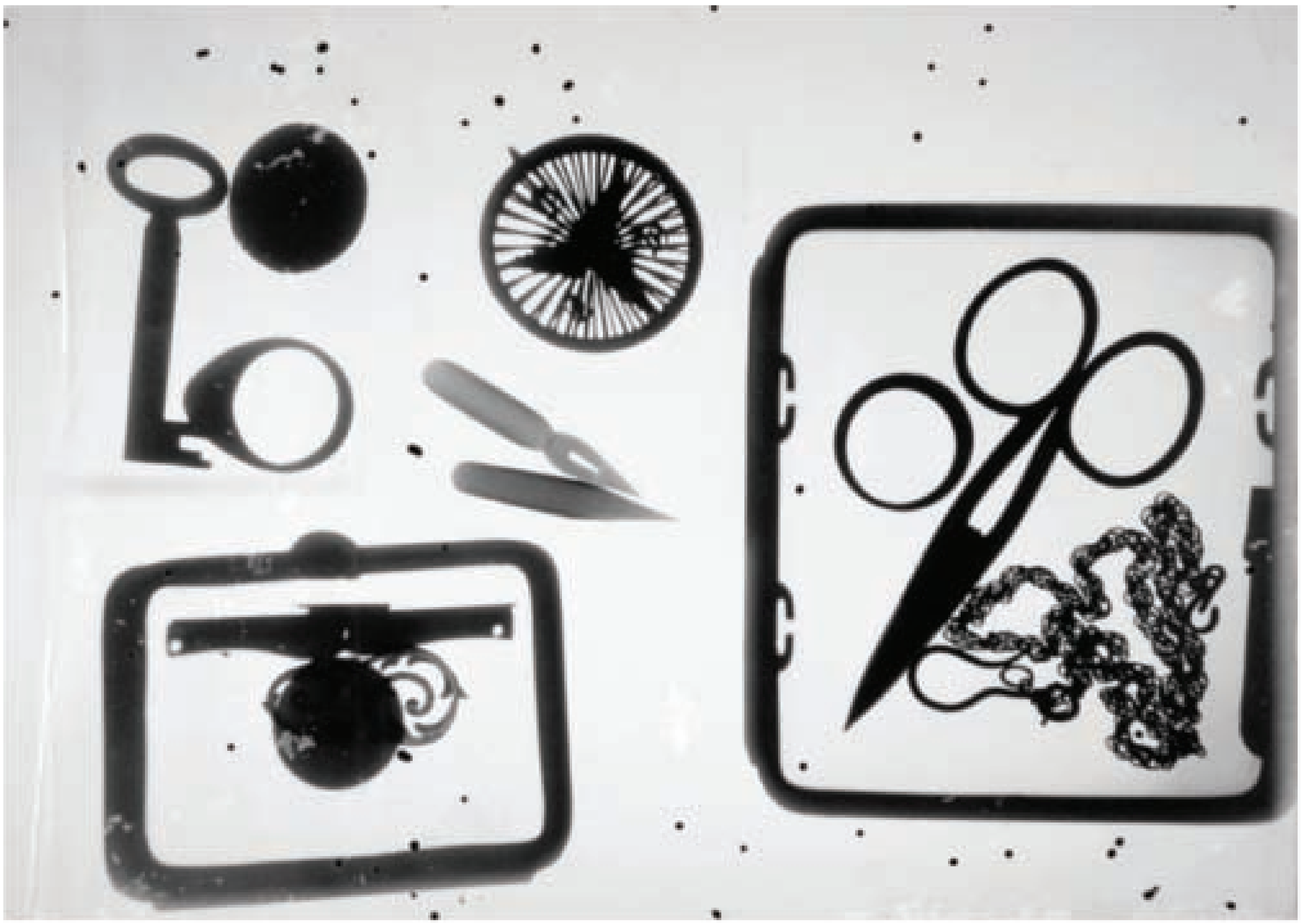
His discovery had an impact all around the world. The Leprosy Archives of Bergen document this breakthrough; although they deal with leprosy patients in Norway, its documents are relevant for the history of this disease and this stigmatised group of people in general.

"The Treatment of Leprosy (Hansens's disease). Coloured sketch of a Leprosy patient, 1847, Bergen.
Dr. Gerhard Henrik Armauer Hansen in his study, ca. 1887, Bergen"

1 page, coloured sketch on paper

The Leprosy Museum in Bergen

Ref Code: 'Johan Ludvig Losting Atlas colorie de spedalskhet; photo: Johan van der Fehr.'



X ray experiment, 1896

1 photo; 13,0×18,0 cm

Ref Code: Richard Ellis Archive, Malta

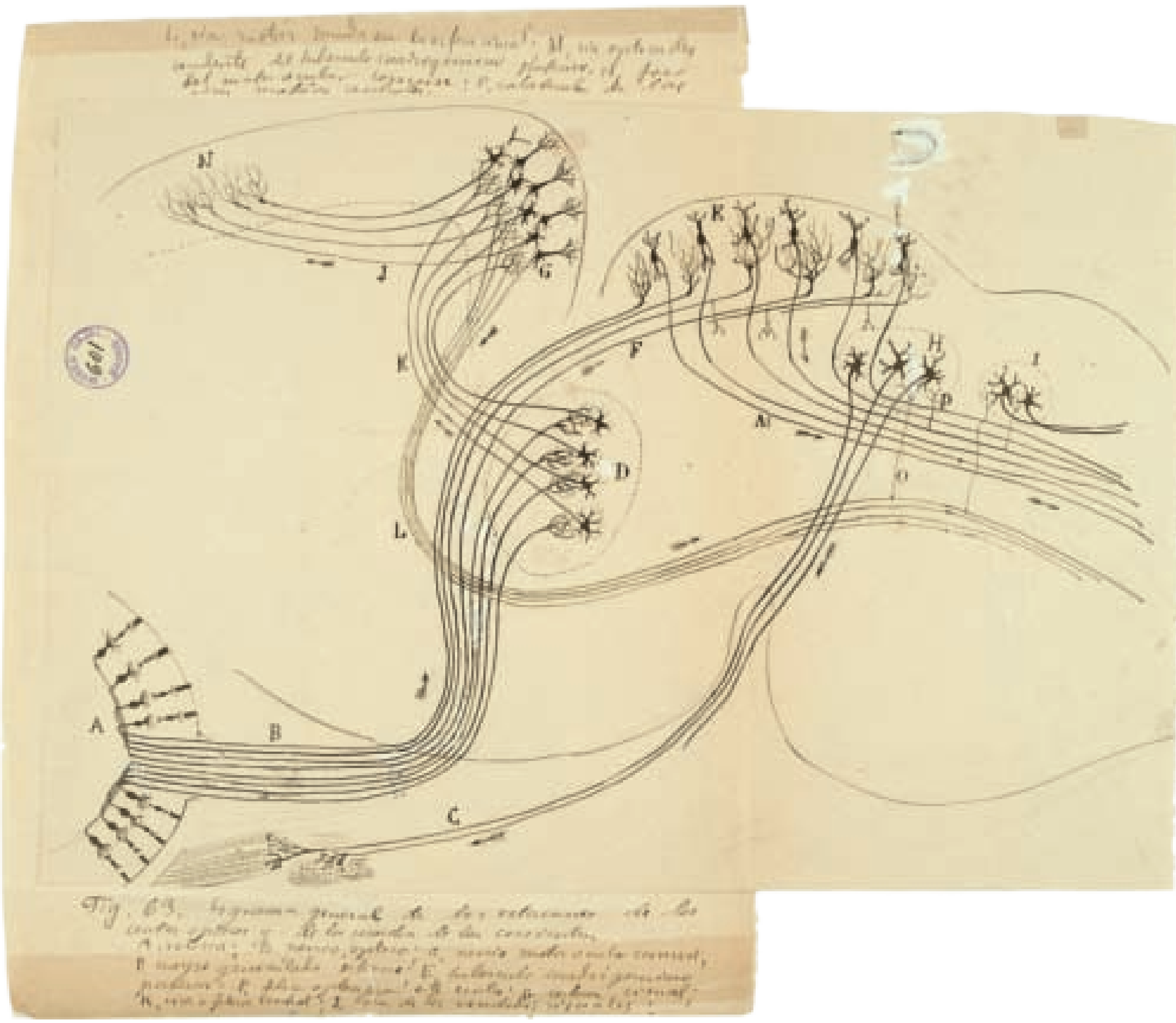
The first X-Ray Experiments in Malta

The German physicist Wilhelm Conrad Röntgen (1845-1923) observed a new form of radiation, while performing experiments with vacuum tubes on 8 November 1895. In the absence of a better name he provisionally called it X-Rays. In the following days he frantically investigated the properties of these rays, discovering to his great astonishment that they allowed the bone structure inside the body to become visible. By the end of that year, on 28 December, the remarkable discovery was made public when Röntgen presented the X-Rays to the Wurzburg Physical Medical Society and published his results in a paper titled *'On A New Kind of Rays' (Über eine neue Art von Strahlen)*. News about the startling discovery and the properties of the new rays spread rapidly. Reports appeared in non-specialist periodicals and in the general press at the beginning of 1896, and by 30 January the importance of the new rays in the diagnosis of fractures and the location of foreign objects inside the body was recognised. Röntgen went on to win the Nobel Prize in Physics in 1901, but even more significant than the prestigious award was the fact that his discovery initiated a radical change in the imaging techniques used in many fields, especially in medicine.

News of the 'New Photography' appeared in Malta on March 12th 1896. The editor of *The Daily Malta Chronicle* expressed his regret that he was not able to provide "full particulars of the recent advances made" but hoped to do so within a few days following the return of the Science Editor from a vacation. By early November 1896, and probably earlier, experiments with the new rays were being carried out in Malta by John Ellis of the photographic firm of Richard Ellis in Valletta. Born in England, Richard Ellis (1842-1924) arrived in Malta in 1861 and was a pioneer of photography on the island.

The photo shown here documents some of the first X-Ray images produced in Malta. On the 5 November, Mr. Ellis sent a letter to the Chief Secretary of the Government with "copies done by the X-rays of this week's experiments", including those of an aluminium cigarette case, a gold chain, a ring, a leaf, a tortoise shell money case, a cardboard case, a wooden box of which the grain is plainly seen, a silver coin and "a hand with cut finger."

The last item is of the greatest interest as it records the first known instance of an X-ray photograph with a medical slant produced in Malta.



Visual pathways, circa 1901

1 sheet, drawing with India ink on paper; 21,8×31,2 cm

Cajal Legacy. Cajal Institute (Spanish Main Research Council).

Ref Code: Madrid,Cajal Legacy-26115

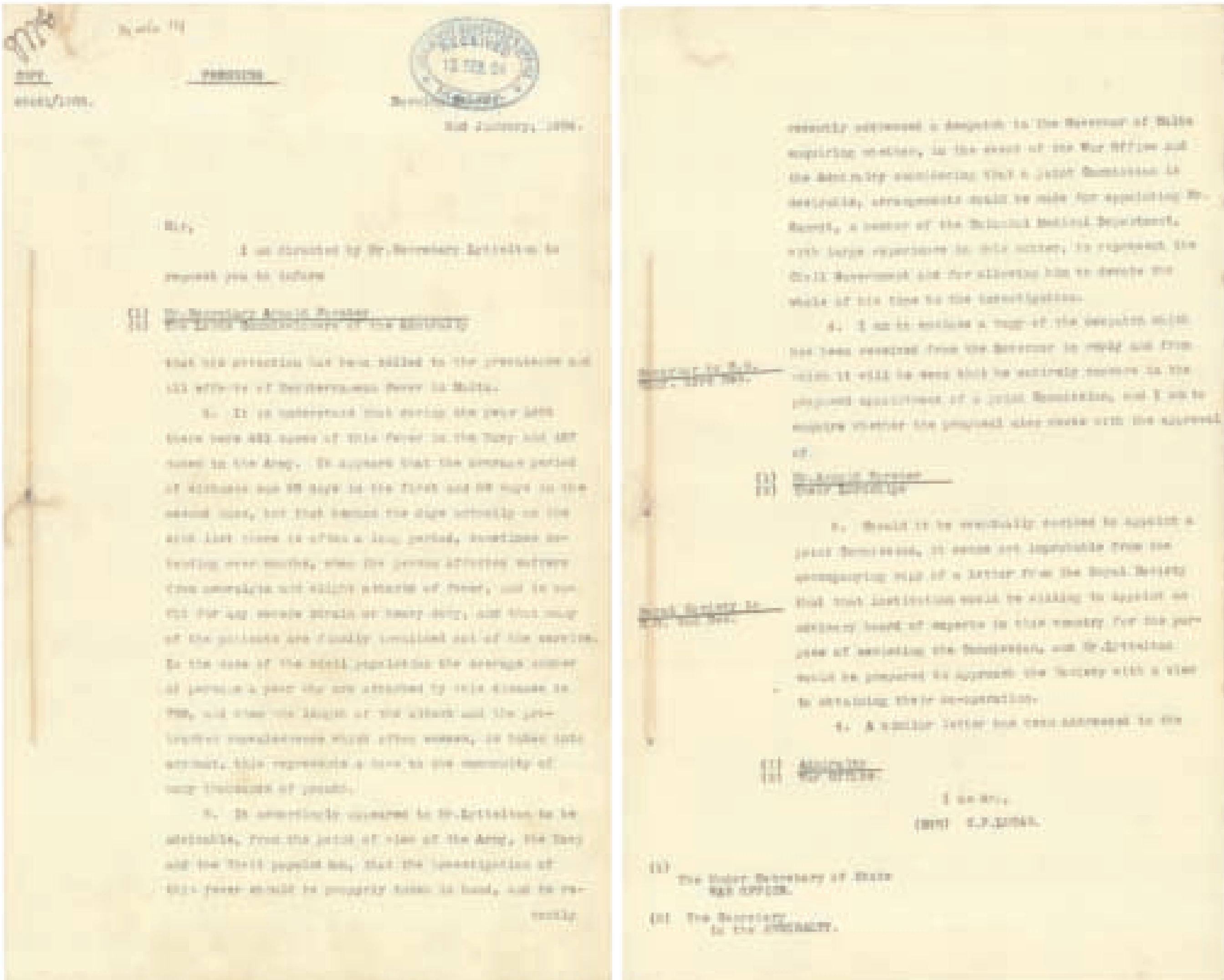
Visual Pathways

Our understanding of the human central nervous system took a major step forward at the beginning of the 20th century, with the work of the Spanish physiologist Santiago Ramón y Cajal (1852-1934). Born in a small town in Navarre and having studied at the University of Zaragoza, Ramón y Cajal was a professor at several universities in Spain, where his most important contributions were in pathology and histology. He demonstrated the existence of individual nervous cells (neurons) as the basic constituents of the human nervous system, describing these cells in some detail and clarifying their fundamental structural features and function. This discovery heralded a greater comprehension of the propagation of nerve impulses, the functioning of the human nervous system, and ultimately facilitated the emergence of modern neuroscience. In 1906, together with the Italian physiologist Camillo Golgi (1843-1926), Ramón y Cajal was awarded the Nobel Prize in Physiology or Medicine, "in recognition of their work on the structure of the nervous system".

Ramón y Cajal's contributions to neuroanatomy are manifold but his most important was without doubt the clarification of the nature of nerve cells, showing the individual character of neurons, and the highly interconnected networks formed by these cells. His careful and striking drawings are superb examples of scientific diagrams and of illustrations carefully conceived to explain complex anatomical and physiological structures.

The document presented here is a drawing made by Ramon y Cajal around 1901, showing an outline of the optical pathways. It belongs to a scientific manuscript of a seminal work on the visual, auditory and olfactory centres of mammals, presented by Santiago Ramón y Cajal and his brother Pedro, to apply for the Martínez y Molina Prize awarded by the Royal Spanish National Academy of Medicine. Both brothers won that prize in 1902.

The document is a general scheme of the nerve cells from the eye to the brain, that is, the radiations of the optical centres and the visual pathways. It is clear enough to allow the identification of the different organs and parts depicted: A, Retina; B, Optic nerve; C, Common ocular motor nerve; D, External geniculate body; E, Superior colliculus; F, Optic fibers; G, Visual cortex; K, Central optical pathway; J, Path of visual memories; L, Motor pathway born in the visual sphere; M, Descending optical path of the superior colliculus; H, Common ocular motor nucleus; O, Collaterals of the central motor ways.



Appointment of a joint commission to investigate Mediterranean Fever, 2-1-1904

2 pages, typewriter, paper; 33,0×24,0 cm

National Archives of Malta

Ref Code: NAM/GOV 2.2/14/9 February 1904

The eradication of Malta Fever

Malta Fever, also known as Mediterranean Fever, Undulant Fever or *Brucellosis* is a highly contagious disease caused by a microorganism. Its symptoms are similar to those of other febrile diseases, such as muscular pain and night sweats, but they can persist for long periods of time, from a few weeks up to many months and even years. It is a disease that causes a great deal of incapacity and until recent times it was rampant in Malta.

In 1886 David Bruce, a British Army doctor serving in Malta, discovered the causative agent of the disease: a microbe that was named *Brucella Melitensis*. While Bruce's discovery was of fundamental importance, it could not be used to combat the disease and safeguard the health of the populations because it was not known by what means Brucella entered the human body.

In the beginning of the 20th century, Malta was part of the British Empire and the Imperial authorities decided to set up a medical commission to study this problem and to clarify how the microbe entered the human body. The document presented here is the appointment in 1904 of that commission to investigate Mediterranean Fever. The commission included Themistocles Zammit (1864-1935), a Maltese doctor who had specialised in bacteriology in Paris and London and would play a crucial role in the cure of the disease. The members of the commission started a systematic search for the microbe. They searched for it in drainage fluids, in the air, in the dust of the streets, in drinking water and in sea water, in mosquitoes and other insects. They also carried out experiments on guinea-pigs and on monkeys housed on the roof of the Health Department at Valletta. And still the microbe eluded them. Eventually, experiments were also carried out in goats.

At that time goats were driven into towns and villages in large herds to supply families with milk. The task of experimenting with goats fell to Dr. Zammit who, on 25 June 1905, discovered the microbe in their blood. Zammit thus showed that the microbe was transmitted to humans through the consumption of milk from infected goats.The same members of the commission rapidly showed that the microbe could be destroyed by boiling the goats' milk but the populations took little heed of the warnings of the health authorities to boil the milk before drinking. Indeed, there was no lowering of the incidence of the disease among the civilian population. Undulant Fever, however, disappeared completely in the British navy and garrison when soldiers and sailors were no longer provided with goats' milk.

By 1922 it was realised that pasteurisation of milk on a national scale was the only means of combating the disease. The idea was only put into effect in 1938 when authorities introduced the pasteurisation of milk and prohibited the sale of unpasteurised milk and the entry of goats into towns. Undulant Fever was eradicated.

Dr. Egas Moniz making his lecture at Lisbon Medical School, 24-7-1927

1 photo negative on glass, b/w; 9,0×12,0 cm

Torre do Tombo – National Archives of Portugal

Ref Code: PT/TT/EPJS/SF/001-001/0006/0965B

Egas Moniz lecturing in Lisbon

António Egas Moniz (1874-1955) was a renowned Portuguese medical doctor with major contributions in neurology, along with the development of new techniques to study the brain and in the treatment of mental illnesses. He was a pioneer in cerebral angiography and also developed a technique called leucotomy. In 1949 he was awarded the Nobel Prize in Physiology or Medicine, together with the physiologist Walter Hess. Although the prize was attributed to him on account of leucotomy, the technique was later abandoned on ethical grounds.

Egas Moniz completed his medical studies at the University of Coimbra in 1899, and remained a lecturer there until 1911, when he was appointed neurology professor at the University of Lisbon. His medical career was sporadically interrupted due to his involvement in various political and diplomatic activities, but in 1926 he abandoned his political posts and returned full time to medicine. The years immediately after his return were very productive. He established the basis of cerebral angiography, pursuing the idea that visualising blood vessels in the brain with radiographic means would allow for more precise localisation of brain tumours. He was the first person to successfully visualise the brain using radiopaque substances, as previous scientists had only visualised peripheral structures. Moniz presented his results to great acclaim in 1927, both in Portugal and France. At the Neurological Society in Paris and the French Academy of Medicine his results generated great interest and immediately caught the attention of the Nobel Committee.

The photograph presented here dates from that period. Egas Moniz is giving a lecture at the Faculty of Medicine in Lisbon, to an attentive audience of fellow doctors. The scene took place very close to the moment when he succeeded in obtaining the first arteriography of a living human being (28 June 1927). Egas Moniz was three times nominated for the Nobel Prize on account of his results in angiography, but it would be his more controversial leucotomy, a surgical procedure he developed in the 1930s to treat extreme mental illnesses, that finally persuaded the Nobel Committee to attribute the prize to him.

02

ENERGY AND INDUSTRY

Machines to enhance and amplify the power of the human body have been in use since remotest antiquity. The simplest of machines, the lever, seems to have emerged independently in many different cultures, thousands of years ago. Simple systems of pulleys and cranks have been used all around the world for many centuries. The advantage provided by machines is anything but a modern discovery.

Machines became more sophisticated throughout history in a flurry of unstoppable technological development. In Europe, during the 19th century, the introduction of the steam engine in factories led to radical changes and to exponential increases in productivity. The development of machines was so dramatic in Europe, and the growth of their use in industry had such radical consequences, that historians have labelled this an ‘Industrial Revolution’. Based on ever more powerful and efficient machines, the industries in Europe grew in size and ambition. Production levels exploded, with the exploration of the planet’s resources increasingly based on vast industrial complexes that deploy machines of gigantic dimensions.

While machines were an indispensable element in the economic development of Europe and the world, their impact has been felt well beyond the economic sphere. Consider the societal impact of television on the modern world. Or, ponder the impact of machines and industrial processes in our eating habits and the way we dress. Or, on a darker note, the crucial importance of machinery in warfare and in creating the potential for mass destruction. Machines and industrial processes have shaped our lives in ways so deep that it is almost impossible to disentangle them from the very fabric of our societies and our collective conscience.

The story of the construction of machines and the improvement of technologies related to industry has always been a remarkable story of inventiveness, discovery, and many times of sheer intellectual brilliance. It has also been a story of collective work, of common efforts to overcome obstacles that sometimes seemed unsurmountable. Engineering feats are to be counted among some of humanity’s greatest creations. For example, modern bridges are often technical accomplishments of such complexity and difficulty and indeed beauty at times, that one feels tempted to place them alongside iconic accomplishments in science, literature and the arts.

The wide-ranging documents in this exhibition relate to a variety of machines and industrial procedures that are part of the history of Europe, from the 15th to the 20th century. Here one finds documents about constructions for the management of water, and about machines for the sieving of tobacco; diagrams of coal mines and plants of a dyeing factory; patents for new industrial processes as well as patents for a new type of refrigerators. They have all left a mark on Europe, albeit in very different manner they have left some mark in the history of Europe.. Preserving these documents preserves the memory of an important part of Europe’s history.

On the Making of Cannons and Missiles

Conrad Haas (1509-1576), a famous 16th century military engineer, was a pioneer of rocket propulsion and, indirectly, one of the earliest pioneers of space exploration. Not much is known about his biography. Born near Vienna, he went to Transylvania in 1551 and was later appointed *Arsenal Master* in Sibiu (German: Hermannstadt) by the Holy Roman Emperor Ferdinand I.

In 1529 he began writing an ambitious and surprisingly innovative treatise on rocket technology. Although rudimentary rockets are known to have been used in a military context in many places since the Middle Ages, especially in Asia, Conrad Haas' contribution displayed an altogether new level of technological sophistication. Using his knowledge not only of mathematics, but also chemistry, physics, ballistics and pyrotechnics - he was well versed in fireworks and weapons technologies, he produced a text which presents for the first time many concepts and designs that became established in modern rocket technology. He is thus one of the undisputed pioneers of modern missile and rocket engineering. The text is ambitious and original, a true masterpiece in its genre, with no less than 17 types of rockets described. Haas was the first person known to put into writing the concept of motion of multi-stage rockets (two and three stages), of different fuel mixtures using liquid fuel (including brandy!), delta-shaped fins for the flying machines (´the flying houses´) and bell-shaped nozzles. Besides the calculations and written descriptions of these fundamentally innovative technologies, Conrad Haas also provided stunning colour illustrations in his manuscript to show the design of his devices and experiments.

Haas appears to have worked on this treatise for several years. The manuscript was completely unknown until its discovery in 1961 in the Sibiu public records.

The item presented here consists of three different manuscripts: a book of fireworks (ff. 1-36), a book of military techniques (ff. 37-111) and the manuscript of Conrad Haas (ff. 112-394).

Manuscript of Conrad Haas -Coligatus of Conrad Haas from Sibiu about cannons and missiles, 1400-1569

Bound volume, 394 pages, manuscript on paper; with covers: 21×16 x 6 cm, without covers: 20,5×15 x 5,5 cm

National Archives of Romania

Ref Code: BU-F-00642-2286 (Centrale, Colecția Manuscrise nr. 2286)

Managing Water in Toledo

Water management has a long tradition in Iberia. With long, hot, dry summers, and certain areas where water is scarce, an efficient and rational use of water has always been a serious issue for the various peoples that inhabited the Iberian Peninsula. As a result, complex irrigation schemes and sophisticated water management machines were installed in many parts of the peninsula, throughout the centuries.

The document shows the plan for a machine to raise fresh water from the river Tagus to the Alcazar de Toledo, to supply the city. The ambitious plan was designed by Giovanni Turriano (ca. 1505-1585) known in Spain as Juanelo Turriano, an engineer and technical advisor to King Charles I. Born in Cremona, Italy, Turriano moved to Spain in 1529 to serve king Charles V, initially as a clockmaker and Court Clock Master. A brilliant and somewhat eccentric personality, he soon started many other projects and inventions, and participated in different technical enterprises. After Charles' death in 1558, he passed to the service of his son, King Philipp II, and was appointed Matematico Mayor.

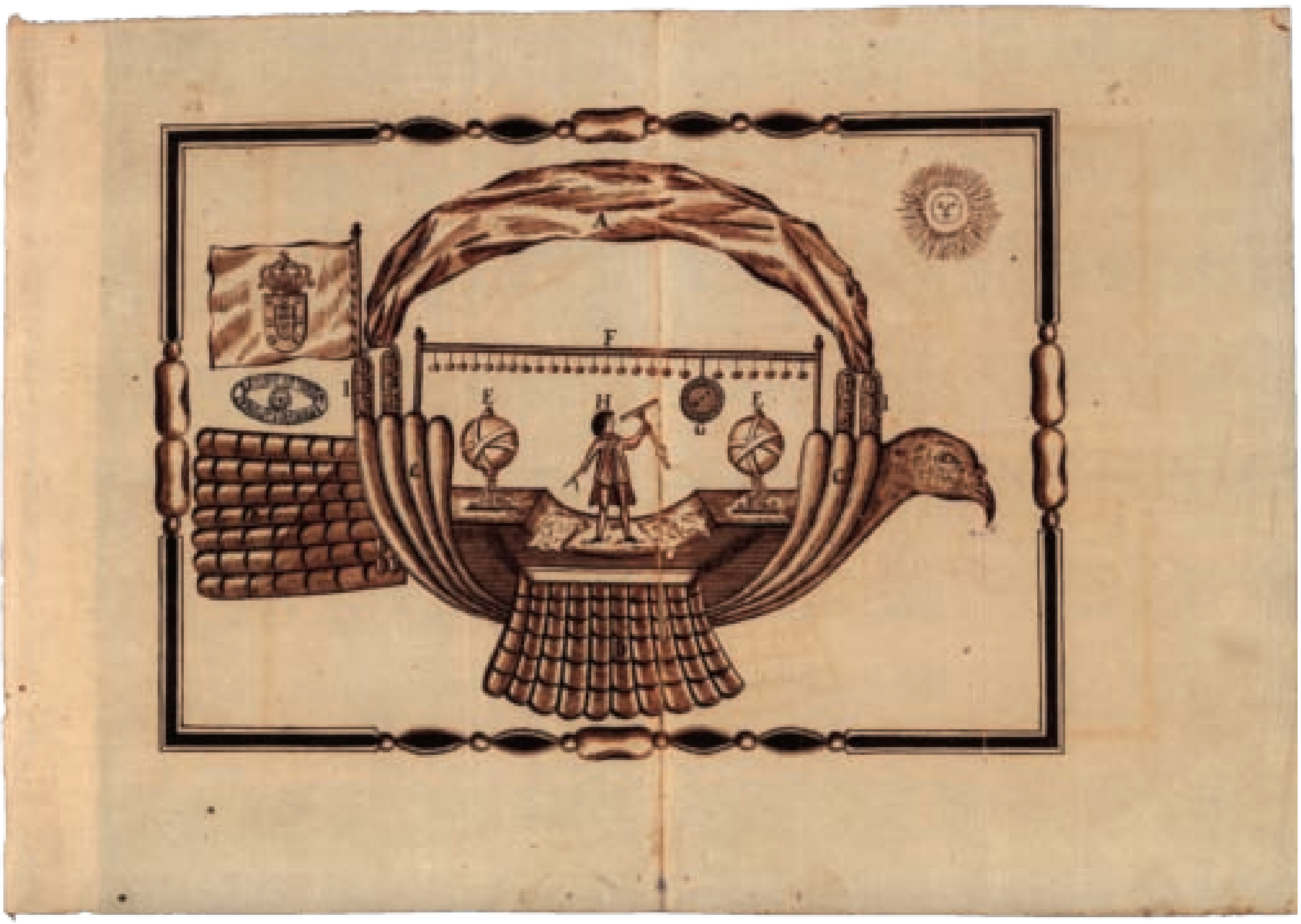
Turriano started living in the city of Toledo in 1534. The old constructions that used to provide water to the city - an aqueduct built by the Romans and a giant water wheel built during the time of Islamic domination - had been destroyed, and water was brought from the nearby river Tagus by horses and donkeys, enduring a climb of some 100 metres. Turriano must have been aware of the problem from the time of his arrival in the city but it appears he took a few years before starting work on an engine to supply fresh water to the Alcazar of Toledo. The plan presented here is from 1561, but construction seems to have been delayed until around 1565. The first engine he built was a success; it was working at full capacity by 1568. Despite some legal disputes, Turriano was commissioned to build a second one, which went into operation in 1581. The two mechanisms, known as *Artificio de Juanelo*, were considered engineering wonders at the time and efficiently solved most of Toledo's water problems. The machines were in operation until 1639. By then, general lack of maintenance and even thefts rendered the machines inoperative and they were later disassembled and afterwards abandoned.

Plan of a machine to raise fresh water from the river to the Alcazar of Toledo and supply the city, 17-10-1561, Toledo (Spain)

1 page, coloured drawing on paper; 59×44 cm

Spanish State Archives – General Archive of Simancas

Ref Code: ES.47161.AGS/5.1//MPD,27,3



Letters, consultations and more works of Alexandre de Gusmão: The aerostatic machine of Father Bartolomeu de Guerreiro, [17--], Lisbon

1 page of a bound volume of 204 pages, paper; dimension of the design: 21,6 x 30,0 x cm; book: 22,5×47,0×2,0 cm

Torre do Tombo – National Archive of Portugal

Ref Code: PT/TT/MSLIV/1011

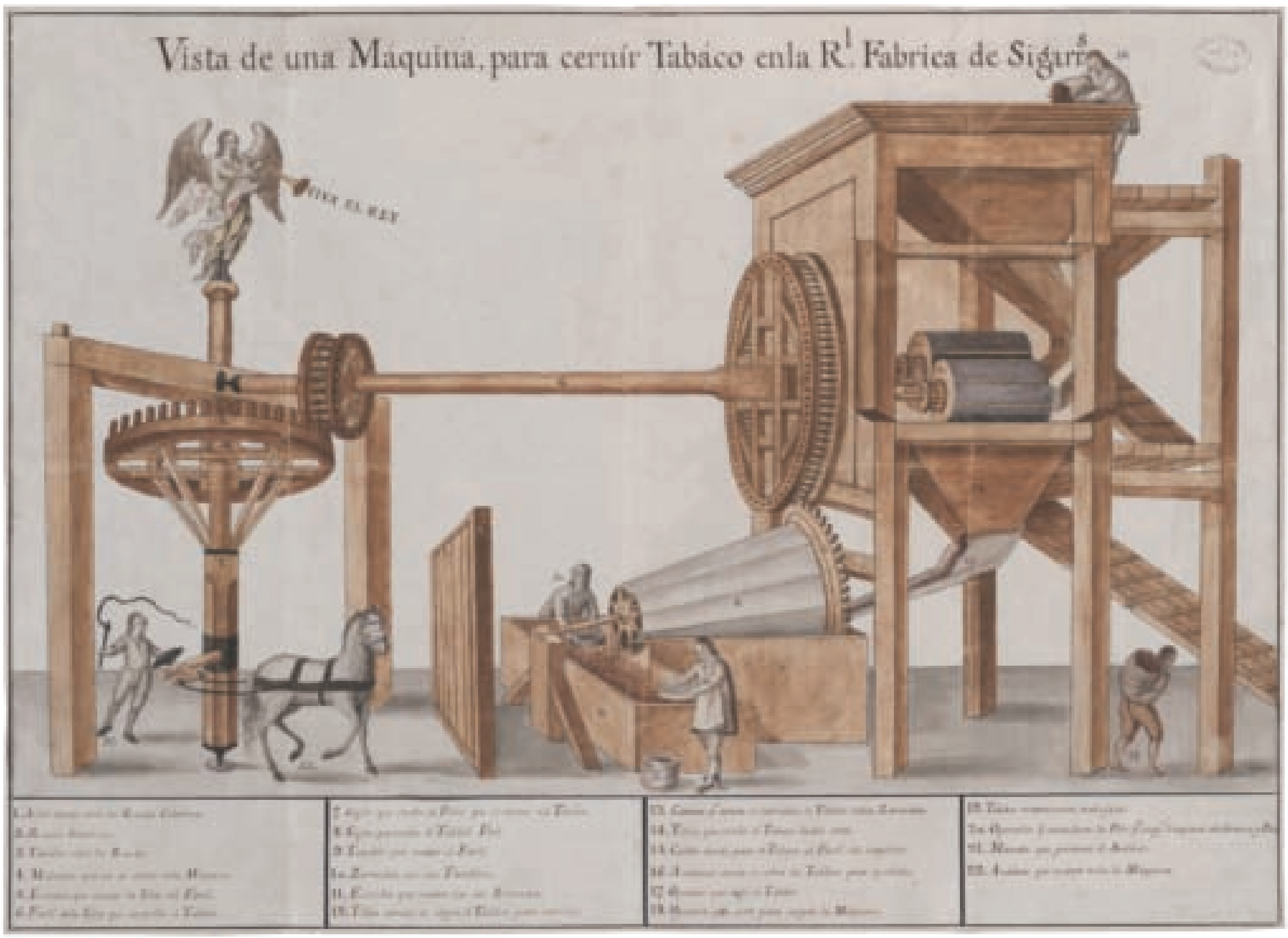
A priestly project to fly

The idea of human flight has fired our imagination since antiquity. A constant theme for writers and artists, it also fascinated inventors and scientists.

In 1709 a young Jesuit priest called Bartolomeu Lourenço de Gusmão petitioned the Portuguese King, John V, for the right to construct a vehicle to move in the sky. According to Gusmão, his vehicle would be able to fly for more than two hundred leagues over sea or land. Besides its obvious military application, the vehicle could also reach the regions near the poles of the world, thus adding further glory to the King of Portugal. The King was obviously interested by the idea and just a few days afterwards, on 17 April 1709, authorised the construction, granting exclusive rights to the Jesuit father.

Outlandish stories featuring amazing machines, mingled with gossip and sarcasm, spread very quickly. It wasn't long before a picture of the supposed flying apparatus appeared, showing a remarkable vehicle inspired by the anatomy of a bird. The supposed flying machine was given certain scientific gravitas by the inclusion of scientific instruments on board, such as globes and a telescope. As it happens, Gusmão's actual proposal was much more modest, but also more realistic. A few months later, in August 1709, he was allowed to make a demonstration of his projects at the Royal Court, in front of the King, Queen and all dignitaries of the country. What Gusmão did on that occasion was to demonstrate the flight of a hot air balloon, using a small prototype to show that it was able to fly. The balloon rose in front of the spectators, eventually reaching the ceiling of the room, where it had to be rapidly destroyed in order not to start a fire.

It appears Bartolomeu Lourenço de Gusmão performed demonstrations with hot air balloons on some other occasions, but his projects didn't go much further. Many decades later, the French Montgolfier brothers finally achieved successful balloon flight. Gusmão's plans were soon forgotten, one more episode in the long list of heroic and ingenious attempts to take flight.



"View of a tobacco sieving machine from The Royal Cigar Factory of Mexico", 1785

1 sheet, coloured drawing on paper; 30,7×42,5 cm

Spanish State Archives – General Archive of the Indies

Ref Code: S.41091.AGI//MP-INGENIOS,162

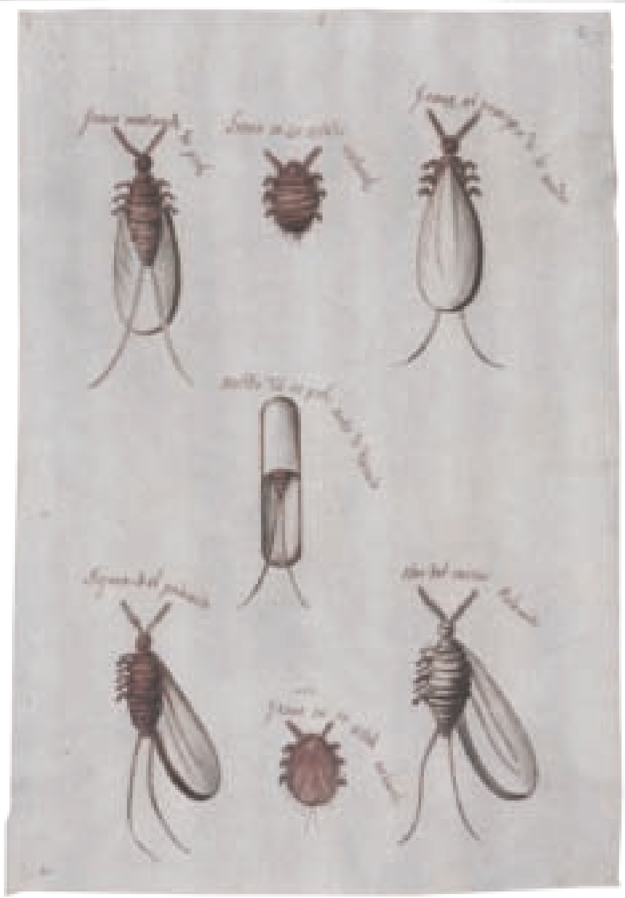
Tobacco Sieving in Mexico

Tobacco had been used by the native peoples of America long before Europeans arrived on their continent. The new arrivals quickly took to it, and tobacco became a very lucrative product as the smoking habit spread across Europe, and on to Japan.

Tobacco was used by the native peoples of America for different purposes and in a variety of contexts. It was a form of currency and could be traded; it was a ceremonial product to consume on special occasions, either political, diplomatic or religious; it was a pain killer and medicine to treat different sorts of ailments, thought to be especially effective in respiratory diseases and tuberculosis; it was also consumed on social occasions, as a form of leisure. The religious use of tobacco is still common today among many indigenous peoples in the Americas.

Europeans changed the uses of tobacco, initially using it mainly as a medicine and pain killer, but its social function also interested the new consumers. This bolstered consumption and demand, and tobacco was on sale in various European cities by the early decades of the 16th century. In 1559 the French ambassador in Lisbon, Jean Nicot, sent samples of the new product to France (hence the name nicotine). The demand for tobacco across Europe led to increased cultivation and enhanced preparation techniques, as cigars, cigarettes and other tobacco products came on the market.

The Tobacco estanco was established in Mexico during the second half of the 18th century, within the framework of the Bourbon reforms. It resulted in the creation of a monopoly for the cultivation, production and trade of tobacco, allowing the state to effectively corner the market. Technological progress boosted the commercial possibilities. In 1768 the Royal Factory of Cigars of Mexico was the first to be founded in America, concentrating the manufacturing operations that were previously carried out in craft workshops. This streamlining and technological progress led to a significant decrease in production costs.



Dyeing with Cochineal

The drawings presented here show the insect called grana or cochineal, from which an important and popular natural dye (crimson) was extracted. The documents show different steps in the harvest and processing of the insect, along with production of the dye as it was carried out in Oaxaca, Mexico, in the early 19th century. The insect is shown through its life cycle and we also learn how the grana was obtained: they are found on some species of cacti, where they are collected by brushing them off the plants, before being killed and dried.

Cochineal dye originates from the American continent, where it was used by the Aztec and Maya as early as the 2nd century BC. By the time Spanish colonisers arrived in the 15th century, the dye was used extensively in America for colouring fabrics. The European newcomers were quick to grasp the commercial opportunities offered by this dye, with demand booming as they began exporting it back to Spain. Cochineal, produced almost exclusively in Oaxaca by indigenous producers, became Mexico's second-most valuable export after silver. It was traded and consumed throughout Europe and in the 17th century it reached many regions in Asia. The invention of chemical and synthetic dyes in the late 19th century eventually saw its use decline in Europe. Cochineal dye is but one example of the many products and goods that were introduced into Europe and elsewhere from other continents in the 16th century, thus changing traditional processes and daily habits in a profound manner.

The document comprises three sheets. *Sheet 1* presents illustrations of the insect and the cactus, its nesting in a stalk of the plant. A male figure is drawn brushing the insects and collecting them in a container. *Sheet 2* displays the cochineal insect at different stages in its life cycle. *Sheet 3* presents the process of killing cochineal insects. It could be done by boiling them in a pot or by introducing them into a ‘tenate’ or basket and suffocating them by means of steam in an oven or ‘temascal’. The process ends with the drying of insects in the sun.

Drawings of the insect called grana or cochineal, its harvest and processing in Oaxaca,
29-10-1821, Madrid

3 sheets, coloured drawings on paper; 30,5×21 cm
Spanish State Archives – General Archive of the Indies
Ref Code: ES.41091.AGI/27.17//MP-MEXICO,515

Map of the Brennberg Coal Mine, 1825

1 sheet, coloured drawing on paper; 33,7×49,8 cm

Győr-Moson-Sopron County Archives in Sopron of the National Archives of Hungary

Ref Code: HU-MNL-GYMSMSL – IV – 1403 – c – 17. (XXV.) – Nr. 3532/1.

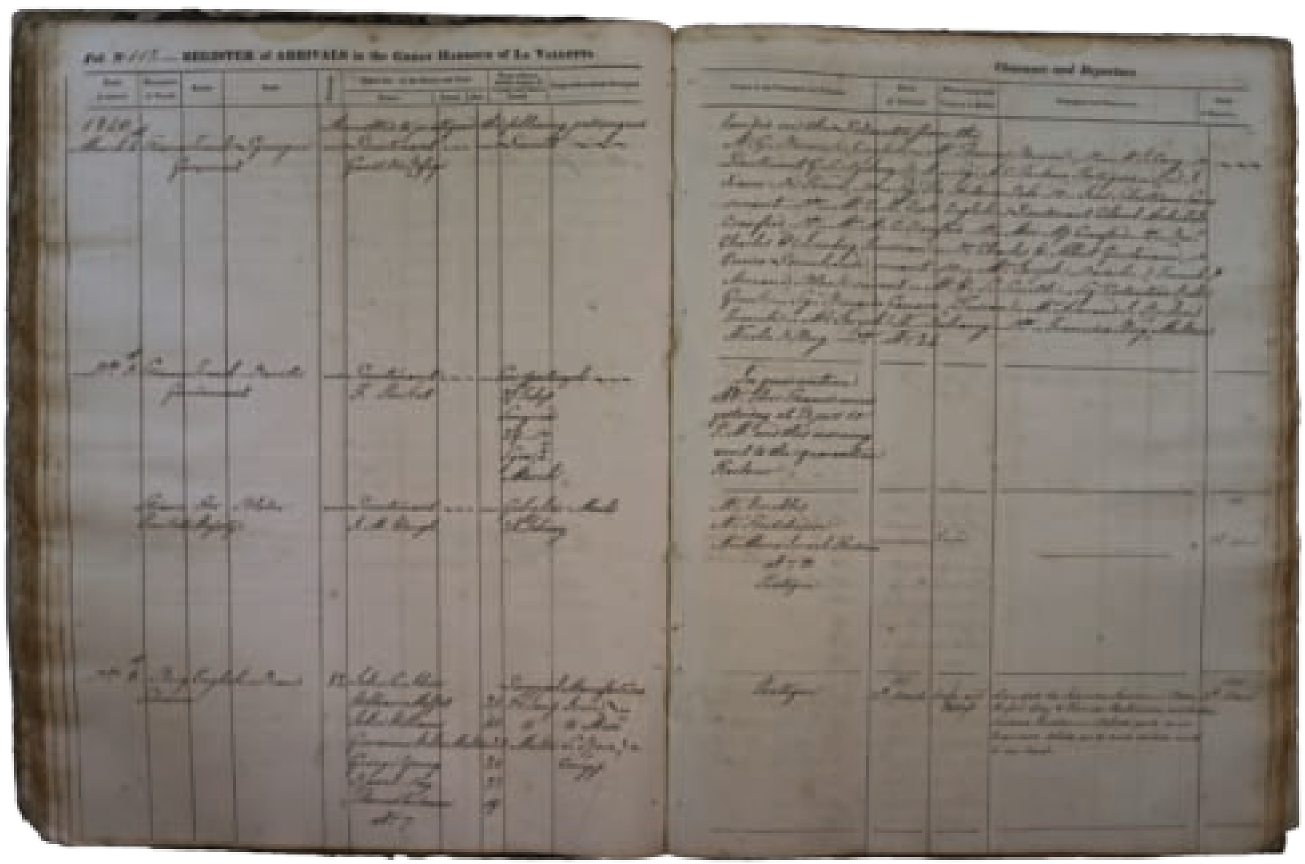
Map of the Brennberg Coal Mine

The mines in the village of Brennbergbánya (today part of Sopron, Hungary, in German: Brennberg), were some of the most important coal mines in Hungary for about two centuries. They were also some of the most challenging and difficult due to their physical characteristics, especially due to the great depth and the high temperatures experienced inside.

Although the exploration of surface deposits of coal dates back to ancient times, it was only in the 18th century that demand for coal to power steam engines increased to enormous proportions. And while coal can be found at the surface, the richest deposits of coal are located underground.

The high-quality coalfields near Sopron were discovered in 1753 when, according to legend, a shepherd observed burning stones, a sight that appeared to him to be a miracle. Curiosity helped overcome his fears and he is said to have collected some of these stones and brought them home. The rich coal of Brennberg had been discovered, with systematic exploration up and running with in a few years. The first coal mine in Hungary was opened there in 1759, owned by the Free Royal Town of Sopron, with exploration and production performed by the tenants. The map on display here, shows the coal mine in 1825.

Mining families of Austrian and German origin, where coal mining dated back to the Middle Ages, settled on the site. The number of miners increased greatly over time, spawning a settlement with its own church, school, kindergarten, movie theatre, post office, restaurant, etc. The story of the Brennberg coal mines involves many ups and downs, shutdowns and re-openings throughout the years, while always maintaining the highest standards in the difficult and dangerous profession of mining. By the early 1950s the mine was said to be economically inefficient, and in December 1959 it was permanently shut down.



Arrival of the French steamer 'Dante' in the Grand Harbour of Malta, 4-3-1840, Malta

2 pages of a volume, handwritten, pre-printed form, paper; 52×80 cm (open volume)

National Archives of Malta

Ref Code: CUS 18/49

The Steamer *Dante* arrives in the Maltese harbour

Everyday administrative records can document moments of great significance. The document shown here records the arrival of the French steamer, *Dante*, at the Grand Harbour of Malta on March 4th, 1840. Maltese harbours were crucial in the island's development, of course, and records about all activities were carefully and diligently kept.

This record is important because on board the *Dante* were two Frenchmen that played a vital role in the early introduction of photography to Malta: Émile Jean-Horace Vernet (1789-1865) and his nephew Frèdèric Auguste Antoine Goupil-Fesquet (1806-1893). Horace Vernet was the son of Carle Vernet, known for his realistic, large-scale panoramic paintings of battles in the Napoleonic Wars. The party started out from Marseilles to Malta in October 1839. They departed Malta for the island of Syros and continued on to Santorini, Crete and Smyrna, and subsequently visited Egypt (Alexandria, the Nile, Cairo), the Holy Land, Syria, followed by a short stay in Constantinople. They gathered sketches and other material but more significantly, they produced many Daguerreotypes of the sites they visited, using the new photographic technique that had appeared in France just some months before.

On their way back to France on the steamer *Dante* they stopped again in Malta on March 4th, 1840. Arriving from the Levant, they were placed in quarantine. Not surprisingly they used their confinement in the Lazzaretto to show off the new amazing photographic process. The newspaper *Il Portafoglio Maltese* recorded that during their forced stay in the quarantine islet they invited the Governor, Sir Henry Bouverie, other artists and distinguished guests, including the French Consul, to witness a practical demonstration of the new art. The newspaper claimed that the experiment was “perfectly successful” (*Il Portafoglio Maltese*, March 16th, 1840) adding that the daguerreotypes were so detailed, “that the pedestal inscription of the statue, hardly visible to the naked eye, was legible by using a lens.”

Thus the remarkable new technique that Louis Daguerre (1787-1851) had developed and made public in France in 1839, arrived in Malta only some months afterwards.


PLANTA TOPOGRAPHICA

A Stamping and Dyeing factory in Lisbon

Industrialisation during the mid-19th century had a significant impact on city landscapes. The document here illustrates the effects that new industrial facilities had on the urban environment.

The document is part of the administrative procedure to obtain construction permits, submitted by one Francisco de Silva Pinto, on 14 March, 1856, in Lisbon. It is the topographic plan of a Stamping and Dyeing Factory, owned by Francisco da Silva Pinto, in an industrial neighbourhood in Lisbon. This unpretentious topographic plan, carefully made in a 1/250 scale by an architect named V. J. Correia, provides a bird's eye-view of the construction work around the factory.

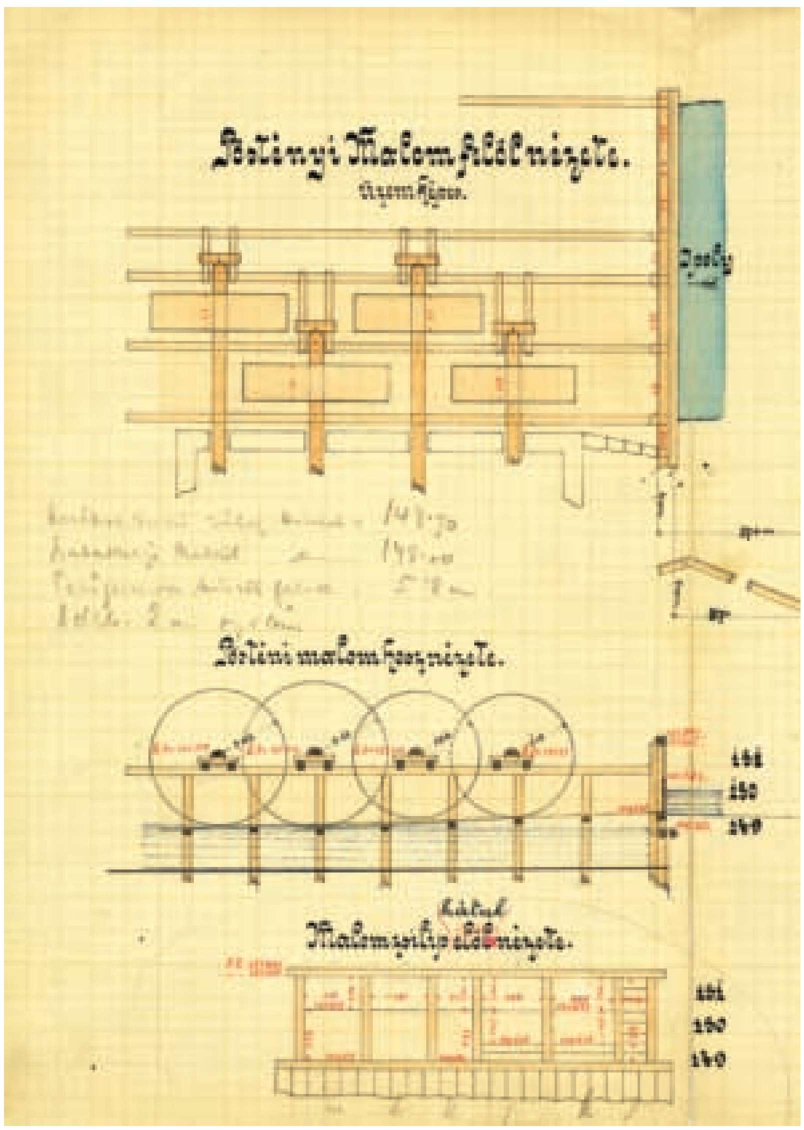
The plan, in the north-south direction, shows dwelling places, a tank and well, fields for staining fabrics, washing buildings, a group of buildings with an exit to the main road, with the house of habitation and the house of the porter on each side. It also shows the building for dyeing, the building housing the boilers, the water-mill and well, the washing house and two tanks. In addition to these main buildings there are auxiliary constructions such as the carpentry workshop, a haystack, the house for the calendar (a machine that presses cloth) and deposit of drugs, a press house and a general warehouse with terrace, the building for preparation of the paints, the barrack of the dyeing vat, the barrack of the washers, the printing house, latrines, and more.

"Topographic plant of the Stamping and Dyeing Factory, belonging to Francisco da Silva Pinto, located Chelas road, No. 22, parish of Saint Bartolomeu of Lisbon, Olivais county", undated.

1 sheet hand-colored drawing on paper; 111,5×62,0 cm

Torre do Tombo – National Archive of Portugal

Ref Code: PT/TT/MR/1/123



Structural design of the water mill in Pöstény

Extracting power from running watercourses or rivers is an age-old form of energy production. Water mills were used across Europe and the world, in many different cultures wherever flowing water was to be found. Early mills, built centuries ago using rudimentary devices, progressively developed into more efficient machines. They have been used to power different forms of artisanal production, a common sight in many landscapes and a reminder of the ingenious ways that humans have tapped natural resources.

There are many watercourses in the region of the Cserhát Mountains, in Hungary. During the 18-19th centuries, virtually every small town or settlement in the region had at least one water mill, deployed to take advantage of the natural surroundings.

The most important river in the historical Nógrád County is Ipoly, a 232-kilometre-long river and a tributary of the Danube, which was suitable for operating water mills on several of its stretches. These favourable conditions led to extensive and notorious development in the settlements in those neighbourhoods.

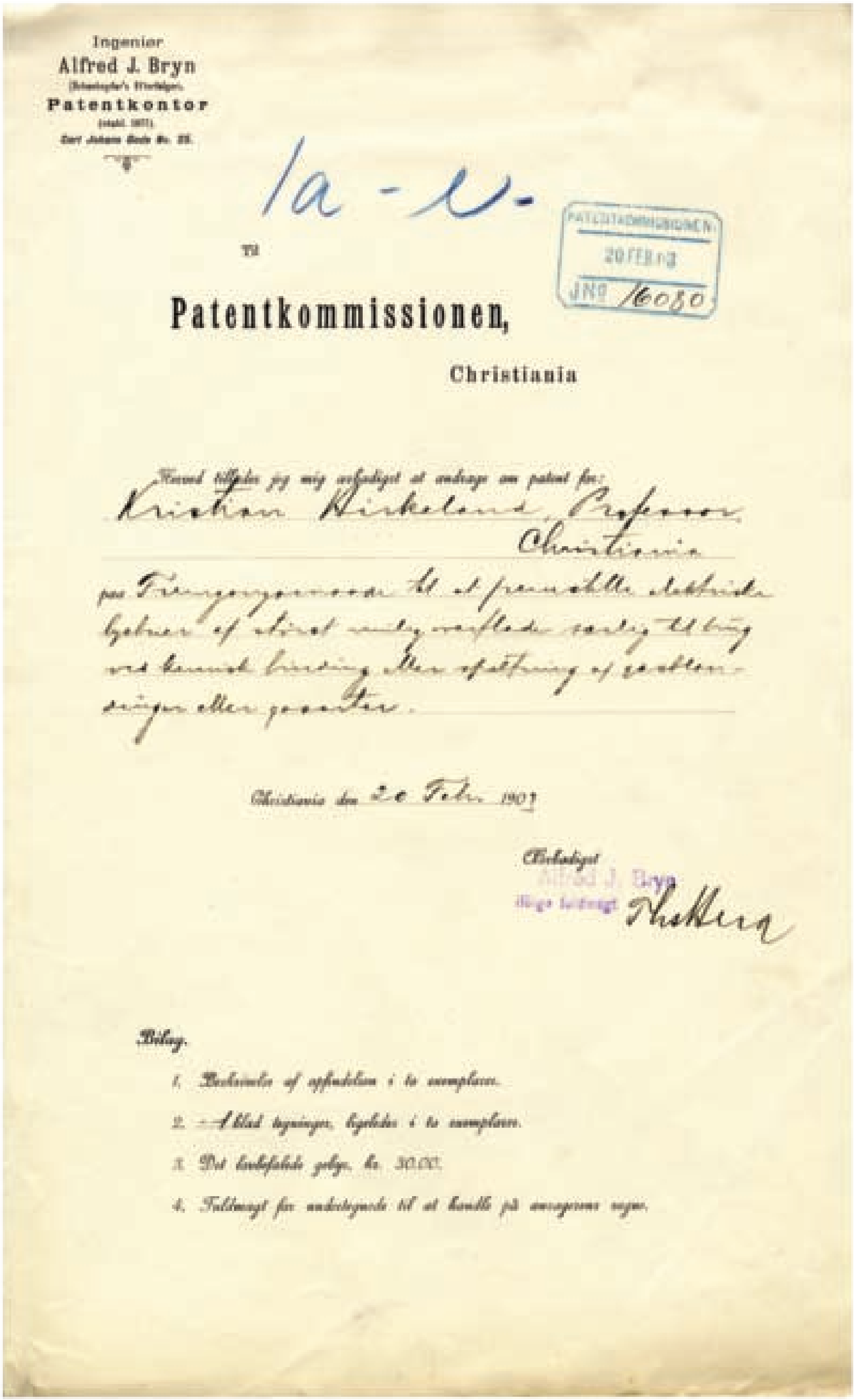
Water mills were common in the area until the mid 19th century, with several mills operating in the vicinity of Szécsény and Balassagyarmat. However, new regulations affecting water management were issued in the second half of the 19th century. Nationwide stipulations were imposed to regulate the flow of many rivers in an attempt to diminish and control the effects of floods. As a result, most water mills were decommissioned after the regulations were applied to the river Ipoly. Yet the Pöstény (today: Pösténypuszta, part of Szécsény, Hungary) water mill remained; in fact, it was renewedin 1892. The document presented here shows the plans of this mill.

Structural design of the water mill in Pöstény, 1892

2 sheets hand-coloured drawing on paper; 55,5×33,5 cm

Nógrád County Archives of the National Archives of Hungary

Ref Code: HU-MNL-NML – IV – 536 – 2



Ingeniør
Alfred J. Bryn
Patentkontor
Carl Johans Gade No. 25.

1a - 21 -

PATENTKOMMISSIONEN
20 FEB 03
JNº 16030

Til

Patentkommissionen,

Christiania

Herved tillader jeg mig ærbødigst at andrage om patent for:
Kristian Birkeland, Professor,
Christiania

Christiania den 20 Febr. 1903

Ærbødigst
Alfred J. Bryn

Bilag.

1. Beskrivelse af opfindelsen i to exemplarer.
2. 1 blad tegninger, ligeledes i to exemplarer.
3. Det lovbefalede gebyr, kr. 30.00.
4. Fuldmagt for undertegnede til at handle på ansøgerens vegne.

The Birkeland-Eyde process

This bland and bureaucratic-looking document marks an important moment in the history of industrial processes and agricultural progress. It is a patent application submitted by Kristian Birkeland on 20 February 1903. Kristian Olaf Bernhard Birkeland (1867-1917) was a Norwegian scientist who made technical and scientific contributions to a number of different fields. In addition to several technological inventions he was especially noted for his pioneering investigations into the geophysics of the aurora borealis and the nature of the geomagnetic field in the polar regions. He is known, in particular, for having identified the so-called Birkeland currents.

In this patent application Kristian Birkeland proposed a novel industrial process for the production of nitrogen-based fertilizers. The idea had been developed by Kristian Birkeland and Sam Eyde (1866-1940), an engineer and entrepreneur. The new process, later known as the Birkeland-Eyde process, played a crucial role in the development of methods to manufacture artificial fertilisers to meet the western world´s growing demand for agricultural products in the early 20th Century.

The essence of the process is to convert atmospheric nitrogen (N2) into nitric acid (HNO3), one of several chemical processes generally referred to as nitrogen fixation. The resultant nitric acid was then used as a source of nitrate, NO3. The process requires a specific plasma arc, proposed here in a design which makes it economically viable for large-scale manufacture.

In collaboration with Sam Eyde, his engineers, and international funding sources, the process of manufacturing fertiliser was developed further, with the first factory built in Rjukan and Notodden, in Norway, in 1904. The factory started production with 34 arc furnaces in 1907.

Birkeland thus opened the way for the industrial production of fertilisers, a technological advance that had an enormous impact on agriculture, and hence food production and the living conditions of countless human beings. In the following decades, other energy-efficient processes were designed and constructed. But the Birkeland-Eyde electric arc furnace, based on the patent from 1903, remains a ground-breaking development that had a profound impact.

The Birkeland-Eyde process, 20-3-1903

1 page, handwritten, pre-printed form on paper; 33,02×21,59 cm

National Archives of Norway

Ref Code: S-1654/Dda/193B/Patent no. 12961

Coalmining at Svalbard. Minors at work down in the mine. Coal is being loaded on to the railway cars. Photo: Sigvald Moa, 1918, Svalbard (Norway)

2 black and white photos, no. 1: 9,78×14,29 cm, no. 2: 19,77×28,86 cm

National Archives of Norway

Ref Code: RA/PA-1632/D/L0001/0007 and 0009

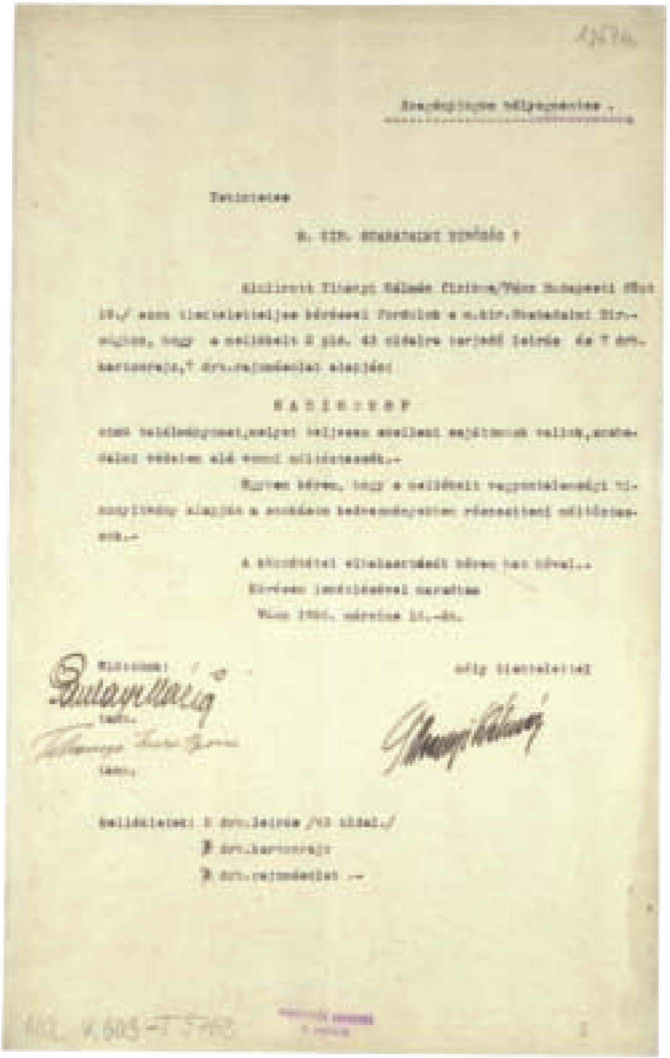
Coal Mining at Svalbard

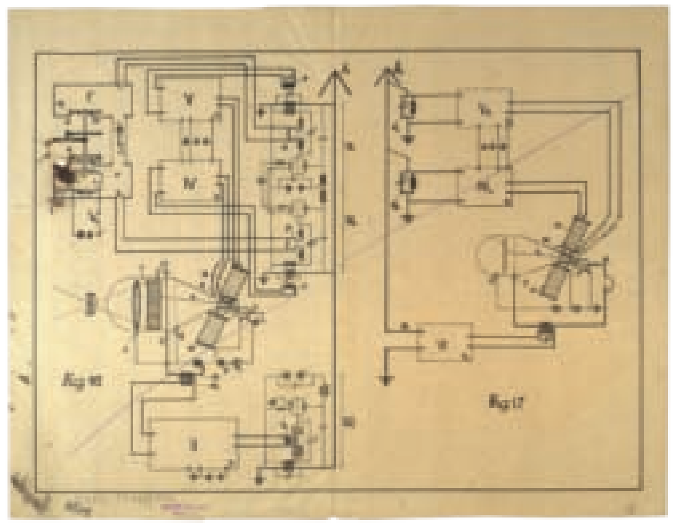
Coal was the most important energy source in the world from the late 19th to mid 20th century, when it was overtaken by petroleum and natural gas. Coal mining was a critical industry during its peak, and remains very relevant today, directly related to economic progress and development. In recent decades, however, variations in the commercial value of coal and a growing awareness of environmental issues along with policies destined to assure long-term sustainability have all affected the extraction of coal and the nature of the industry.

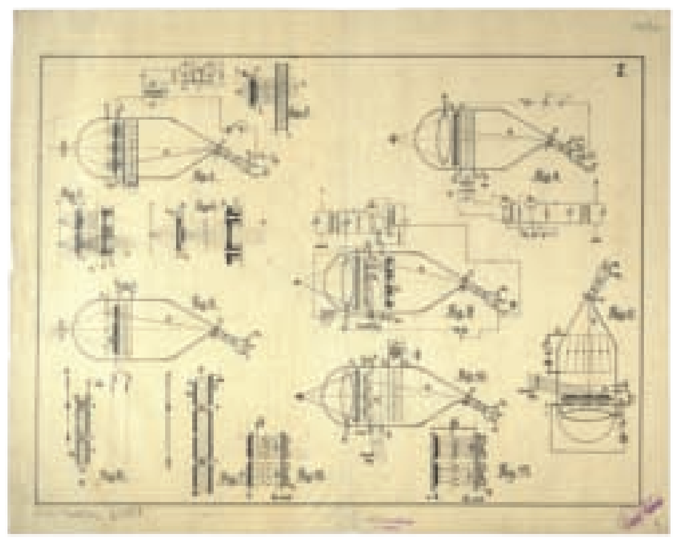
Svalbard, featured here, is an archipelago in the Arctic sea, north of mainland Europe. In the 17th and 18th centuries the islands were primarily used as a base for whaling activities. In the early 20th century, however, coal extraction began and in due course it became the dominant commercial activity in the islands. Treaties in the 1920s recognised Norwegian sovereignty in the archipelago, and various settlements dedicated to coal mining, both Norwegian and Russian, were created on Svalbard.

The photos capture mining activities and mining works on Svalbard in the early decades of the 20th century. In recent decades, the mining industry has progressively diminished at Svalbard. Kings Bay Kull Company, which had been exploring coal since the beginning of the century, stopped its activity in 1964, and since 2007, there has not been any significant mining in Barentsburg by the Russian state-owned Arktikugol. The last company, Store Norske Spitsbergen Kull Company in Longyearbyen is about to end its activities too. Attempts to explore alternative natural resources have been made, without success. Test drilling for petroleum on land was made, but did not give satisfactory results for permanent operation. The Norwegian authorities do not allow offshore petroleum activities for environmental reasons.

An epoch of intense coal extraction at Svalbard is coming to an end, at the same time as geopolitics has elevated the strategic importance of the Arctic archipelago.







Hungarian patent application entitled Radioskop filed by Kálmán Tihanyi, 20-3-1926

1 sheet with 14 attached drawings; 21×34 cm

National Archives of Hungary

Ref Code: HU-MNL-OL – K 603 – T –3768

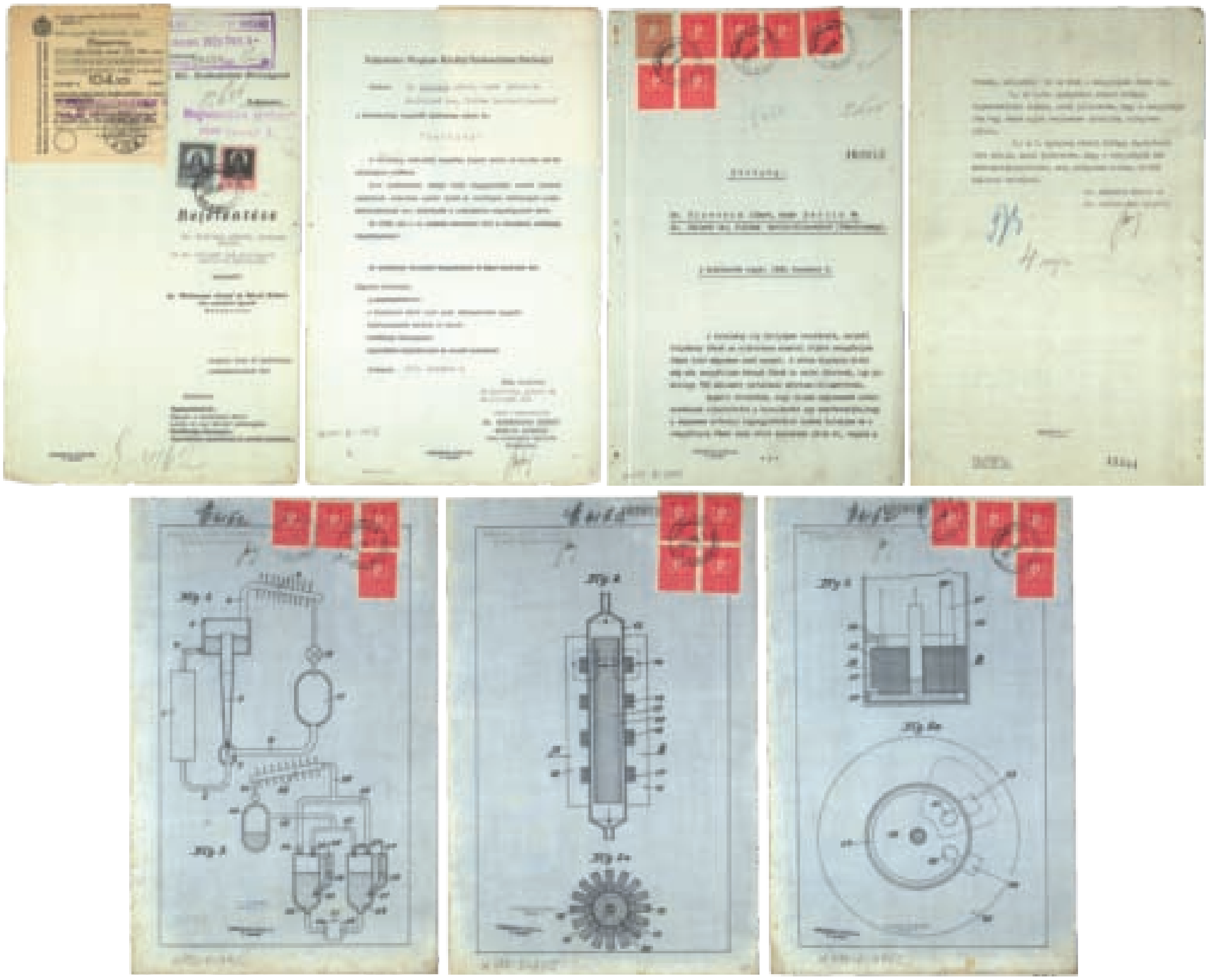
Invention of the High Resolution Television System

On 20 March 1926, Kálmán Tihanyi (1897–1947), a physicist, electrical engineer and inventor, submitted a patent application for a high resolution television system under the designation of Radioskop. The documents pertaining to this submission – one letter plus several folios with technical drawings – are today recognised as testimonies of a crucial moment in the creation and development of television systems.

Tihanyi was born in Zbehy, Slovakia (Hungarian: Üzbég), then the Kingdom of Hungary (now Zbehy, Slovakia) and graduated in 1917 at the School of Electrotechnical Studies in what is today Bratislava, Slovakia (Hungarian: Pozsony, German: Pressburg). His outstanding scientific talent and technical abilities were apparent from an early age. By the time he had reached his early twenties in 1918, he had already completed a military invention which received an important distinction, and another one that was sold to the military authorities. But it was the invention of the Radioskop in 1926 that really made his name.

Systems for image transmission using cathode ray tubes, precursors of television systems, had been discussed by several inventors since the beginning of the 20th century. But no truly efficient system had been produced because fundamental design issues were still to be resolved. The crucial step forward was provided by Kálmán Tihanyi in 1926 when he proposed a novel design and operation that was later known as 'storage principle'. The system he proposed became the basis of modern television: a system operating on the basis of continuous electron emission.

Tihanyi's dedication to the subject didn't stop with the patent application submitted in 1926. He evolved his original design and submitted a perfected system in 1938. In the meantime, he submitted many other patent applications for television-related inventions, in 1928, 1929, 1935, 1937 and 1939. All except the last one, a flat-screen plasma-type television, which could be hung on the wall, were sold to, and developed for mass production, by major manufacturers such as Loewe, Fernseh AG, and RCA. Kálmán Tihanyi also patented an infrared television camera in 1929, which was used for many years in military and civil applications.



Albert Einstein's and Leo Szilard's patent for refrigerators together with their plans, 30-11-1929, Berlin and 5-12-1929, Budapest

17+5 sheets, typewritten on paper; 34×21 cm

National Archives of Hungary

Ref Code: HU-MNL-OL – K 603 – E – 4162

Albert Einstein and Leo Szilárd's patent for refrigerators

Albert Einstein (1879-1955) needs no introduction. One of the most famous scientists of all time, Einstein is known for his revolutionary physical theories (especially the theory of relativity) and for his public stances. His discoveries and theories completely re-shaped physics in the first decades of the 20th century and they remain relevant today. Less known is Leó Szilárd (1898-1964), a brilliant and very creative Hungarian-born physicist, who helped conduct the first sustained nuclear chain reaction and was instrumental in initiating the Manhattan Project. Szilárd was also the author of other discoveries, namely a process for separating isotopes, developed with British physicist T. A. Chalmers.

Although both men – especially Einstein, of course – were noted for their scientific contributions, it is not widely known that they worked together in more prosaic matters. In the 1920s, Leó Szilárd met Albert Einstein during his physical studies in Berlin, and together they proposed several inventions. The document shown here refers to one such invention. It is a patent for refrigerators submitted by Einstein and Szilárd in 1929. The origin of this proposal is related to a tragic accident during which a family suffocated to death because of the poisonous gases leaking from their home refrigerator. The rather primitive and dangerous design of the refrigerators used at the time led Einstein and Szilárd to propose a new, safe refrigerator. Their refrigerator was without rotating parts, and operated with an electromagnetic pump. Plans of this invention were submitted by delegation on the 5th December 1929 to the Hungarian Royal Patent Court. on 11 November 1930, the patent was also awarded in the United States of America, under file No. 1.781.541. Despite its novelty, and the reputation of the inventors, the fridge was never actually manufactured. However the principle of the magnetic pump with coolant flow is still being used in nuclear power plants today.

25 of April bridge, Lisbon

The city of Lisbon lies on the banks of the vast estuary of the river Tagus. Lisbon occupied the northern (right) side of the river for many centuries, while the sparsely populated south (left) side of the river was used for agriculture and later as an industrial area. Travel between the two sides was very limited, with infrequent boat crossings the only way to traverse the estuary.

By the 20th century, the growth of Lisbon had created a demand for urban development on the south side, which would require the construction of a bridge. Government commissions began analysing the issue during the 1930s, but it would take until the early 1960s before design and construction were entrusted to a consortium headed by the United States Steel Export Company. Construction started in 1962, and the opening of the bridge was greeted by an enthusiastic public on 6 August 1966. Finally, the two sides of the river were connected.

The bridge over the Tagus remains a remarkable piece of engineering. With a total length of 2,277 meters the bridge was, at the time of its inauguration, the largest suspended steel structure in Europe and the fifth largest in the world. It has one of the longest trusses in the world, with both main towers rising to about 190 meters above water level, with a free sailing height of 70 meters ensuring that large ships can access the port of Lisbon. The bridge was officially inaugurated as 'Salazar Bridge', in honour of the President of the Council of Ministers, António de Oliveira Salazar. With the revolution in April 1974, its name was changed to 'Bridge 25 of April'.

As usual with engineering constructions of such magnitude, the bridge generated some controversy during its planning and construction phases. However, the enormous advantages of its presence soon became apparent and it would be impossible to find a person doubting the importance of this construction today. The impact of this bridge on Lisbon's economic and social life has been immense. Easy access to the other side of the river led to rapid growth not only of important industrial complexes but also of new cities and large urban areas.

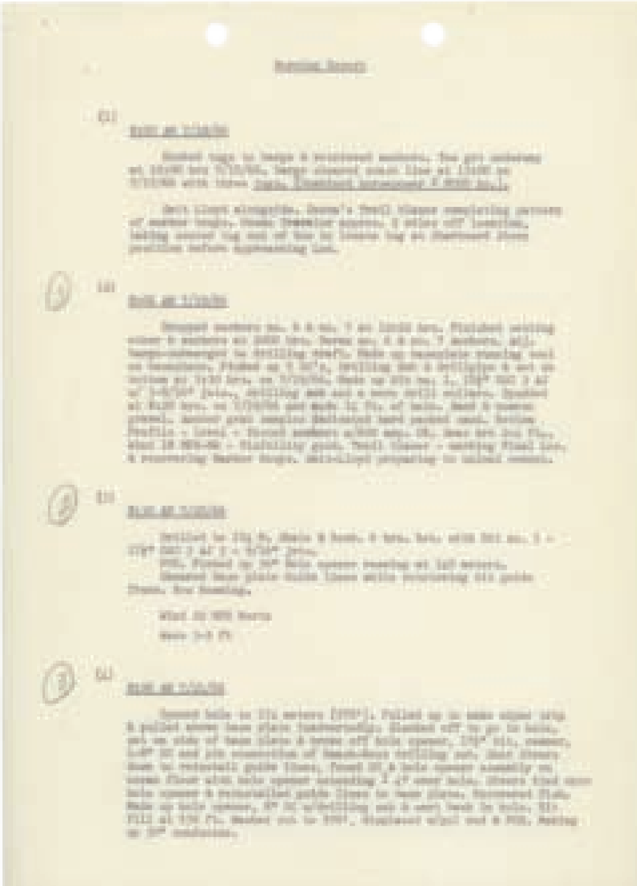
Today, the bridge over the Tagus is one of the most familiar sights in Lisbon, adding a touch of modernity and boldness to a city which is greatly shaped by its long and rich history.

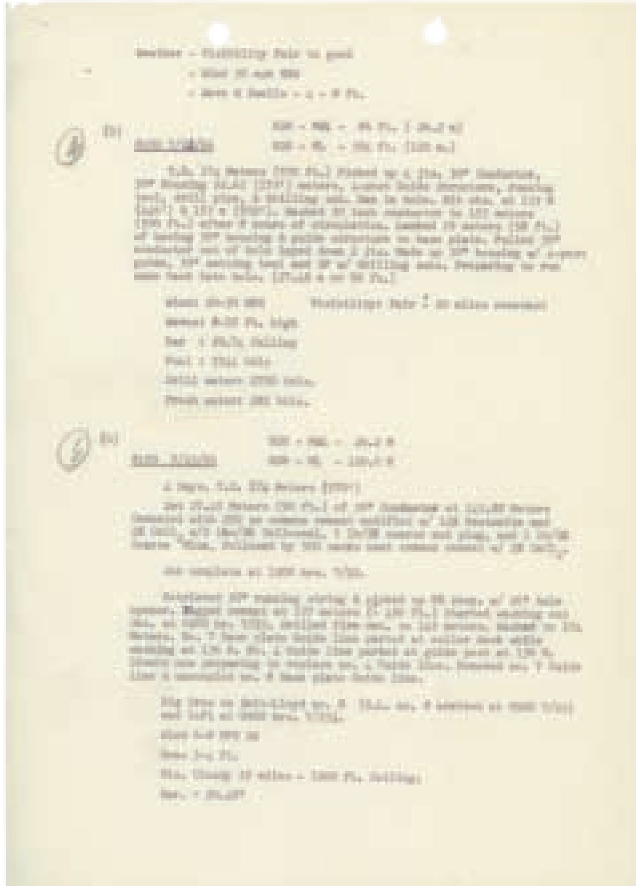
"Lisbon 25 of April Bridge", [Post. 6-8-1966]

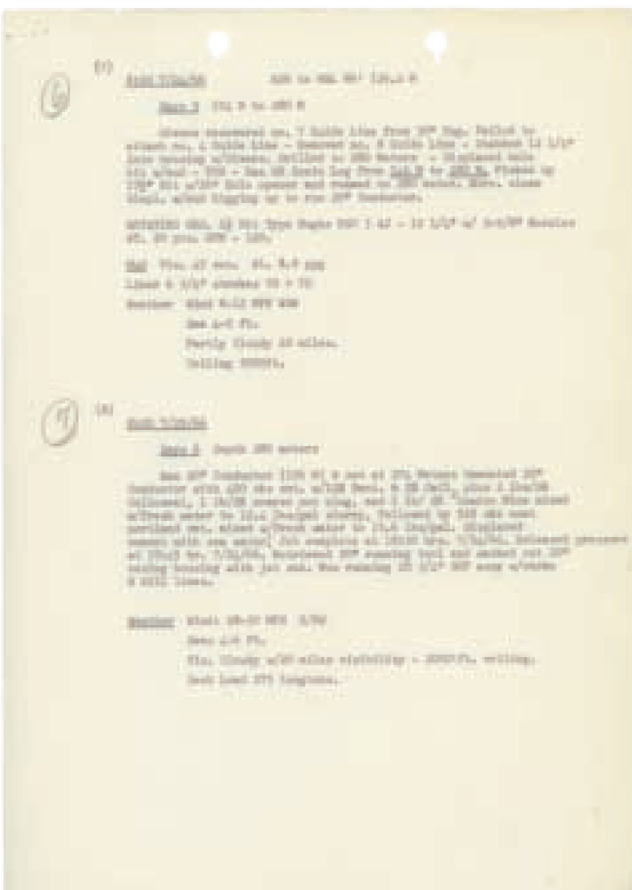
1 black and white photo, paper; 23,2×16,0 cm

Torre do Tombo – National Archives of Portugal

Ref Code: PT/TT/SNI/ARQF/DO-014-002B/52478







First oil drilling on the Norwegian shelf

Norway is the leading producer of oil in Europe today (excepting Russia), and one of the most important producers in the world. This is a relatively recent situation as oil production wasn't in the plan for Norwegian authorities until the 1960s. Things changed rapidly when oil was discovered in the Norwegian continental shelf in the early 1960s, and the first round of licensing of oil activity was announced on 9 April 1965. A total of 11 applications were received by the deadline on 15 June. On 17 August, 78 blocks were distributed on the Norwegian continental shelf.

These documents and photos witness the beginning of oil in Norway. In addition to its obvious relevance in macroeconomic terms, offshore drilling requires outstanding engineering feats, some of which can be discerned in the documents presented. Esso rented a drilling rig in November 1965 from Odeco, one of the world's largest players in offshore exploration drilling. The 'Ocean Traveler' rig was constructed in New Orleans and towed over the Atlantic when it was completed. On 21 June 1966, it entered Stavanger. The size of a football field and 40 meters up from the pontoons to the deck, the rig had to be prepared for the North Sea before it could start drilling. This took a few weeks, but by the morning of 18 July 1966 the platform was ready for drilling.

The platform manager on the 'Ocean Traveler' wrote the Morning Report, a brief summary of the day's events. The document presented is the report from the first trip on the shelf in the North Sea, covering 18-21 July 1966.

Other documents included the 'Daily Drilling Report', a diary of the activities on the rig, recording weather and wind conditions, the crew on board, the condition and status of the rig itself and a summary of the actual drilling. There is a separate geology section in this report where the geologist on board summarises the core samples they have taken from the well.

First oil drilling on the Norwegian shelf,
Morning report 18-7-1966 – 21-7-1966.

2 sheets, paper; A4 size

National Archives of Norway – Regional State Archive in Stavanger

Ref Code: SAS/A-101917 (PA-1512)/E/Ea/L0011, L0012 and L0020

03

TRANSPORT AND NAVIGATION

Pillar 3 in this exhibition charts the perennial impulse to travel, and how it was done. The documents displayed relate to machines, gadgets, inventions, maps, and a variety of other items attesting to Europeans' passion with voyages and exploration. Of special note are the documents relating to long distance sea voyages, and the impact these voyages had on the economic history of Europe along with the story of how we came to discover the geography of the Earth.

The same can be said about land travel, of course. Intense transportation across land and along rivers is a characteristic of the history of Europe and documents about these activities are also present in this Pillar of the Exhibition.

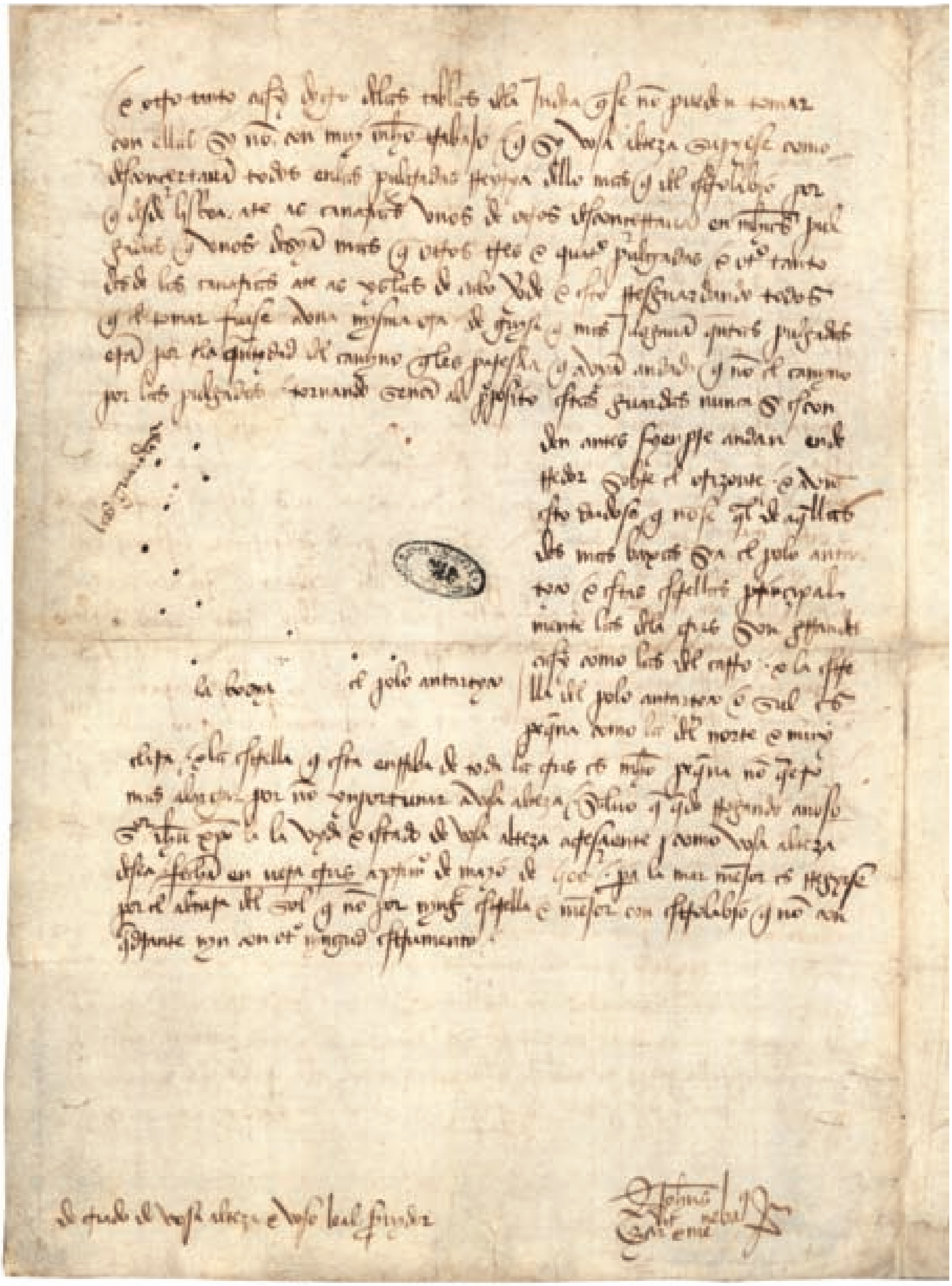
The drive to improve means of transportation is one of the key chapters in the history of technology. The challenges posed by the need for safe and efficient travel stimulated a raft of different technological improvements, many of them a testament to human brilliance and ingenuity.

The history of many regions in Europe is intimately related to sea voyages. Indeed, maritime enterprises played a central role in the political and economic history of Europe, during certain eras. For example, the famous voyages by the Vikings, along with the celebrated 16th century sea voyages during the period of Europe's maritime expansion are important parts of the history of Europe. Along with their economic and political repercussions, these voyages enhanced our geographical knowledge, which is documented in the maps, charts, reports and the history of geography and cartography. Mastering the sea inspired many technological improvements, particularly in ship construction and navigation techniques. But it was not only ships that were involved in sea explorations - as you will see in this Exhibition, diving into the oceans and travelling underwater also has a long story of technological progress. More recent sea voyages are also documented here, such as the celebrated Kon-Tiki expedition led by Thor Heyerdahl, a voyage that combined academic objectives with the allure of a great adventure.

There is more to travel than sea voyages. Rivers have been used for travel in Europe since the earliest times, the preferred route for transporting goods across the centuries. European rivers provided a natural network of communication that was rapidly transformed into an efficient network of commercial routes.

A wealth of ingenuity and engineering talent has been employed throughout the ages to meet the challenges posed by travelling over land. Funicular systems are some of the most spectacular engineering creations, making transportation easier and leaving a permanent sign of humankind's determination to overcome the most difficult obstacles created by nature.

Finally, flight, the most technologically challenging, and perhaps the most adventurous form of transportation. Pursuing the ancient dream of being able to fly like the birds, Europeans spent centuries attempting, and gloriously failing, to fly. Flying machines were being planned and built at the onset of the 18th century, but it would take a while longer before humans could finally master the heavens.



New Lands and a New Sky

The arrival of the Europeans in America, and the opening of maritime commercial lines between Europa and Asia, were epoch-defining events destined to transform the history of the world. Long-distance ocean voyages were the engine of these events and thus at the heart of radical changes in the economic and political configuration of early modern Europe. These voyages were to become the backbone of the empires built by the European powers and it is no surprise that a great deal of thought and work was put into improving them and making them safer.

This manuscript page shows a letter to the King of Portugal, Manuel I, written by one 'Master John' a bachelor in Arts and Medicine, physician on board the fleet led by Pedro Álvares Cabral, that reached Brazilian shores for the first time in April 1500. Instead of describing the luxuriant forests, the exotic indigenous people or the almost unbelievable beauty of the new lands, 'Master John' briefed the King on a number of scientific and technical aspects related to his voyage to Brazil. Specifically, he comments on the difficulties of navigating in the Southern Hemisphere, where the night sky is different to the one in the Northern Hemisphere. He also relates how he measured latitude when sailing in southern latitudes, with no Polar Star in sight. The letter contains one of the first depictions of the Southern Cross, a cross-shaped asterism that sailors could use to identify the South Celestial Pole. It is interesting to note that the king is supposed to understand the astronomical discussion. But the letter is not just about informing the king. Drawing from the experience he had acquired, 'Master John' offers advice to those that will follow. When sailing at latitudes below the equator, he explains, it is better to estimate latitude by measuring the height of the sun, than by measuring the height of stars.

In its apparent simplicity this remarkable letter is very revealing. It shows that, in their voyages, European sailors and seamen were not meeting only new coasts and new lands, but, as a famous contemporary mathematician said, they also discovered "new stars and a new sky".

Letter from Mestre João to king D. Manuel I, 01-05-1500

1 document of 2 folios, manuscript on paper, 31,0×21,9 cm

Torre do Tombo – National Archives of Portugal

Ref Code: PT/TT/CC/3/0002/000002


Decraraçaõ pa saberes as legoas
que vall cada hũ dos Rumos dagulha/
Decraraçaõ pa saber quando he
mea noite pella estrella do norte

A Compilation of Knowledge to cross the Oceans

Starting in the 15th century, several European nations initiated a maritime expansionist movement that led to the creation of vast colonial empires. The Portuguese and the Spanish were first, soon followed by the English and the Dutch, and afterwards several other European nations learned to master ocean voyages and create vast networks of commercial sea routes.

Long-distance ocean voyages posed many technical challenges and great efforts were made to overcome those difficulties, requiring the contribution of professionals from different disciplines. Pilots recorded their experiences, geographers and cartographers produced charts and offered advice, cosmographers wrote treatises, even mathematicians and astronomers were enlisted to help solve the array of problems faced when attempting such voyages.

The document presented here is a collection of diverse texts on the technical aspects of oceanic navigation. Some of these works are attributed to João de Lisboa, a celebrated Portuguese pilot from the first half of the 16th century. Whereas some of the works contained in this document may have been authored by him, it is likely that in other cases he was just the compiler of information that circulated in nautical circles. A particularly noteworthy document covers the use of the magnetic compass on board, the first of its kind. Originally from China, the magnetic compass came into use in Europe around the 12th century, but its behaviour remained something of a mystery for a while after that. It was only by the late 15th century and the beginning of the 16th century that pilots and seamen finally grasped the nature of the compass needle's behaviour, in particular the fact that needles exhibit magnetic variation, i.e. magnetic needles do not point to geographical North but in a slightly different direction, and this difference changes with location.

This document also contains a collection of rutters (sailing directions) for the most important routes from Europe to America, Africa and Asia.

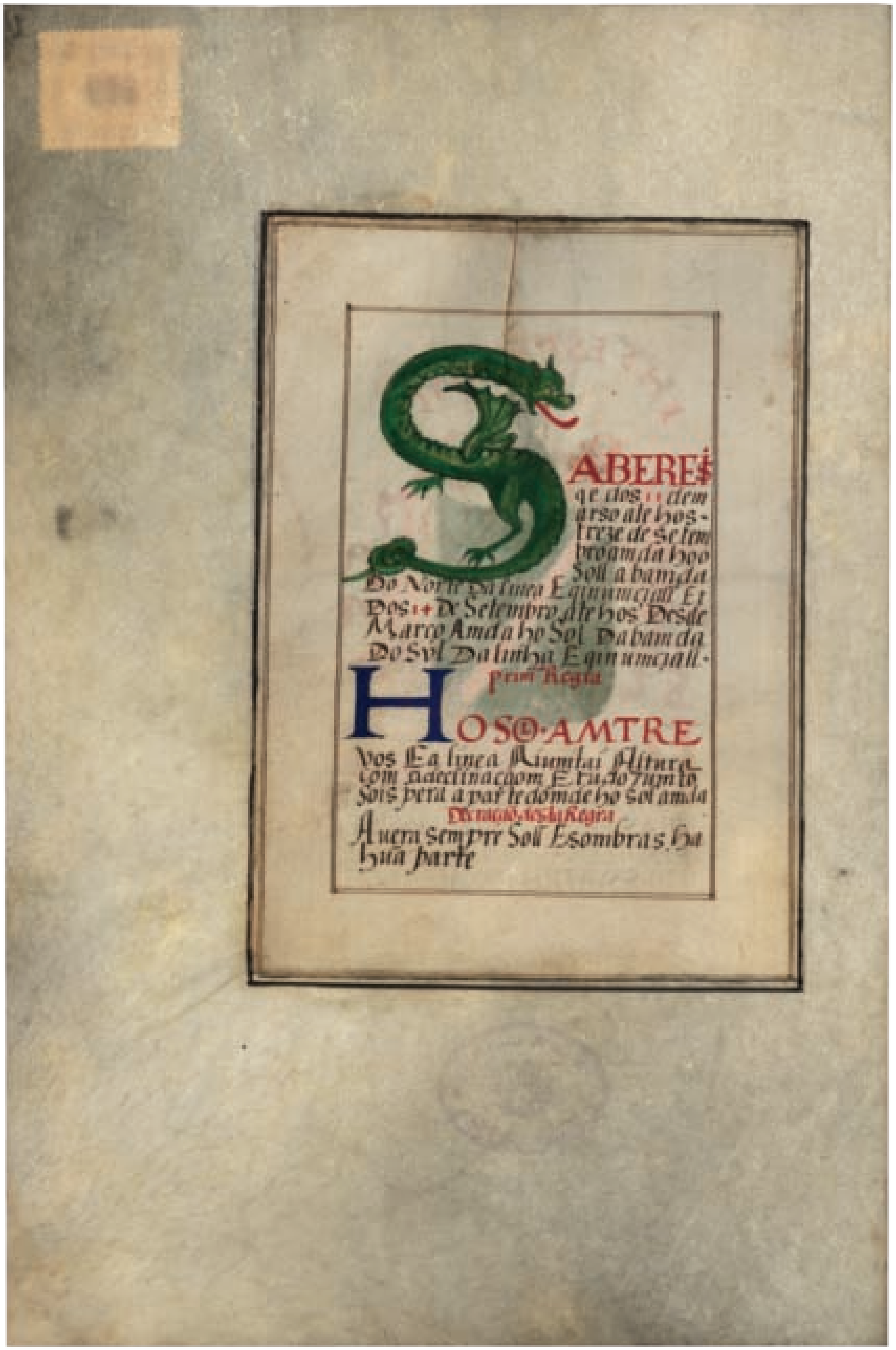
Despite their importance, the texts in this 16th manuscript were not printed. This document reminds us that while some technical literature was printed in early modern Europe, much of it still circulated in manuscript form.

Book of Marinharia, by João de Lisboa, 1560

1 bound volume, manuscript on paper and parchment; 241 folios; 42,5 x 30,0 x 6,0 cm (cap), 40,3×27,7 cm (folios)

Torre do Tombo – National Archives of Portugal

Ref Code: PT/TT/CRT/166



Mathematicians helping sailors

Many scientific and technical developments made during the 16th century, in response to the new needs of oceanic navigation, were adaptations of previously existing procedures. Both nautical instruments and nautical techniques were frequently adapted from instruments and methods that astronomers and astrologers had used for many centuries. One such example was the nautical astrolabe, which is an adaptation of the medieval planispheric astrolabes.

Astronomical techniques were also adapted to solve navigation issues, such as calculating the current latitude, a crucial operation for any venture on the high seas. This process of progressive adaptation was complex and required the joint collaboration of sailors and scholars such as mathematicians, professional groups that had very little in common up to that time.

The manuscript presented here records astronomical data necessary for the determination of latitude. More specifically, it tabulates the values of an astronomical parameter – the declination of the sun along the year – necessary for the determination of latitude on board. Ships going to sea had to carry a considerable number of these technical documents such as rutters and sailing directions, nautical charts, and astronomical tables. In addition, pilots had to be trained how to use them. The text contains the rules for use, framed in rectangular boxes, and numerical tables with the values of declination for the months of the year. It's an uncommon design, where both the rules and the tables are adorned with numerous iconographic elements which provide an unexpected liveliness to the whole document. The capital letters are also coloured.

Manuscripts such as this, collecting the technical information and tables necessary to calculate latitude or aid navigation, were common in the 16th century.

"Regiment of the declination of the sun which goes in letters that mean the name of sir Fernão Lopes Martins Freire de Andrade and his daughter D. Isabel Freire" 1564

1 bound volume, manuscript on parchment, 29 folios; 31,5×21,5×1,5 cm

Torre do Tombo – National Archives of Portugal

Ref Code: PT/TT/MSLIV/0869

Portolan charts and Mediterranean voyages

Portolan charts are perhaps the most iconic cartographic artefacts of the Middle Ages and early modern period. They depict geographical locations around the Mediterranean Sea and were used to assist voyages along its coasts. The first extant portolan chart is the famous Carta Pisana, of ca. 1280, but many others have survived from the centuries that followed. Portolan charts are striking for the amount of information they contain and the detail of their representation of coastal lines. They are also much more accurate than other contemporary cartographic depictions. One of the most characteristic features of portolan charts are the windroses, which indicate compass directions, and the lines that emerge from those windroses, rhumb lines, were used to set the course of ships. Although drawn primarily as technical devices to help pilots and sea captains, it is well known that portolan charts were also used for political and diplomatic purposes.

The portolan chart presented here covers the eastern part of the Mediterranean Sea. It is a fragment of a wider chart, encompassing a larger part of the Mediterranean. It was discovered recently, in 2014, in the inside cover of a collection of documents (Notarial Deeds of Natale Parmesciano). The chart is unsigned and undated. In order to attempt an identification of the author and a probable date for its execution, experts carefully examined its geographical content as well as the place names (toponyms), the style of the handwriting and all visual and graphical clues. Scholars classified this as a fine example of early modern nautical cartography, probably dating to the 1570s, having studied elements such as the representation of cities and flags, along with the remaining fragments of scales and windroses. The prominent Calabrian cartographer, Domenico Vigliarolo is a credible source – at present there are only eight portolan charts in the world which are signed by or attributed to Vigliarolo, who was active in the final decades of the 16th century.

Portolan charts are eloquent reminders of not only the dense commercial network that criss-crossed the Mediterranean since antiquity, but also the effort put into acquiring geographical knowledge and improving cartographical representations in order to make sea voyages safer and more efficient.

Notarial Deeds of Natale Parmesciano, vol 29, 1570

1 page (fragment), coloured map on parchment (calfskin); 56×40 cm

The Notarial Archives of Malta

Ref Code: Notarial Deeds of Natale Parmesciano, vol 29


STREITO·DE·GIBALTAR
OCEANVS·CANTABRICVS·
CIRCVLVS·CANCER·
ITALIA

Painting the World: a Manuscript Atlas

Fernão Vaz Dourado (ca. 1520- ca. 1580) was a Portuguese cartographer who worked in Goa, India. Not much is known about his biography, but it is very likely that he was born and lived there. Goa was an important commercial melting pot at the time, a meeting point for all the peoples, cultures and products circulating in the Indian Ocean. This made it a perfect location for anyone interested in acquiring geographical information about faraway places and making maps of the world.

The item shown here is one of the sheets of an Atlas (depicting western Europe and part of North Africa) produced by Fernão Vaz Dourado, in 1571. The Atlas is a superb cartographic document, one of the finest and most beautiful examples of 16th-century manuscript cartography.

The Atlas is composed of eighteen illuminated folios, in high quality parchment, exquisitely painted by professional hands. Fifteen of these folios are charts of different parts of the surface of the Earth and its oceans, while the other three contain navigational and technical information, such as rules for astronomical observations at sea, tables, etc. This combination of cartography and navigation is not a fluke. In fact, it reveals that the coasts of the world were being charted as a result of sea voyages and these charts were intimately related to maritime expeditions.

Each chart is drawn within a rectangle, along whose sides is written the title of the chart, identifying the geographical area depicted. Each of these rectangles corresponds roughly to 40º of latitude and 50º of longitude. The dimensions of the all folios are very similar and all charts are drawn to the same scale.

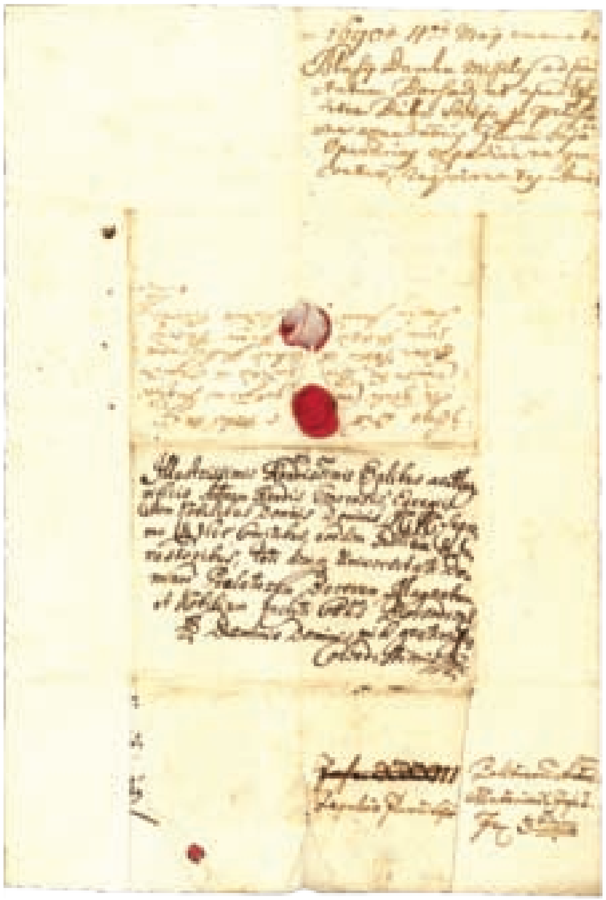
Although Vaz Dourado is the only name attached to this Atlas, it is evident that other people were involved in its creation, especially artisans with different artistic skills.

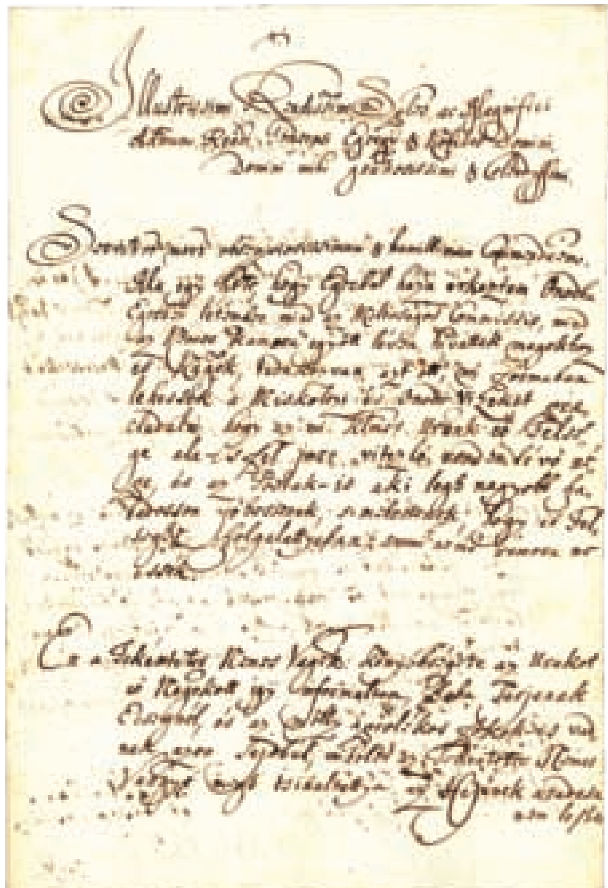
Atlas of Fernão Vaz Dourado, 1571, Goa

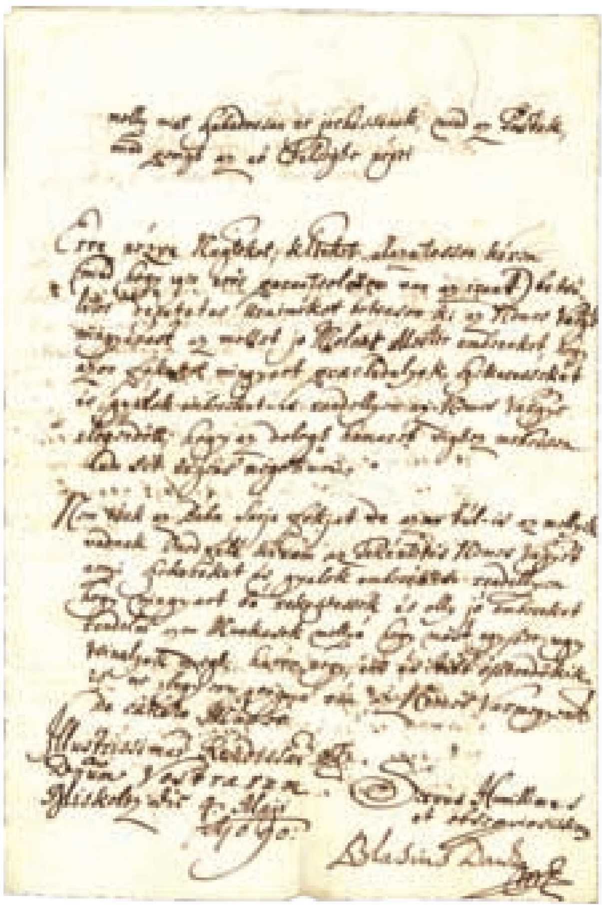
1 volume of 18 folios, coloured maps on parchment; 53,0×40,4 cm

Torre do Tombo – National Archives of Portugal

Ref Code: PT/TT/CRT/165







Diverting Rivers

Controlling the course of rivers and preventing floods has a long history across Europe and the wider world. Indeed, managing water courses was a well-developed engineering speciality in Europe even before a fully scientific discipline of hydraulics was established. Rivers were diverted for many reasons – either to irrigate lands or dry them, to control the river flows in order to avoid floods, or simply to improve transport networks by creating new or more efficient river courses.

The document presented here refers to a discussion about the possible alterations of river courses to improve transportation and irrigation, in Hungary during the late 17th century. It is a three page letter, dated May, 4th, 1690, from Balázs Danka to Borsod County, about three rivers (Sajó, Bába Sára and Hejő) in the towns of Miskolc and Ónod, which hinder traffic in the region.

Balázs Danka informs Borsod County that in Eger, both the dignified Commission (Committee) and the noble Chamber had inquired about how the waters of rivers in Miskolc and Ónod could be diverted so that both His Majesty's subjects and the postal service could move around without obstacles. The letter is a testament to both the importance of the issue in question – altering river courses to improve transportation – and the involvement of regional and municipal authorities in the matter, and the discussions it generated. Engineering interventions such as this will always have a social impact that cannot be underestimated. The letter also provides interesting information on the techniques to be used, the people that should be involved in the works, and the main difficulties such an operation would encounter. The writer revealed that the county would do the "meticulous water-meadow ditches" of the river Sajó, and neither the stream Bába sara nor the stream Hejő would flood at Ecseg. He asked the county to send millers and workers with carts to block the water-meadow ditches. If these works were done all the way down to Ónod, the county would be free from the threat of flooding for the next four or five years.

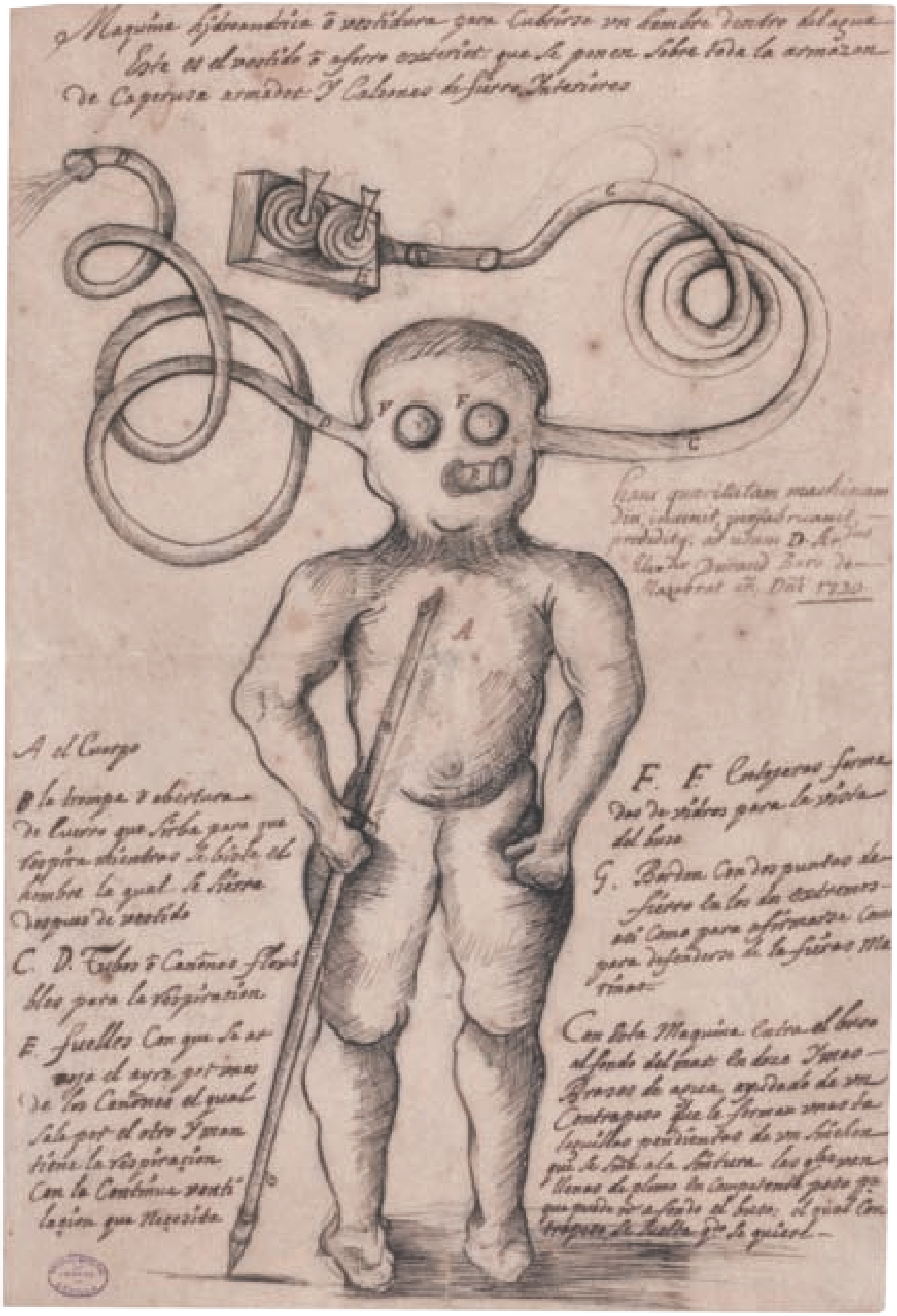
The water-meadow ditches referred to in the letter are openings that interrupted the high river banks, allowing water to exit the river and irrigate the floodplains in the surrounding flat areas. Water movement was reversible thus bringing stagnant waters back into the river; in addition, the ditches could be widened or narrowed to control irrigation of the surrounding terrain.

Letter from Balázs Danka to Borsod County, about the rivers – Sajó, Bába Sára and Hejő – of towns Miskolc and Ónod, which hinder traffic in the region, 4-5-1690, Miskolc

3 pages, manuscript on paper; 31×21 cm

Borsod-Abaúj-Zemplén County Archives of the National Archives of Hungary

Ref Code: HU-MNL-BAZML – IV. – 501/b. – X. – I. – 3


A el Cuerpo

A Garment for Underwater Exploration

Underwater exploration has a very long history. Free-diving (to collect food or other sea products, such as sponges or pearls) took place since early antiquity in the Mediterranean Sea and in many other regions and seas around the world. The idea of using a contraption such as a diving bell to allow someone to remain underwater for extended periods has been with us for a long time. The limitations of these devices were well known; the methods used to provide air to the diver were very primitive and frequently led to fatalities. It was only in the 16th and 17th centuries that more sustained efforts were made to design and construct equipment for underwater work, but the question of providing air to the diver remained problematic.

In the 18th century different models of diving suits were proposed and different breathing systems were also developed. Systems that pumped air to the diver were designed, allowing greater autonomy for the diver underwater. One such development is documented here, a project for an underwater garment that was presented in 1720 in Spain. It is titled 'Máquina Hydroándrica o vestidura para cubrirse un hombre dentro del agua', a 'Hydro Andric machine or garment to cover a man inside water'. Actually, as the document explains, only the external layer is presented here, to be used over the whole body armour, with hood and iron breeches.

The new hydro andric machine or underwater garment is described in considerable detail in the document. Different parts are labelled with alphabetical references, on both sides of the document, and descriptions relative to each label are provided. The concept and fabrication is attributed to one Alexander Durand.

Hydroandric' machine or underwater garment: this is the external layer over which the structure for the head, the doublet, and the inner iron breeches were disposed, 1720

1 sheet, manuscript with drawing on paper; 41,5×28,2 cm

Spanish State Archives – General Archive of the Indies

Ref Code: ES.41091.AGI//MP-INGENIOS,248

Submarine for attack, 1808

1 sheet, manuscript with drawing on paper; 15,94×36,27 cm; 2 colour photos of a wooden object 27,15×40,84 cm and 26,78×40,51

National Archives of Norway – Regional State Archive in Bergen

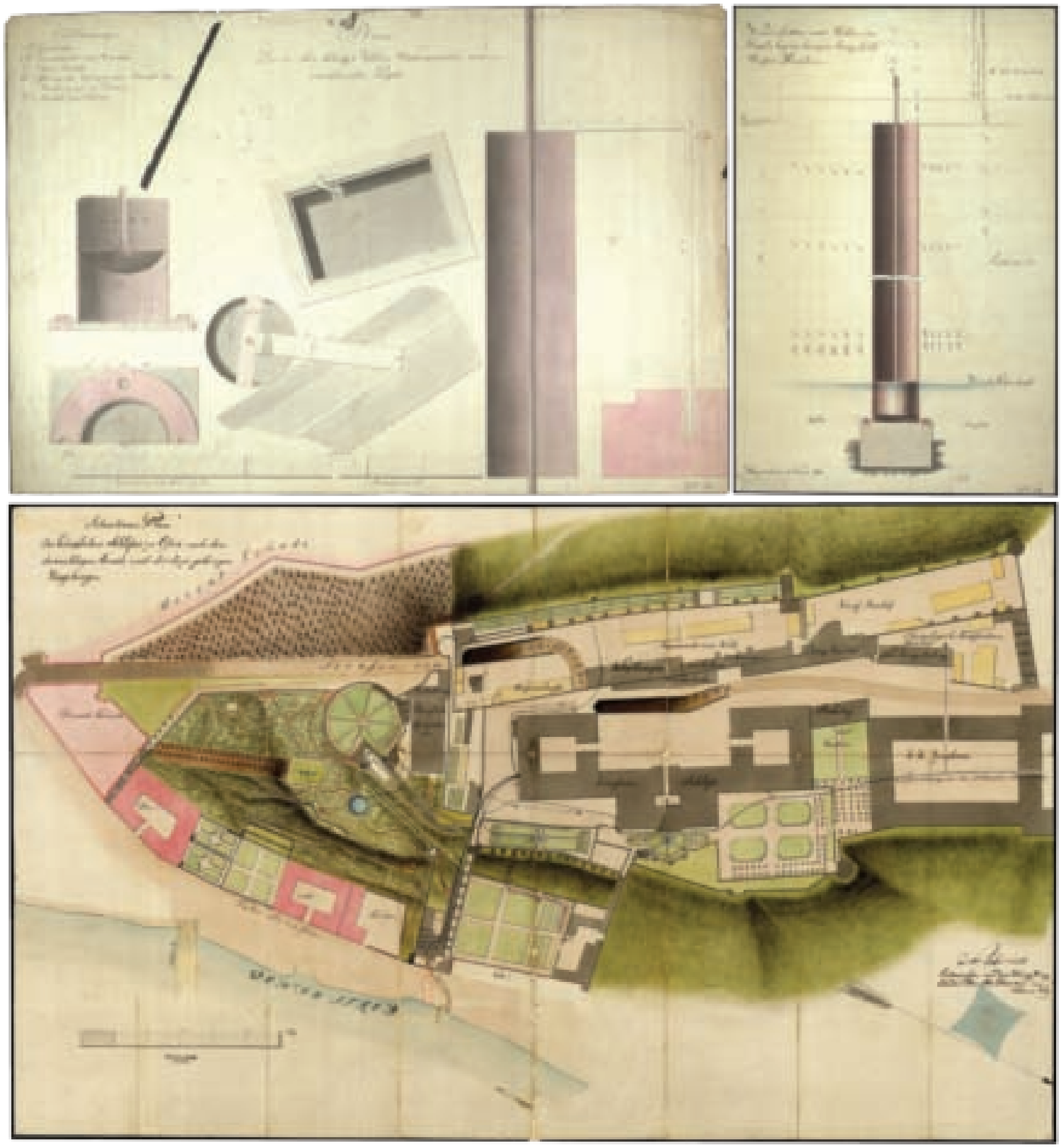
Ref Code: SAB/A-100006/Eb/0048

An Attack Submarine in 1808

Design concepts for submarines and submersible boats have been with us since the Middle Ages, but genuinely feasible proposals didn't emerge until the 16th century. These were completely enclosed wooden vessels, sheathed in waterproofed leather, that could be submerged. They also included some type of mechanism that would allow for rudimentary manoeuvring. It's extremely doubtful that any of these proposals ever reached the construction stage. Functioning submarines have however been documented since the 17th century, including those designed and constructed by Cornelius Van Drebbel, a Dutchman in the service of James I of England. Throughout the 17th century, several inventors planned increasingly sophisticated submarines and by the mid 18th century over a dozen patents for submarines had been granted in England alone. The proposed vehicles had a variety of uses and it is clear that military applications were a key attribute. Indeed, during the 18th century several projects for military submarines were presented and these culminated with the planning and construction of the famous *Nautilus*, in 1800, by Robert Fulton in France.

In June 1808, the City Council member Bull in Bergen, Norway, received drawings and plans for a submarine designed to attack enemy vessels. Denmark-Norway was at war, with Norway under blockade by English ships, preventing vital supplies of grain, among other things. Mikkel Hallsteinsson Lofthus (1782-1850), a mechanic from Ullensvang outside Bergen submitted the drawings of the submarine. His sketches aroused great interest and he also made a model of the boat that he offered to build. The submarine was to be driven forward by three pairs of oars, and it would move up and down in the water by moving the weight inside the boat back and forth. The submarine would include air intakes and hooks that could seize enemy ships in order to drill holes or attach mines.

The evaluation of the merits of this proposal generated a considerable discussion. While many were eager for the plan to be implemented, the County Governor, after advice from military experts, concluded that the plan was unrealistic. The discussion was not closed until 1815. However, Mikkel Hallsteinsson Lofthus did get the Dannebrog Order, a Danish Order of Knight, probably for his initiative and plans for the attack submarine.



Plans of the first water level gauge (Plan des in der königsSchloss Wasser maschin neu zu errichtenden Pegels, Niveau Cotten sammt Höhen, des Pegels, bey der hiesigen könig. caal Wasser Maschine), [1817]

2 sheets, coloured, hand-drawn plans; No. 1/73: 30,5×45,6 cm; 1 map 99×66 cm

National Archives of Hungary

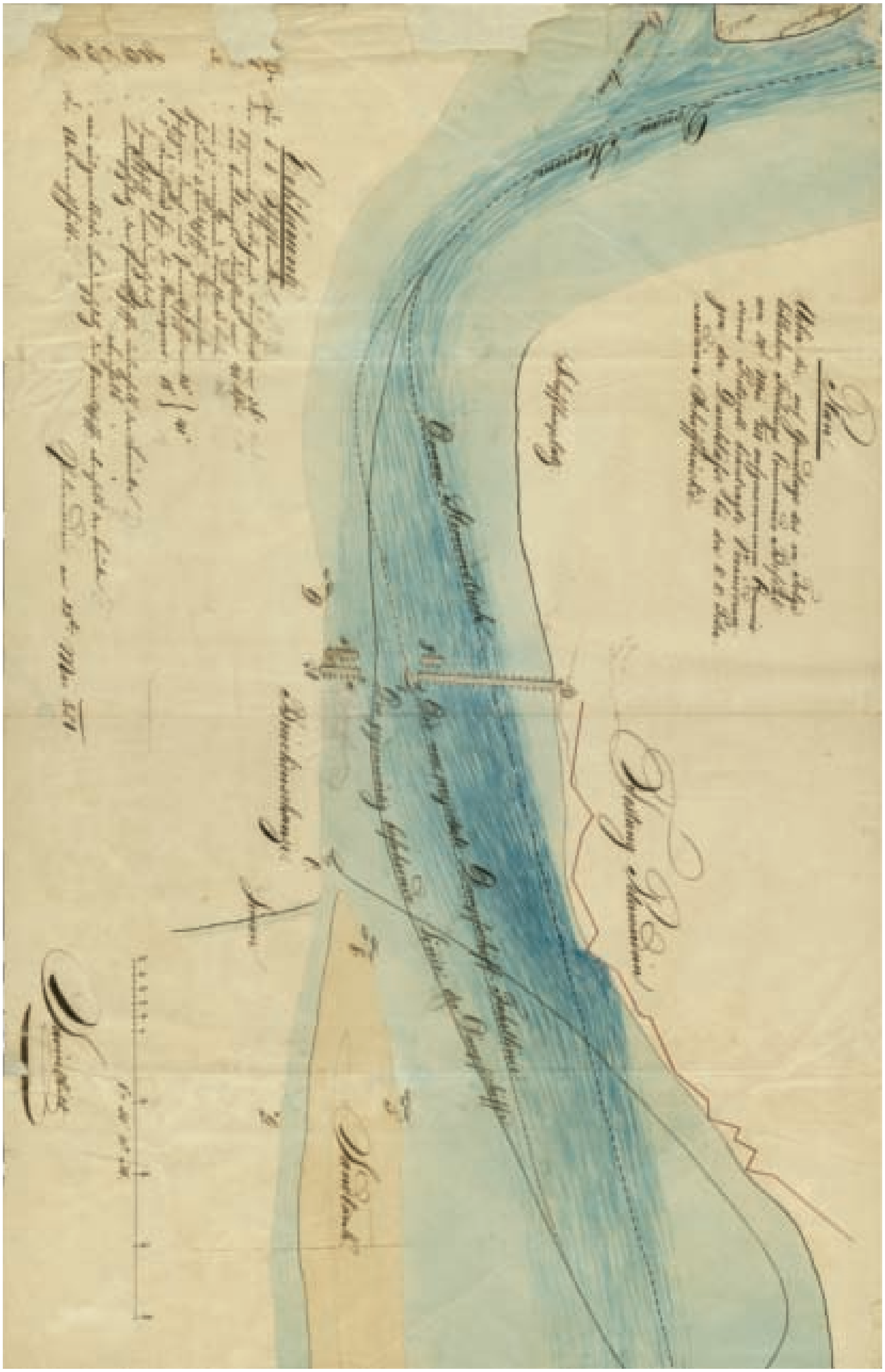
Ref Code: HU-MNL-OL – T 14 – № 1/72, 1/73; HUMNL-OL – S 11 – No. 1541/03

Plans for the first water level gauge

Europe has had a long history of works related to water management and hydraulic engineering. By the latter decades of the 18th century, water level measurement was recognised for its importance in terms of navigation and river regulation, particularly for transportation planning, flood prevention and irrigation. However measurement techniques and instruments were poorly standardised, with irregular designs.

In 1816, Johann von Svoboda, director of the State Direction of Water and Construction (*Directio in hydraulicis et aedibus*) in Hungary, applied for the cost of producing two reliable water level gauges. The State Direction of Water and Architecture had been founded in 1788, by King Joseph II, in order to supervise river regulation, road and bridge construction, and other civil engineering works. It was subordinated to the supreme interior organ, Royal Hungarian Council of Governors.

Svoboda's request, directed to the Hungarian Royal Chamber and the Royal Hungarian Council of Governors, asked for the funds and presented a specific new design for the desired water level gauge. The vertical water gauge was supposed to be fixed to the ground, but it could not be set directly on the Danube or in the riverbed. It was attached instead to the front channel of the Danube of the Royal Waterworks (near Buda Castle), which was directly connected to the river. The water meter gauge was prepared by Gregor Huck, a master from Vienna.



A new waterway route on the Danube

Rivers have been used for transport since time immemorial. Long before the modern and efficient networks of highways and even before ancient roads, rivers were used as routes for trade and the movement of people and goods. Even today, rivers retain their economic and social importance as transport routes all over the world.

The main rivers traversing Europe have been significant waterways since ancient times, including of course the Danube, Europe's second longest river. Originating in Germany, the Danube crosses Central and Eastern Europe, flowing today through 10 countries before draining into the Black Sea. It was one of the most important trade routes in Europe, crossing a collection of important towns that included four capital cities (Vienna, Bratislava, Budapest, and Belgrade). The Danube is 2,850 km in length, and most of it (2,415 km) is navigable.

Economic development and ever-greater industrialisation generates a dramatic increase in the levels of river traffic. Various bodies and institutions were created to regulate river transportation and to determine routes which had to be approved and controlled in the interests of safety and efficiency.

The document here shows the plans for a new waterway route on the Danube, near the pontoon bridge, between Petrovaradin and Bruckschantz (today part of Novi Sad, Serbia), dated 22 May 1851. It is the protocol for a new steamboat route, requested by the Command of the Fortified place of Petrovaradin. The new waterway route is indicated by a dashed line on the map.

Project of the new waterway route on the Danube, near the pontoon bridge, between Petrovaradin and Bruckschantz (Novi Sad) 22-5-1851, Petrovaradin (today part of Novi Sad, Serbia)

1 sheet, manuscript and coloured drawing on paper, 49×32 cm

Historical Archive of Vojvodina of Novi Sad (Serbia)

Ref Code: RS 002 F. 373 190

Viking Ship, Ship: ca. 820 ; photo: 1904, Oseberg, (Tønsberg, Norway)

1 black and white photo

National Archives of Norway

Ref Code: RA / S-1021 / Ej / L0697

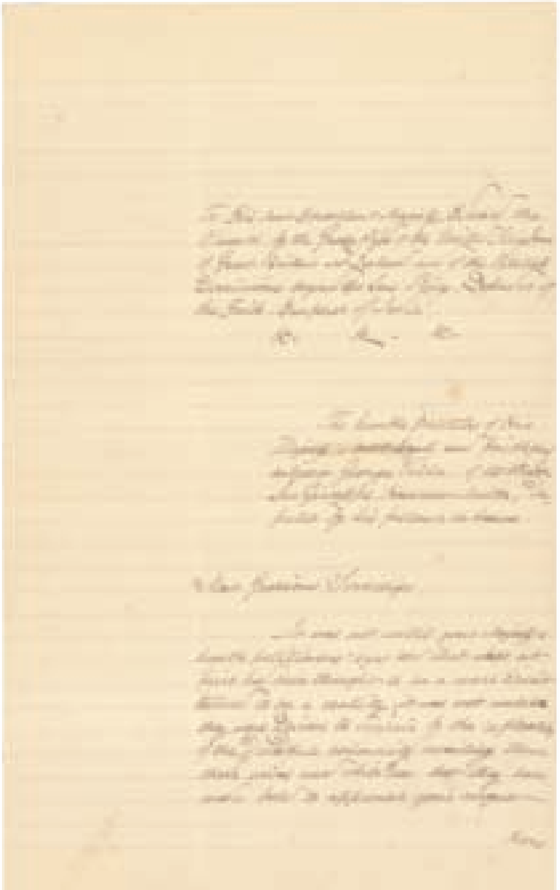
Viking Ship

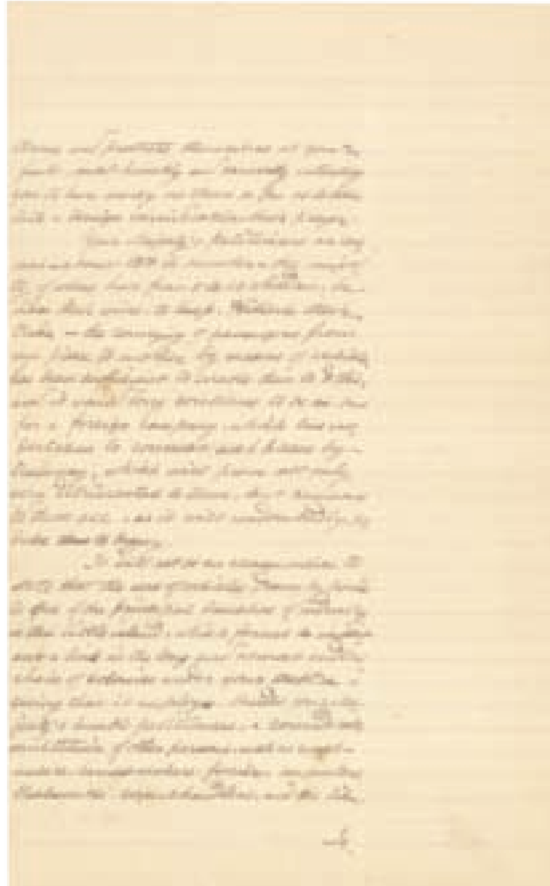
The term 'Viking Ship' refers to a large category of Nordic wooden vessels built and used by the Vikings, during the era that bears their name, 800-1050 AD. The Vikings were feared and admired across Europe; their voyages and their incursions remain the stuff of legend, and their ships were almost as famous as the Vikings themselves.

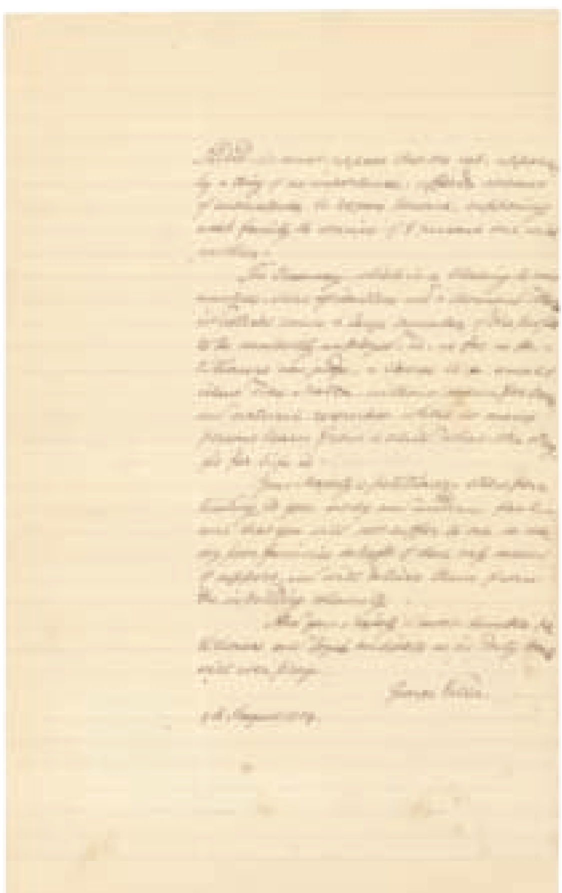
Viking ships of all types were known for their technical and artistic perfection. The design varied, depending on whether they were intended for military or commercial use. Most Viking navigation was coastal or along rivers, but, as is well known, they sometimes engaged in deep sea voyages, with ships designed for Atlantic navigation sometimes known by the Norse term 'Knarr'. Viking ships were fast and manoeuvrable, with the strength to survive ocean crossings and a draft as low as 50 cm, allowing navigation in very shallow water. These features made it possible for the Vikings to cross large sea areas, while the flat bottom made it possible to sail into shallow coves.

Remains of various Viking ships have been discovered in modern times and three Norwegian ships have been excavated: the Oseberg ship (ca. 21.5m), excavated in 1904-05; the Gokstad ship (ca. 23.3m), excavated in 1880; and the Tune ship (ca. 18.7m), excavated in 1867. They are quite well preserved, along with other finds in Viking tombs around the Oslo Fjord. These ships are to be found today in the Viking Ship Museum, in Oslo. Built in the 800s, they were ocean going vessels before they were hauled onto land to be used in burial rituals for their wealthy owners.

The discovery of these ships greatly enhanced our knowledge of Viking shipbuilding techniques and their navigational capacities. But more has been learned. Skeletons were also discovered along with the ships, and a great quantity of grave goods, ornaments and funeral paraphernalia, which not only indicate opulent rituals, but also broaden our understanding of Viking religious and cultural practices.







Petition to HM the King by George Vella on behalf of cabmen

Innovation is not always welcome. The Malta tramway was inaugurated on 23 February 1905, with Mgr Pietro Pace, the bishop of Malta, blessing all sixteen new trams as three of them made the inaugural trip to Valletta. Newspapers reported that an enthusiastic population were keen to ride on the new trams, and the profits of the first two days (£50) were donated to charity. However, not everybody was happy. The new trams were in direct competition with the cabs, boats and railway.

However, six months later, on 9 August, George Vella submitted a petition to the King denouncing the "dreadful calamity" that had fallen on the 1,800 cabmen, "the majority of whom have from 5 to 10 children, besides their wives, to keep."

Vella claimed that cabmen, their wives and children "were driven to despair", adding that "it must appear that the cab, apparently a thing of no importance, affords means of subsistence to 25,000 persons". He concluded, "trusting to your mercy and wisdom, feel sure that you will not suffer to see so many poor families bereft of their only means of support, and will deliver them from the impending calamity."

The petition was eventually submitted to the King and on 7 September the local authorities were informed that "the king has not been pleased to give any directions". Twenty-five years later, the tramway had to face the cab's fate. Unable to compete with buses and the car, the Malta Tramway shut down on 15 December 1929. Several of its employees petitioned the Prime Minister, asking for jobs, compensation and free instruction in car driving, similar to that offered to cabmen who had suffered from the tram competition.

Petition to HM the King by George Vella on behalf of cabmen, 9-8-1904

3 pages, manuscript on paper, 20,4×33,0 cm

National Archives of Malta

Ref Code: NAM/CSG02/879/1904

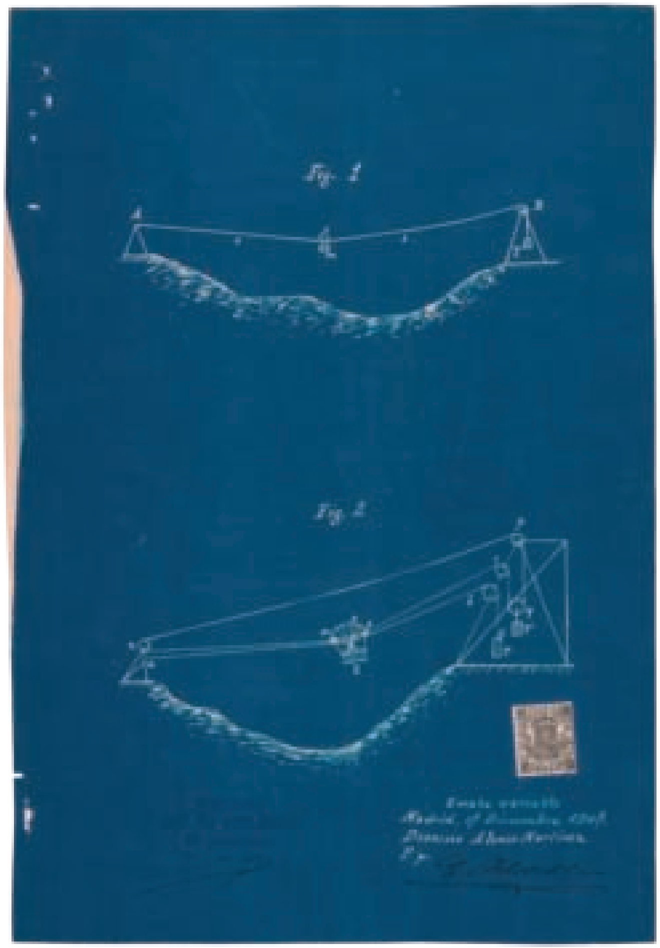


Fig. 1
Fig. 2

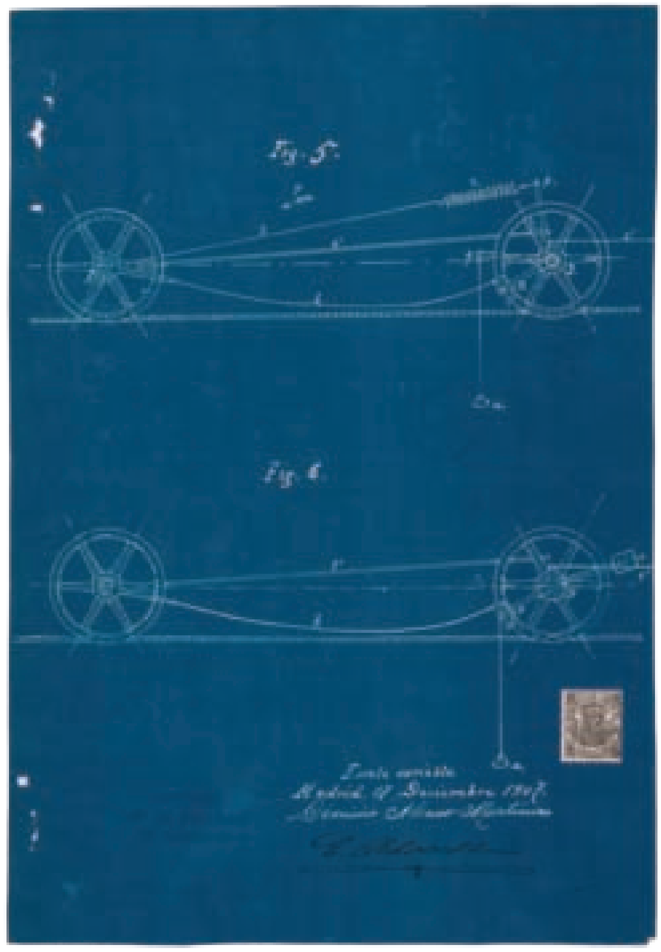
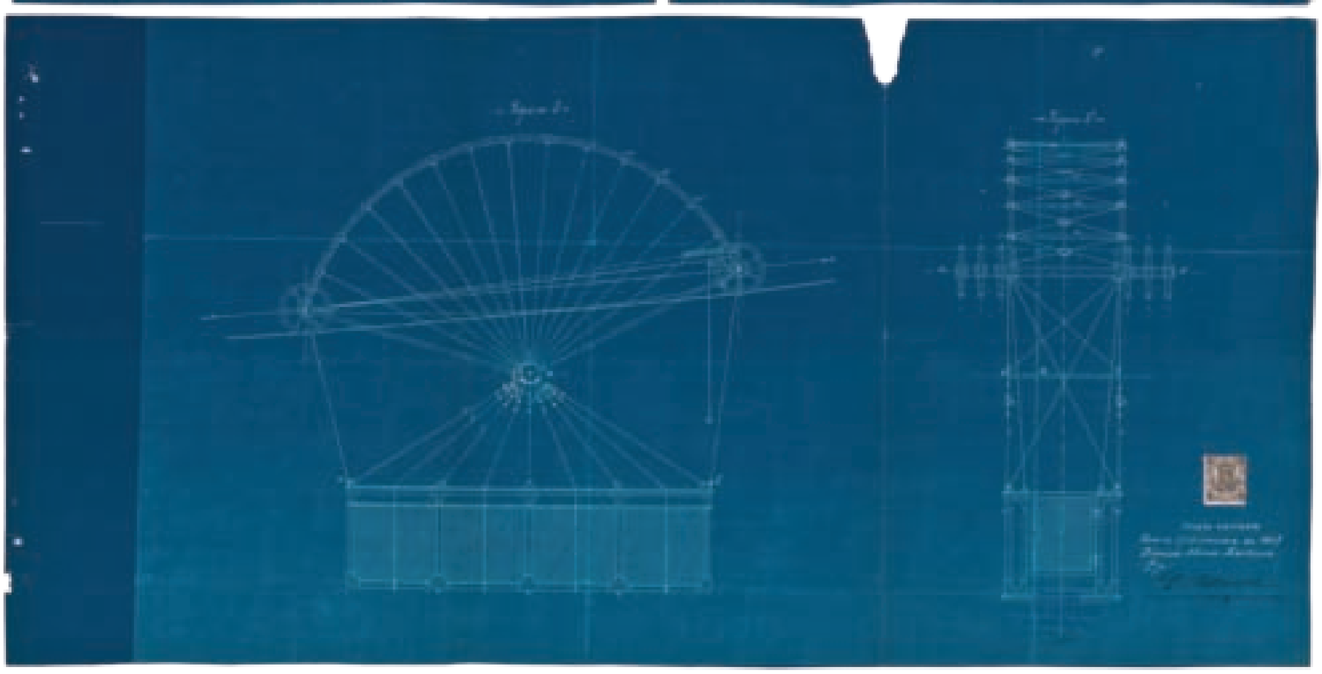


Fig. 5
Fig. 6



Funicular railway system

Leonardo Torres Quevedo, born to a well-off family in Santa Cruz de Iguña (Cantabria), studied in the Official School of the Civil Engineers between 1871 and 1876. He developed a type of aerial cableway for the transport of people. The first tests, carried out in the Iguña valley, were a success and the invention was patented in France, Switzerland, England and the United States.

Another of his inventions presented here was a new system for ferries, patented in December 1907, proposing what would in time become the Spanish Aerocar used in the cataracts of the Niagara. The invention proposed several innovations in the cable system using a cable with greater sections and more flexibility. His final invention for funiculars was the automatic hitch and brake for aerial ferries, patented in January, 1915.

Funiculars were only a part of Leonardo Torres Quevedo's immensely productive life. Between 1891 and 1900 he devoted himself to the development of analog computers or calculating machines; in 1902 he focused his attention on balloon dirigibles, on which he formulated a theory related to stability.

Another of his remarkable inventions was the telekino, developed to direct flights from the ground without the need for human pilots, which was the world's first radio-direction or direction guidance device. As a result of this invention, he developed his calculating machines and his automatons. Of the latter, he said, "They will have senses (devices sensitive to external circumstances), they will have members (devices capable of executing operations), they will have the necessary energy and, in addition, and above all, they will have the capacity for discernment (main purpose of the automatic), of choice between different options".

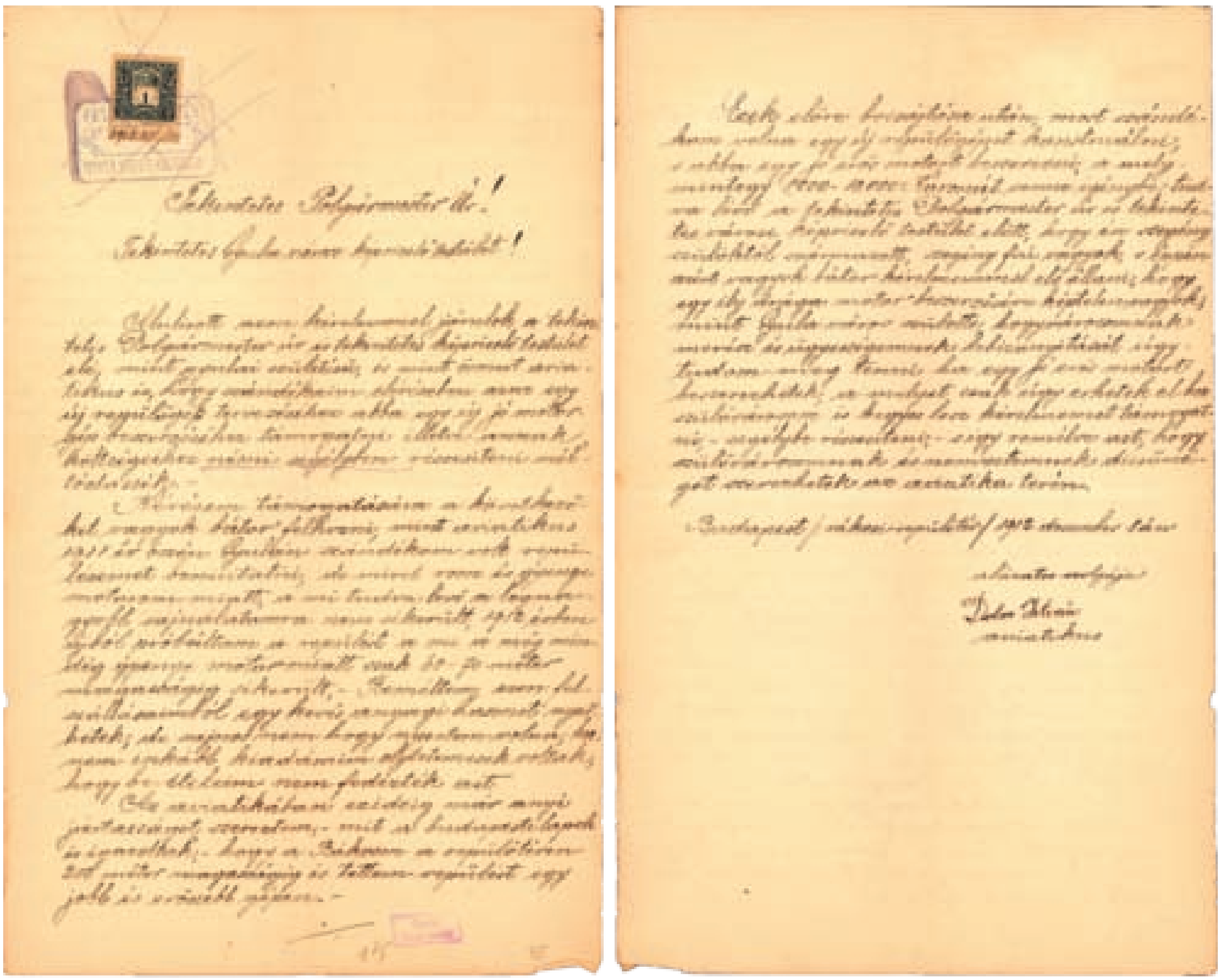
Torres Quevedo received numerous distinctions during his life. In 1920 he joined the Royal Spanish Academy. He was distinguished by the Academy of Sciences of Paris and was awarded several distinctions, including Associate foreign academician of the Academy of Sciences of Paris, Honorary Academician of the Société de Physique et d'Histoire Naturelle, de Genève, Doctor honoris causa by the University of Paris and commander of the French Legion of Honour. He died in Madrid on December 18th, 1936.

Funicular-railway system and car or vehicle therefor, 17-12-1907, Madrid (application date), 26-12-1927 (expiry date)

65 sheets of paper (application), 3 white and blue drawings on paper (plans); 32,5×22,8 cm

Spanish Patent and Trademark Office OEPM

Ref Code: Archives of the Spanish Patent and Trademark Office ES42237


Tekintetes Polgármester Úr!

Tekintetes Gyula város képviselő testület!

Budapest / rákosi repülőtér / 1912 december 8án

alázatos szolgája

Dobos István

aviatikus

Letter from István Dobos to the Mayor of Gyula, asking for financial support for his new machine that needs a suitable engine, Record date: 8-12-1912, Budapest (Aerodrom in Rákos) , Photo date: between 1914-1918

2 pages, manuscript on paper, with stamps,

Békés County Archives of the National Archives of Hungary

Ref Code: HU-MNL-BeML – XV – 77 – Dobos István

Letter from István Dobos to the Mayor of Gyula

The history of flying is filled with adventure, invention and tragedy. The early decades of the 20th century were an especially lively and heroic age, witnessing major breakthroughs in aviation.

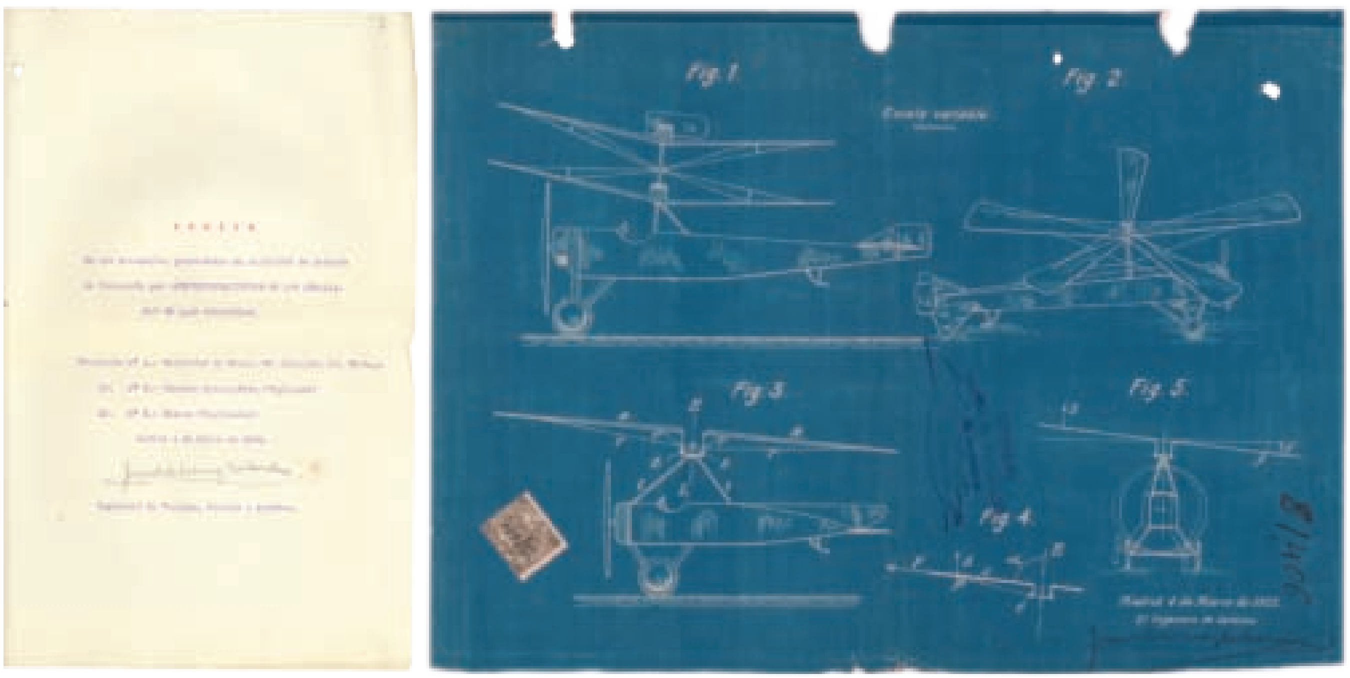
On 8 December 1912, István Dobos (1892-1937), born in the city of Gyula, in Hungary, and at the time a young and ambitious aviator, wrote to the Mayor of his home town. Dobos told the Mayor that he had been carrying out experiments in the Rákos Airfield, but that results had been disappointing due to inadequate motors on the planes. He added that he did not have the finances to acquire the necessary materials to improve the motors. As a citizen born in the city of Gyula, he pleaded with the Mayor and other authorities to help him in his endeavours, concluding, "I hope that I can get my home town and nation a glory in aviation".

Dobos fulfilled his dream, bringing glory to his home town and nation with his aviation feats. Having sat his pilot's exam in 1910, he became a member of the Hungarian Aero Club which had been founded in that same year, and started his career as a pilot. He didn't achieve immediate success. His first aeroplane, built by him and another pilot, was shattered. As a pilot, he travelled around the country promoting aviation. He was successful in several races and set some new records, reaching 1850 metres of altitude in 1914 , breaking the previous record of 1240 metres. In 1919, he made a unique flight with a Hansa-Brandenburg C.I reconnaissance biplane, travelling twice the Kiev-Budapest trip in eight hours of flight time. In the 1920s and 1930s, having been excluded from the Aero Club, he worked as a private pilot for Count József Wenckheim.

His death was tragic, but not wholly unexpected for someone leading such an adventurous life. He died on 1 June 1937, the result of an accident with an M19 type plane, designed by Ernő Rubik.

(Above) Portrait photo of István Dobos

Békés County Archives of the National Archives of Hungary



Improvements in airplanes with rotating wings, 18-4-1922 (application date) 1-1-1937 (expiry date)

45 pages on paper (application), 1 white and blue drawing on paper (plan); 21,2×34,1 cm

Spanish Patent and Trademark Office

Ref Code: Archives of the Spanish Patent and Trademark Office ES81406

Improvements in airplanes with rotating wings

Juan de la Cierva y Codorníu was born in Murcia, Spain in 1895. Interested in engineering from a very early age, he constructed prototypes of airplanes and helicopters along with a group of his friends. By 1910, aviation had arrived in Spain and the youngsters were already conducting trials with the first BCD glider model near the Castellana racecourse. Together with his friends he built the BCD1 (‘Cangrejo’), the first Spanish airplane that can be said to fly.

After some failures with traditional designs, Juan de la Cierva directed his attention to a different type of aircraft – these had rotating blades instead of fixed wings, allowing them to remain in motion at low speed. Thus he conceived the idea of autorotation, and he baptized this machine as ‘Autogyro’.

In 1921 he was fully focused on his work on the Autogyro. Having solved a number of structural problems with axial transmission and the blade's design, by April of 1922 he was submitting patents concerning the paddling of blades. The device with the new improved characteristics was named the C.4 model, which was flight-tested in June 1922, with disappointing results. It would take until January 1923 before the first sufficiently stable flight of C.4 was achieved, after which Juan de la Cierva dedicated himself to building a new version, the C.5. Other models followed the C.5, with de la Cierva building more than twenty different versions of these Autogyros of Spanish origin.

The technical legacy of Juan de la Cierva is reflected in the more than 120 patents related to the Autogyro that he recorded during his life. Only ten percent of these patents are Spanish, as about thirty patents were registered in the United States, as many again in the United Kingdom, twenty in France, fifteen in Germany, and a smaller amount, in other countries (Switzerland, Denmark, Ireland and Austria). In 1932, by virtue of the merits obtained in the aeronautical field, Juan de la Cierva was awarded the Gold Medal of the International Aeronautical Federation.

He died on December 9th, 1936, in an aircraft accident at Croydon airport in England.

The Kon-Tiki expedition, 1947

1 black and white photo

Thor Heyerdahl. Photo: Bjørn Fjørtoft, Billedbladet NÅ;

Kon-Tiki Museum

Ref Code: The Kon-Tiki Museum

The Kon-Tiki Expedition

The Kon-Tiki expedition in 1947 was one of the most famous and celebrated maritime expeditions of the 20th century. In an astounding feat of navigation, a crew of six sailed 8,000 km across the Pacific Ocean in a hand-built raft, from South America to the Tuamotu Islands, in Polynesia. The voyage started on 28 April 1947 and ended on 7 August. During those 101 days, the crew manned a raft built with the materials and technologies available to South American seafarers of pre-Columbian times. The expedition's goals were not simply adventurous; they had a specific scholarly objective, to demonstrate that ancient peoples could have made long sea voyages, creating contacts between separate cultures. This was linked to a diffusionist model of cultural development.

The intellect and driving force behind the expedition was the Norwegian explorer and ethnographer Thor Heyerdahl (1914-2002), who also had a background in zoology, botany, and geography. The Kon-Tiki was not his only expedition. He made four oceanic trips in primitive vessels to demonstrate his theories that ancient civilisations may have spread from a common source through sea voyages. Also notable was the Ra II expedition of 1970, when he sailed from the west coast of Africa to Barbados in a papyrus reed boat.

His expeditions on primitive rafts and boats were documented in books, films, and television programs, and helped popularise Heyerdahl's feats and ideas; he generated huge public interest in the possibility of travelling vast distances at sea in primitive vessels, in order to make links between ancient cultures. His Kon-Tiki voyage in 1947 established Thor Heyerdahl as one of the modern world's most renowned explorer-adventurers. More than a dozen books about his adventures have sold tens of millions of copies worldwide. His work has included several documentary films and hundreds of articles for journals and magazines. Heyerdahl received numerous distinctions and was appointed a government scholar in 1984.

But while he garnered more popular attention than any contemporary anthropologist, the scholarly reception of his ideas has been controversial, and the scientific community has rejected some of his theories.

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